(ESTABLISHED 1832.)

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AMERICAN ENGINEER AND RAILROAD JOURNAL.

JANUARY, 1904.

RAILWAY SHOPS.

BY R. H. SOULE.

IX.

THE POWER PLANT.

The electric power plant as a feature of railway shop practice is a product of the last ten years, but there are now a sufficient number of such plants to indicate the general trend of design, and to emphasize those conditions and requirements which are peculiar to the service. Electric power is usually needed for transfer tables, traveling cranes, tools, fans, lighting; in addition to the steam being required as motive power for these purposes, it is also required for air compressors, pumps, hammers and heating; the latter of course only when the supply of exhaust steam is insufficient for the purpose.

The size and capacity of the plant are determined by totalizing the demands for power both internal and external to the building. Beginning with the electric generators, their capacity is ascertained by adding the total fan load and total lighting load, and then a percentage of the total rated capacity of motors used for other purposes; this added percentage may range from 30 to 60 according to whether there are few or many traveling cranes, and the kind and frequency of service they are likely to be called on to perform. To the total so arrived at may be added a percentage to cover distribution losses, growth, and contingencies, this latter percentage of course being largely influenced by local conditions.

Taking the total generator capacity in kilowatts, but expressing it in horse power, it is divided by 0.85 (assumed factor of efficiency for direct connected sets) to determine the necessary equivalent engine horse power, to which is commonly added 25 per cent. in order to have power available for at least a portion of the overload capacity of the generators. Many railway shop power plants hitherto built have provided a very large excess of power over what has actually been required in service; with the experience now accumulated, this is not so likely to recur in the future.

The boiler capacity may be worked out by assuming a rate of steam consumption suitable to the size and type of engine to be used; under present conditions it is probable that the steam consumption per horse power per hour should be taken somewhere between 15 lbs. and 20 lbs. according to the degree of refinement in the engine design. Fifteen lbs. seems far in excess of the 9 lbs. minimum which has been recorded in a few cases in exceptional plants, where triple expansion was used with superheaters and reheaters; but 15 lbs. is a fair minimum for purposes of estimate for every day service under commercial conditions, as compound non-condensing engines are what we now generally find. It is probable that the future has something better in store for us, but we are dealing with present conditions.

Unfortunately boiler horse power and engine horse power are not synonymous terms, as a boiler horse power is simply the capacity to evaporate 30 lbs. of water into steam from temperature 100 (degrees Fahrenheit) to a pressure of 70 lbs. (per square inch,) and this fact has to be borne in mind when estimating boiler capacity corresponding to any given engine capacity. To the boiler horse power thus obtained must be added the necessary excess to furnish steam for hammers and possibly for heating, also to drive air compressors, pumps, or other auxiliaries; the steam consumption rate for auxiliaries will often be two, three, or even four times as great as for the main engines, even under what passes for good practice. The lighting load of a railway shop power plant is usually assumed on the basis of one horse power to each arc light, and one horse power to each ten incandescent lights.

The subdivision of generating units and boiler units can best be accomplished by charting the expected total load through a period of 24 hours, and then so selecting the units as to permit of such combinations as will secure full loads, or as nearly so as possible at all times. Engines and generators are not here assumed to be disabled and unfit for service except in emergencies, but boilers will be out of service periodically for cleaning and repairs, and excess capacity must be provided to cover.

In providing means to drive electric generators we have the opportunity of choosing between the steam engine, the steam turbine, and the gas engine, with increasing thermal efficiency in the series. With conditions as already outlined a unit larger than 750 horse power is seldom required in railway shop power plant practice; this is a little small for best results in steam turbine practice, and a little large for comfort under present conditions of gas engine practice. Steam turbines are actually installed in one plant (Aguas Calientes, Mexico, see page 466, Dec., 1903), while gas engines were contemplated (but not actually used) in a Western plant; meantime current practice has gravitated to the use of compound non-condensing engines, usually horizontal (because floor space is seldom limited), and always automatic, that is, with governor regulated cut off; condensing apparatus is found in one case only, at the West Milwaukee shop of the Chicago, Milwaukee & St. Paul Railway. Gas engine predictions are risky, but a constantly increasing use of the steam turbine may be expected, with condensers as an economical adjunct. When this comes about, power plant buildings can be made of reduced proportions.

Water tube boilers will usually be preferred to fire tube boilers for several reasons: They are much safer to operate (an explosion being limited to a single tube); they take up less space for a given capacity; they are quicker steamers; scale can be removed from interior of tubes by power devices and cheap labor, whereas fire tube boilers must have tubes removed by high priced labor in order to remove scale; and also the boiler will be much longer out of service. These advantages outweigh the greater cost, and the fact that the ratio of water capacity to steaming capacity is small, which means that water tube boilers do not always respond as well as fire tube boilers when there is a sudden and excessive demand for steam; but the net results are in favor of the water tube boiler which is now generally used.

There being several makes of water tube boilers all of high efficiency, the choice will usually be determined by commercial considerations. For a given steam consumption in unit time the water level will fluctuate more rapidly in a vertical than in a horizontal boiler, and the feed regulation will require closer attention; on the other hand a boiler room fitted with vertical boilers will be cooler than one fitted with horizontal boilers, and therefore more comfortable to work in—quite an advantage in hot countries. It is one of the anomalies of power plant practice that the thermal efficiency of steam boilers often approximates to 75 per cent., while that of steam engines seldom exceeds 15 per cent.

Mechanical stokers will be a source of economy in fire room labor in boiler plants of from 1,000 horse power up, and will minimize boiler repairs in a plant of any size, even if considerably less than that; fuel will be used to the best advantage, and smoke reduced to the lowest limit. Feed water heaters are of proved value as a means of rescuing waste heat from exhaust steam, but in winter must usually divide honors with the heating system.

Mechanical draft systems have been perfected so as to be thoroughly practicable and reliable. The fans are usually provided in duplicate and fitted with water cooled bearings; and when the system includes the automatic draft regulator, the amount of draft corresponds to the steam pressure. The whole makes a very flexible arrangement, increases the rate of combustion and evaporation, and reduces the size and cost of boiler plant required to produce a given horse power; saves first cost, and therefore, interest, insurance and taxes; greatly reduces size and cost of stack; these several savings much more than offset the corresponding items for the mechanical draft plant together with its cost of operation and maintenance, and result in a net saving. Four tests have been recorded where mechanical draft produced boiler horse power (on basis of 34.5 lbs. of water from and at 212°) 55 per cent. in excess of rated capacity; this illustrates the flexibility of the system; the draft produced by a chimney without mechanical auxiliaries is proportional to the square root of its height, which means that the same result produced by natural draft would require a chimney nearly two and a half times as high as the original chimney (provided its diameter was not also increased).

Economizers do not always economize under railway shop conditions, where coal is always cheap as compared with its cost under usual manufacturing conditions, and they are regarded as a refinement a little beyond our immediate needs.

The use of power devices for handling coal and ashes depends largely on local conditions. If a trestle can be arranged alongside the boiler room without interfering with, or sacrificing other yard arrangements, it will usually be found that expensive and complicated apparatus are not warranted, and the very simplest home made mechanical appliances will yield the desired measure of economy; this is true even when mechanical stokers are used, when it of course becomes necessary to elevate the fuel to the level of their hoppers.

The piping of a modern power plant is a critical feature. Boiler pressures have advanced from 80 lbs. to 150 lbs. in the past twenty years, and now all pipes, fittings, pumps and engines are required to stand 200 lbs. Copper pipe has disappeared from practice as treacherous and unsafe material. Steam pipes of to-day are of wrought iron or wrought steel, and often with cast or forged steel flanges, which may be either screwed, riveted or welded on, and sometimes with faced joints. Expansion is taken care of by long bends or by swing joints; the old style slip joints and corrugated copper joints have almost entirely disappeared; the development and introduction of separators, with their receivers or reservoirs, and the gradual introduction of higher pressures, have had their effect in reducing the size of steam pipes, and it is now not unusual to see a steam pipe smaller than the admission pipe to the engine.

The choice of current and wire system for a railway shop power plant, is affected by many considerations, among which are the following: Transmission, whether short distance, or long distance, or both; speed of motors, whether constant, or variable, or both; lighting, whether arc, or incandescent, or both; and whether confined to the immediate locality or extending to outlying and remote points. The relative merits of direct and alternating current for distribution are summarized in table 15, which, however, is susceptible of much further elaboration and refinement.

TABLE 15.

RELATIVE MERITS OF DIRECT AND ALTERNATING CURRENT FOR ELECTRICAL DISTRIBUTION FOR RAILWAY SHOP POWER PLANTS.

Item.	Direct.	Alternating.
Generators	Commutator, with attendant troubles.	No commutator.
Engines	Reciprocating (the speed of generators being limited).	Turbines may be used, as generators can be successfully run at turbine speeds.
Motors	Must have commutators, but may be made to yield variable speed by either of several methods.	Induction type, without commutators, but constant speed.
Lighting (arc and incandescent)	May be accomplished with either current, but direct current is simpler and preferred.	
Conversion (to other kind of current)	By machine (rotary converter or motor generator).	By machine at present, but probably by static apparatus in future.
Transformation (to higher or lower voltage, but same kind of current)	By machine (seldom done).	By static apparatus.
Transmission	Feasible for moderate distances, but (voltage being limited) cost becomes prohibitive for long distances.	Feasible for moderate distances, and the only commercially practicable system for long distances.

The facts that our shop problems are constantly growing larger, that power plants are supplying electrical energy (whether for power or light) for increasing areas, that the steam turbine has great advantages (particularly for high speed work) over the reciprocating engine, and that there is somewhat of a reaction from the excessive use of complex and costly variable speed apparatus, all point to the conclusion that alternating current generating apparatus will be the prevailing practice in large installations in the future, with auxiliary apparatus for converting a portion of the primary alternating current into direct current for those applications where it is to be preferred. The Reading shop power plant of the Philadelphia & Reading Railroad is a notable example, and almost the only one, of the use of both currents with the alternating as the primary; in this plant the rotary converter is of course used, but the development and perfection of the Cooper Hewitt static converter (for transforming alternating current into direct current) may lead up to the complete elimination of the rotary converter.

Although it is believed, as has been intimated above, that variable speed has been somewhat overdone, yet for those cases where it ought to be used, a choice of method must be made. Of all the alternatives it seems that three might be eliminated at once, namely, resistance in the armature circuit (because of wastefulness and inefficiency); the double commutator (on account of cost and complication), and the four wire multivoltage system (also on account of its cost and complication.) This leaves the two wire single voltage system, with adjustable resistance in the field circuit, and the three-wire two-voltage system, combined with field control; and it is

TABLE 16.

ESSENTIAL FEATURES OF RAILWAY SHOP POWER PLANTS.

Place.	Railroad.	Size of Building.—Feet.	Generators. Current.	Generators. Voltage.	Generators. KW.	Engines. No.	Engines. Total H.P.	Boilers. No.	Boilers. Total H.P.
Concord, N. H.	B. & M.	65 x 111	Alt.	440	600	2	400	3	600
Dubois, Pa.	B., R. & P.	63 x 93	Alt. / Dir.	220	265	3	300	4	800
Elizabethport, N. J.	C. R. R. of N. J.	106 x 107	Dir.	240	300	3	750	4	1,000
Oelwein, Ia.	C. G. W.	42 x 128	Dir.	230	1,000	3	1,050	.	1,200
Bloomington, Ill.	C. & A.	53 x 97	Dir.	220	900	.	1,200	4	1,400
Chicago, Ill.	C. & N. W.	100 x 110	Dir.	220	880	.	1,335	.	1,500
Hannibal, Mo.	C., B. & Q.	60 x 101	Dir.	240	600	3	750	.	1,068
Danville, Ill.	C. & E. I.	89 x 100	Dir.	240	300	2	450	4	1,000
Collinwood, O.	L. S. & M. S.	85 x 130	Dir.	250	875	3	1,425	6	1,800
Jackson, Mich.	M. C.	87 x 92	Alt.	480	460	3	605	3	660
Baring Cross, Ark.	M. P.	77 x 137	Dir.	250	350	3	475	.	1,000
Oak Grove, Pa.	N. Y. C.	100 x 105	Dir.	230	300	2	450	.	500
McKees Rocks, Pa.	P. & L. E.	81 x 102	Dir.	240	600	4	1,000	6	1,500
Reading, Pa.	P. & R.	112 x 175	Alt. / Dir.	480	1,750	6	2,250	8	2,000
Ft. Wayne, Ind.	P. R. R.		Alt.	220	900	5	1,275	.	900
Columbus, O.	P. R. R.	81 x 101	Alt.	220	900	3	1,500	4	1,200
Omaha, Neb.	U. P.	80 x 150	Dir.	250	650	2	770	6	1,200
Topeka, Kan.	A., T. & St. F.	57 x 176	Dir.	220	875	4	1,095	6	1,200

believed that future practice in railway shop power plants will be limited to these two systems.

The power plant building being the nerve center of the modern shop, and representing with its contents, an investment of from $75,000.00 to $150,000.00, should be fire proof and isolated, the change from mechanical to electrical transmission having made such isolation practicable. A rectangular building approximating to a square easily subdivides into engine room and boiler room of nearly equal floor area, as required. It generally happens that the floor of the boiler room can be depressed below general ground level to good advantage (where sewerage conditions permit) in connection with handling the coal supply: on the other hand the floor of the engine room can be established several feet above the ground level, with a basement for piping and accessories, such as pumps, heaters, condensers, air reservoirs, etc. In many plants too little head room has been allowed in the engine room basement, which should preferably be roomy, airy and well lighted. In the power plant of the Baring Cross, Ark., shop of the Missouri Pacific Railway, all the auxiliary apparatus has been assembled in what is termed a pump room, which is 16 ft. x 75 ft., open to the roof and interposed between the engine room and the boiler room; this arrangement screens these rather unsightly accessories from the more ship shape and tidy engine room, and also protects the wearing surfaces of pumps, etc., from the dust of the boiler room.

Table 16 embodies the principal data for eighteen shop power plants, and fairly indicates their size and capacity:

Reading, Pa., is seen to be the most extensive plant so far put up. It will be noted also that alternating current is used to some extent in six places. The reason that the kilowatt capacity of generators and the horse power capacity of engines vary so much in plants which, judging from the size of buildings, appear to be intended to provide approximately equal amounts of power, is that the individual opinions of the designers vary so much on the question of what spare units should be provided. There is a noticeable tendency to fully double the voltage when alternating current is used, as compared with that used with the direct current; this is probably due to the fact that, as alternating current induction motors do not have commutators, brushes, slip-rings or collectors, employees have no occasion to handle them, and the risk of shock is therefore minimized.

Switchboard design has become a specialty, in which it is well to let the specialists take the responsibility, and it is a poor place to curtail. The fundamental requirements are, complete isolation of circuits, automatic circuit breakers for overloads, separate panels and recording instruments for each principal circuit, etc.

(*To be Continued.*)

With the bad waters in the Southwest and under the necessity of providing engines enough for the trains, an effort is being made to extend the life of firebox sheets by removing in every possible way all unnecessary thicknesses of metal between the fire and the water. In this connection crown bolts with large heads are giving place to crown stays resembling stay bolts, having taper threads in the crown sheet and riveted over like stay bolts. On a number of roads opinion favors wider mud rings with 5-in. water spaces at the bottom of the water leg. There is also a tendency toward widening the spaces between tubes, making 1-in. bridges instead of the narrower spaces now prevalent. Several roads are now experimenting in this direction. They are prepared to sacrifice some tube heating surface for the sake of securing more water space around each tube, in the hope of reducing the amount of tube leakage.

STEEL CAR DEVELOPMENT.

PENNSYLVANIA RAILROAD.

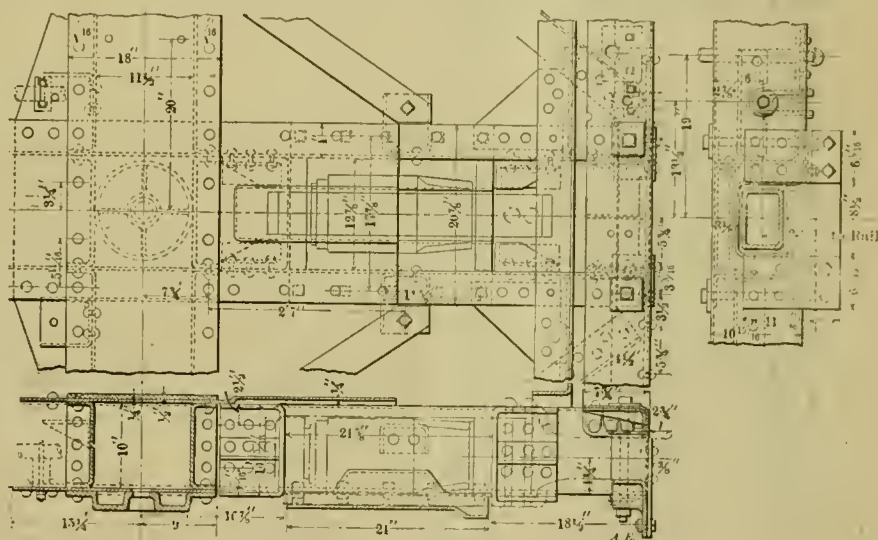
IV.

(*For Previous Article, See Page 435, December, 1903.*)

BOX AND REFRIGERATOR CARS.

After the appearance of the GL car, which was a double hopper gondola, the next step was the FL design, an 80,000 lb. flat car which was considered as experimental and from which valuable information with respect to the action of pressed steel sills under heavy loads was obtained. It did not become a standard, but was afterward redesigned and adopted under another class which will be referred to later.

At this time, November, 1901, attention was directed toward the box car with steel underframing. After a careful study of the question of capacity and the decision to build large capacity box cars was reached the American Railway Association adopted its standard interior dimensions for 40-ton cars. The fact that this road could handle 110,000 lbs. of grain in box cars settled the question in favor of cars of 100,000 lbs. normal capacity and the standard dimensions of 36 ft. in length, 8 ft. clear height and 8 ft. 6 in. width were adopted, the standard door opening of 6 ft. being also used. Since the underframe was to be of steel the additional cost of making

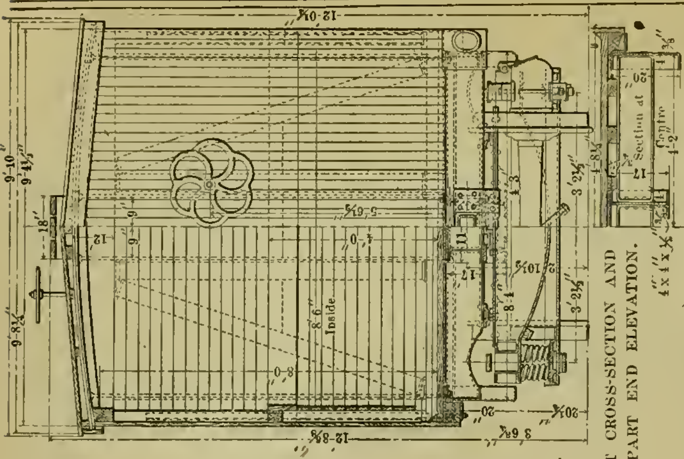


DETAILS OF ATTACHMENT OF DRAFT GEAR.
CLASS XL BOX CARS. — PENNSYLVANIA RAILROAD.

it sufficient for the load of 50 tons was considered as negligible in view of the importance of being able to carry an occasional full load.

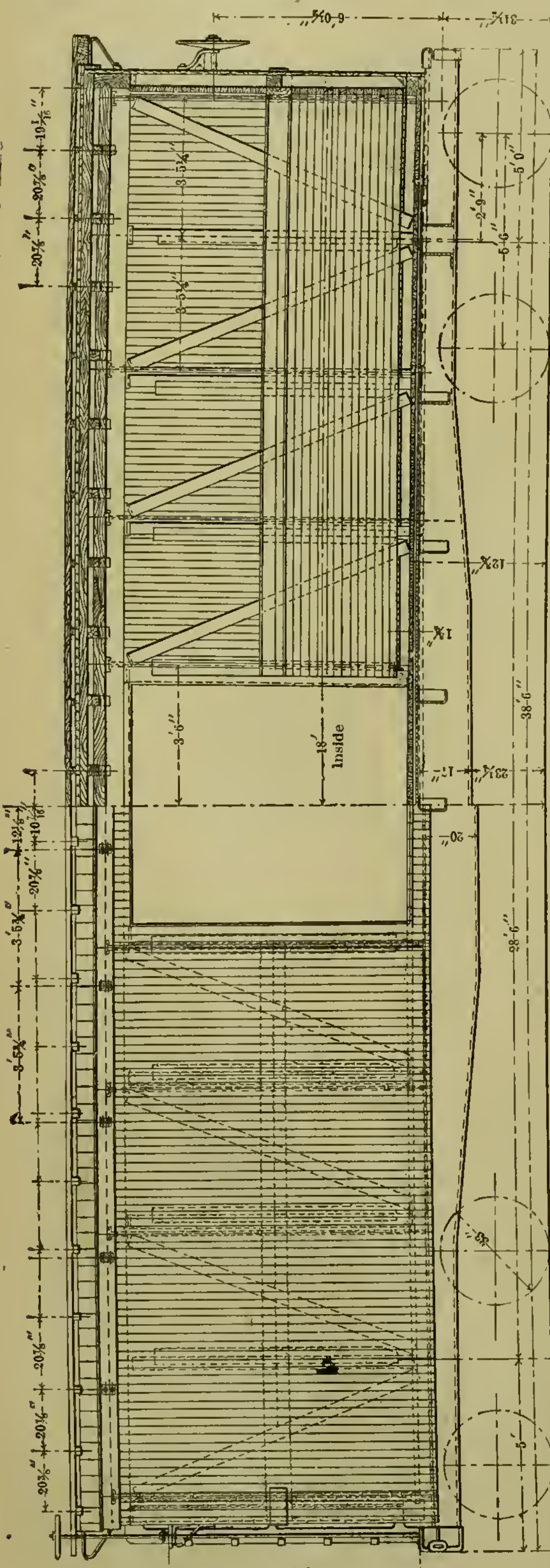
In order to use the standard interior dimensions, a low floor was necessary, and the draft gear was passed through the end sills. The top of the floor is 3 ft. 6¾ in. above the top of the rail and the upper faces of the sills are 3 ft. 4¼in. above the rails. From the excellent and very complete drawings of this car, which is known as the XL design, selections have been made to clearly present the principles of its construction. This is an important design which has led to the introduction of similar construction on a number of large roads. This is essentially a steel underframe car, as distinguished from a car with a steel frame throughout. The box structure is of wood and serves merely to house the load. At this time no attempt was made to embody the frame of the superstructure in the truss structure in actually carrying the load.

While the description is confined to the XL car, the same underframe applies to the refrigerator or RF design. As a backbone, two pressed steel center sills are used. These have 4 in. flanges and are 17 in. deep at the center of the car for a length of 10 ft. At the ends, the sills taper to a depth of 10

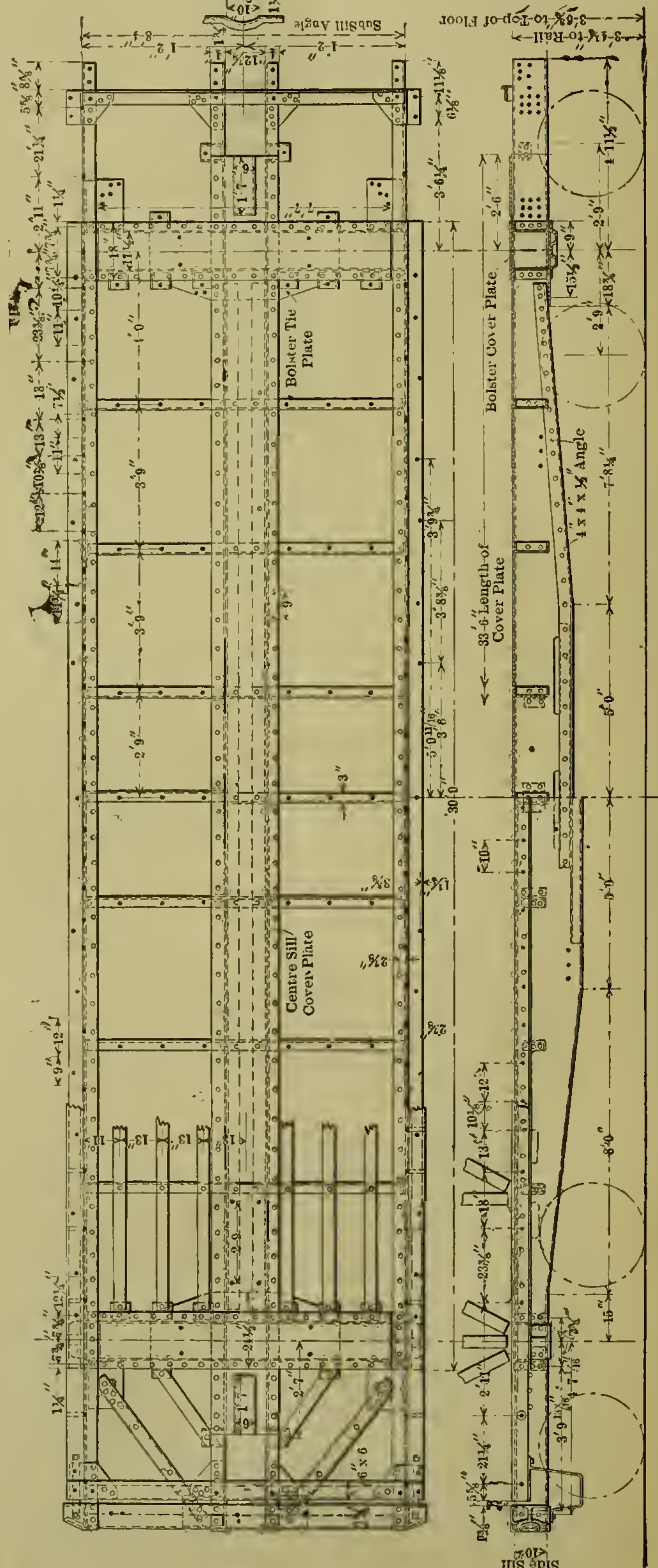


PART CROSS-SECTION AND PART END ELEVATION.

in. The side sills are 20 in. deep at the center. The neutral axis of the center sills is raised by using a cover plate 33 ft. 6 ins. long extending almost the full length of the car (which is the first appearance of this construction) and of the use of 4 by 4 by ½ in. flange angles riveted to the lower part of the webs of the center sills. These angles virtually change the center sills into built-up I beams. With center sills extending the full length of the car the bolsters are necessarily cut. They take the form of pressed trough diaphragms with an 18 in. top cover plate extending across the car. This puts the bolsters into the shape of box girders. The transverse floor supports are pressed steel channels extending between the center and side sills, with short pieces between the center sills. The portions between the center sills are 10 in. deep and those between the center and side sills are 7 in. deep. Upon the latter, the 3 in. wooden floor stringers rest. At the upper

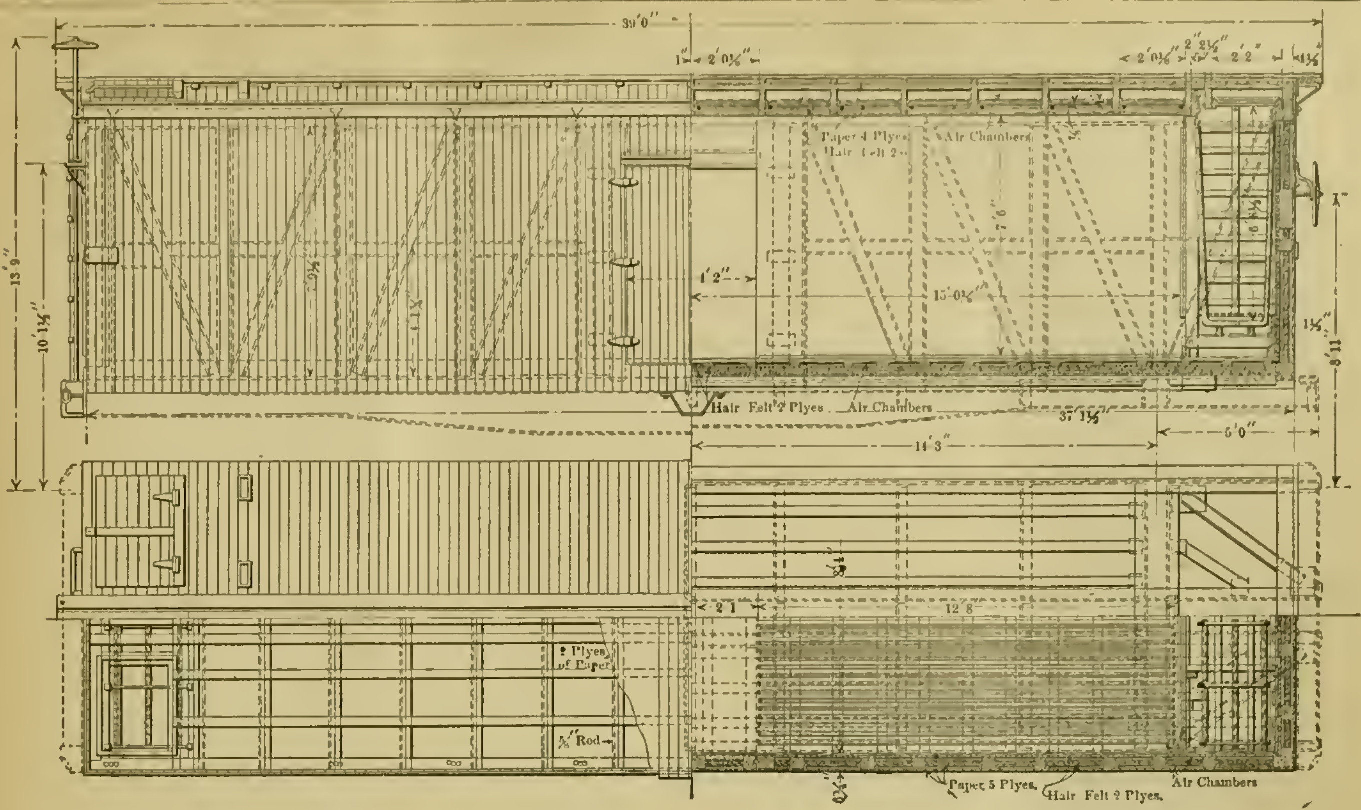


PART SIDE ELEVATION AND PART LONGITUDINAL SECTION OF CLASS XL BOX CAR. — PENNSYLVANIA STEEL CARS.



DETAILS OF THE UNDERFRAMING OF THE CLASS XL BOX CAR.

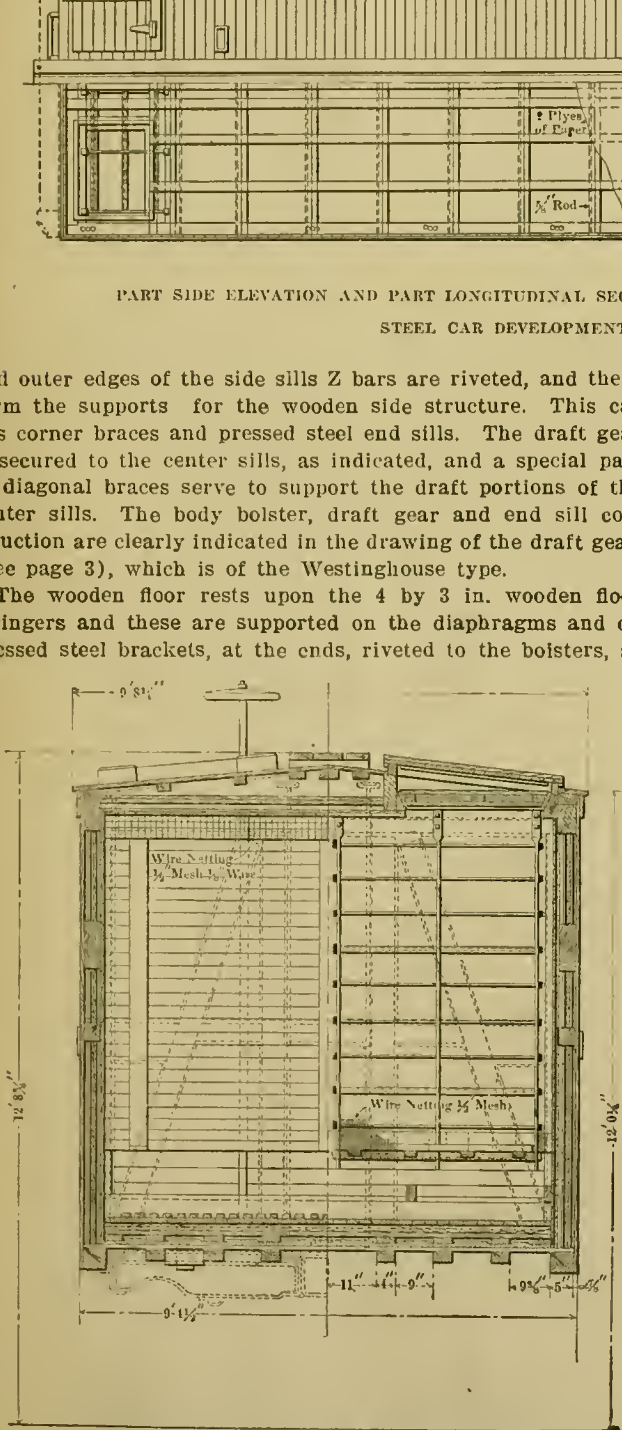
STEEL CAR DEVELOPMENT.—PENNSYLVANIA RAILROAD.



PART SIDE ELEVATION AND PART LONGITUDINAL SECTION, AND PLAN, OF THE CLASS RF REFRIGERATOR CAR.
STEEL CAR DEVELOPMENT. — PENNSYLVANIA RAILROAD.

and outer edges of the side sills Z bars are riveted, and these form the supports for the wooden side structure. This car has corner braces and pressed steel end sills. The draft gear is secured to the center sills, as indicated, and a special pair of diagonal braces serve to support the draft portions of the center sills. The body bolster, draft gear and end sill construction are clearly indicated in the drawing of the draft gear, (see page 3), which is of the Westinghouse type.

The wooden floor rests upon the 4 by 3 in. wooden floor stringers and these are supported on the diaphragms and on pressed steel brackets, at the ends, riveted to the bolsters, as



CROSS SECTION OF CLASS RF REFRIGERATOR CAR,
THROUGH THE ICE BOX.

indicated in the plan drawing. The weight of this car, empty, is 45,300 lbs. It is designed for distributed loads. This is the present standard box car of the Pennsylvania Railroad. The design has been modified in some of the details for the Pennsylvania Lines west of Pittsburg. The drawings and this description apply to the standard construction on the Pennsylvania Railroad proper.

The RF, or refrigerator car, has identically the same underframe as the XL car. The upper frames are also similar, except as to end and side plates, intermediate car lines, door posts and belting boards. Of course the floors and walls, also the roofs for the air chambers and the tanks for ice are special features of cars used for provisions and diary products. The great weight of the body of the refrigerator car reduces the nominal capacity to 90,000 lbs. In the drawings, the construction of the superstructure and the insulation are indicated in a way which renders a description in detail unnecessary. Both of these cars are carried on the standard trucks of this road which will be illustrated in another article.

Bad water continues to be the worst problem the Western roads have to deal with. It is now becoming understood that purifying plants are economical, reliable and satisfactory, and they are being installed—but very slowly. The worst result of poor water is not the scaling alone but a combination of scaling and leaking of tubes and seams. This becomes so troublesome that locomotives in some districts need retubing as often as every two months and they require boiler work after every trip over a division of ordinary length. On one road having only a few purifying plants this term of service has already been extended to six months. The requirements which locomotives must meet in the West will necessitate the installation of water purifying plants on a large scale. Water purification has come to stay. It is to be a necessity on all roads having bad waters and it is highly important to install the apparatus with a view of low cost of operation and absolute reliability. First cost is a mountain to most managers and several are experimenting with "cheap" devices. One thing is now demonstrated—water purification is appreciated as an operating necessity.

EDITORIAL CORRESPONDENCE.

Impressions of Foreign Railroad Practice.

(London, December 5, 1903.)

In forming judgment upon the practice of a foreign country in transportation methods it is necessary to look rather deeply into the principles for superficial indications may not be understood. While the equipment and its operation seems strange to an American, nothing is done here without a reason. Nothing is slipshod here and it is generally easy to trace the causes for the practices which appear to be strange. One of the characteristics of English people is conservatism. It must be remembered that these islands were densely populated when the railroads first came up for consideration. Large estates and busy cities were conceived in the location of the roads. Much opposition was met from the very first and it became necessary to satisfy demands for the public safety which we have never known and which we are only now beginning to appreciate. This led to construction of such heavy and permanent character, with respect to the roadbed, terminals and overhead bridges, as to influence the entire development of the roads in other respects. The rolling stock is affected by this to a great extent and also by the fact that it is a logical descendent of the stage coach. We must remember that we took our rolling stock "ready made" and could begin with a clean sheet. The result is that Europe has built thoroughly upon lines which are now found to be too narrow. Among the progressive English railroad men the large train unit and small dead weight of our freight equipment are greatly desired, but they cannot increase the length of sidings, or enlarge the cross section of their numerous tunnels. They have, however, devoted themselves to economical operation with respect to locomotives in a way which is worthy of most careful study.

European permanent construction is both a blessing and the opposite, in its effects upon practice and progress. As our railroads preceeded the people, and our rails went West in advance of the population we know nothing about this, except in the case of a few large terminals. When so much money is put into English roadway and terminals, when so much is spent to avoid curves and grades and so much sunk in tunnels, it becomes most important to see far into the future, in order to provide for growth and improvement. Our own roads are approaching the important problems of permanent construction. We need to look further into the future than the foreign roads have done or we shall be handicapped as they are with structures, which are too expensive to tear down and are yet too small for growth. This strikes the writer as being an exceedingly important lesson. That part of permanent construction, however, which permits of the statement that there is no grade crossing of two railways in Great Britain is to be most emphatically commended.

Human life is held in high regard in Europe and specially this impresses one in England. Grade crossings with streets are entirely absent and every possible precaution is taken to guard against accidents. At stations, even at small ones, passengers pass from one side of the roadway to the other by subways or overhead bridges and this applies to outlying stations where little business is done, as well as to the larger and even most important ones. The writer came very near getting into trouble on a well known English road because he wandered off into the yard while waiting for a train. It was very pleasant to meet shunters (corresponding to our switching crews) who politely touch the cap in answering a question. It is rather impressive to be firmly, but politely and promptly ejected from the yard by the station police.

No trespassing is allowed on tracks here. The people are brought up to respect authority and they do so. The police of London do not carry arms or clubs, yet they conduct the street traffic so well as to bring the number of fatalities in the city streets for last year down to 158, against 538 for the same time in New York City. This shows a difference which explains the small number of accidents here. The people do not do as they like, but as they are told. Good discipline obtains with the public as well as with railroad train and engine men.

English signaling is a revelation even to one who reads and thinks he knows all about it. These railroads have very small wreck accounts. They pay dearly for an injured passenger and prefer to put their money into preventives. When an engineer comes to a signal in the "on" position he stops, for it means something. It means that if he passes it when he should not, he loses his job. Therefore a stop signal means "stop." These men learn to respect signals, because they have them, not as we have them—for perhaps a few miles of road and none on the rest of it, but they run by them all the way. They are not expected to take any chances as to collisions, but to obey the signals, and they certainly do it. Furthermore, English signals are beautifully placed. They are most carefully "sighted," and there is not the slightest indication of efforts to save money at the expense of perfect signaling. In this matter our railroads suffer severely in comparison. It is true that English block signaling is unnecessarily expensive, and this may be due to the cheap labor, but its completeness and the skill applied in its installation is gratifying. The same results would be possible with automatic signals—if we had the discipline of English roads with respect to this branch of the service. As an English gentleman who has spent a long time in the United States puts it—"In England we have signals all the way. We do not run as you do, 40 miles by signals and the next 1,000 miles by instinct and judgment." The Board of Trade sees to it that a piece of road is properly signaled before it can be put into service.

No better idea of the difference in operating conditions between England and the United States can be given than by comparing freight business in the two countries. In England the "goods" traffic seems very much like our express business. This influences the entire business of English railways. Mr. Edwin A. Pratt says: "At the Great Northern meeting (February, 1903) Lord Allerton presented a statement showing the results of a day's work at one of the freight stations on that line, the figure being as follows:—Total number of consignments, 985; total number of packets, 4,427; total weight, 123 tons, 2 cwt.; average weight per consignment, 2 cwt.; average weight per package, 62 lbs.; total number of trucks used, 53; average load per truck, 34 cwt.

As representing the other extreme the contract taken by a Western road in the United States should be mentioned, namely, that for hauling 6,000,000 tons of ore over a certain section of road in 180 days. In Europe there is nothing like this and it seems impossible to handle business on such a scale over here. Our heavy freight work is entirely unknown here and the conditions of operation are absolutely different. English roads are far ahead of us in small dead weight of passenger cars per passenger carried and we are far ahead of them in handling freight. They, however, do not have our conditions and our large quantities of freight to deal with. Our ore, coal and grain business would swamp English roads. English methods are developed on widely different lines, those of small packages, rapid transit and immediate delivery.

An official of Sir Thomas Lipton's company told the writer that most of their patrons in the United Kingdom keep comparatively little stock on hand, but depend upon the quick delivery of the railroads to keep them supplied. A dealer in Manchester often telegraphs in the afternoon for some needed supplies. They are "fetched" from the Lipton stores by a railroad delivery wagon in time for a 6 p. m. train and go by passenger train, to be delivered by the railroad delivery wagon system before 9 a. m. the next day in Manchester. This is a distance of 183 miles and the service is equivalent to our express business. When sent by goods trains, however, delivery within 24 hours is customary at such distances. This rapid service and the small parcels of freight throw a strong side light upon methods of handling freight traffic in England. This explains the small car and the very light load per wheel.

These small cars are almost amusing. They are scarcely larger than wheel barrows and it is incomprehensible that they should be seriously considered as a limit to the capacity of freight equipment. As a rule they have only hand brakes and here is where the foreign railroad is lame. These trains, light as they are, break in two and the cars pile up over the opposite track. There is nothing to prevent breaking in two, except the screw threads on the couplings in the use of passenger equipment and light chains on the freight cars. In the absence of automatic brakes freight cars are bound to pile up if the train breaks in two. In couplers and brakes we can congratulate ourselves in being years and even generations ahead of our foreign friends. It is necessary to see conditions on this side of the water, in order to fully appreciate what our Master Car Builder's Association has accomplished in the matter of couplers and also in brakes. A series of brake trials here, such as the Burlington tests of that association, would revolutionize English practice. Some of the "joint stock" used on the lines from London to Scotland is equipped with both the Westinghouse and vacuum systems. Imagine the complications of brake gear under one of these small cars having both systems. Even the perfection of signaling cannot indefinitely postpone a serious lesson in braking of freight "trucks" and in the proper braking of passenger equipment. When the need is once appreciated the remedy will probably be applied with characteristic thoroughness. A fair view of the present brake and coupler situation here must be a very unfavorable one. If it were not for the fact that a grade of 1 in 40, three miles in length, is considered a heavy pull in England this would have been fixed long ago.

The English locomotive superintendents are busy men with large responsibilities, yet they seem to have time for all they have to do and are generally very comfortable. "The English do not live for the sake of working, but work for the sake of living." They work hard but are not devotees of the "strenuous life" to the exclusion of proper amounts of rest and pleasure. They are as a rule inaccessible before eleven o'clock in the morning and it is necessary to arrange appointments in advance in order to be sure of seeing them. The writer has been everywhere very cordially received and has been impressed in the case of every one of these officers whom he has met, with the fact that they are big men, keen students, careful thinkers and responsible railroad officials. They all talk as if the entire responsibility of their departments rested entirely upon them, and as a matter of fact it does. In a large sense, they have autocratic powers and as a rule, while subordinate to their general managers, they deal with the directors themselves, and thus play an important part in the policy of the railroad; usually the large motive power questions are dealt with by a committee of the directors, who hold fortnightly meetings, with the highest official of the road, the chairman presiding. The general manager of the road may or may not attend. I am told that he usually does not, unless questions of operation are involved. This brings the motive power department into a prominence which it has not attained with us. In fact, it seems that English stockholders look upon this as the most important department and the one from which most is expected. The officer in charge of it is therefore much in the public eye and is high in the councils of railroad men. Occasionally a motive power officer is selected for the head of the operating department, but, as a rule, he is content to spend his life in his special line of work, because it is made worth his while to do so. Retirement comes usually at the age of 60, and after arriving at that attainment the locomotive superintendent may be requested by the directors to retain his position. Some have thus been requested to remain for ten additional years. These officers seldom leave railroad service for any other work, simply because they are appreciated and are able to do better in it than they can elsewhere. They occupy high social positions and this means much in England. Their opinions are respected. They are encouraged to build up most excellent discipline and to consider safety first, celerity second and economy third, in the order of their efforts. There is much in this which should be seriously considered in the United States, where the situation with respect to motive power officials is not what it should be. It is very rare in England for a road to take a high motive power officer from another road. In fact, this is almost unheard of. How is it with us? Salaries here are higher than on our railroads; that is, those of the locomotive superintendents; and a works manager finds it well worth his while to wait for his turn.

In England there seems to be no connection whatever between the condition of locomotive and car equipment and the stock market. The authority of the locomotive superintendent seems to be far beyond the reach of the stockholders when questions of safety and proper working condition of equipment are concerned. No president or general manager here buys locomotives or cars without consulting the head of the mechanical department. He would not dare take such responsibility.

American railroads might wisely place superintendents of motive power upon the basis of the unlimited authority of the English mechanical superintendents, combined with the unlimited responsibility of the American general managers.

The locomotive superintendent's position here carries with its authority a danger in the temptation to follow fads in mechanical matters. Most of them are too broad-minded to go very deep, but the differences in the practice of roads in the same territory is frequently very marked. The greatest differences in locomotive practice are seen on parallel and even on connecting lines using joint passenger "carriages." Furthermore, the jealousy among the mechanical officers is quite an expensive luxury which an organization like our Master Mechanics' Association would very quickly overcome.

It is the opinion of the writer that the money saved by improved fuel economy of locomotives is lost over and over again in other ways. In the operation of light trains, in the shops and in the lack of labor-saving appliances.

Our Master Mechanics' and Master Car Builders' associations are held in high esteem among English mechanical railroad men. They are even looked up to in admiration because of their influence in improving practice and extending the tendency toward uniformity. There is nothing of this kind here and there is no centralized authority or concerted effort to accomplish anything whatever for the good of the railroads as a whole. The rule is for each superintendent of motive power to individualize his efforts and stamp his practice with his personal views and opinions. Almost all of the mechanical men have carried this to the point of reflecting their own personalties in their practice. The successful use of an important principle on one road, instead of being an example for others to follow, is exactly the opposite, and is practically a thing which the others consider something for them not to do. For example, the writer was told that one road adopted and successfully used track tanks and water scoops, obtaining great advantages in light tenders and long runs, for twenty-five years before the example was followed by other lines.

In England, however, the government controls many matters of construction and operation through the "Board of Trade." By its power—which is far greater than that of our Interstate Commerce Commission—its influence is in a sense restrictive, and it does not always tend toward smooth and unfettered operation, but it is a centralized authority, and it seems likely to act a very prominent and important part in such matters as have been standardized in the United States by the American Railway Association and the mechanical associations. English roads need a Master Car Builders' Association, but in its absence the Board of Trade may, by asserting itself, effect the results which have been accomplished by American railroads by voluntary co-operation in these associations. English railroad men regard with wonder the adoption of a standard coupler contour. They cannot "get together" on anything, whether of that or any other form, and we should therefore not fail to appreciate the achievement of the Master Car Builders' Association in this great work. It is far better to voluntarily agree than to be compelled by government authority to adopt an improvement, because of the failure to come to such agreement! G. M. B.

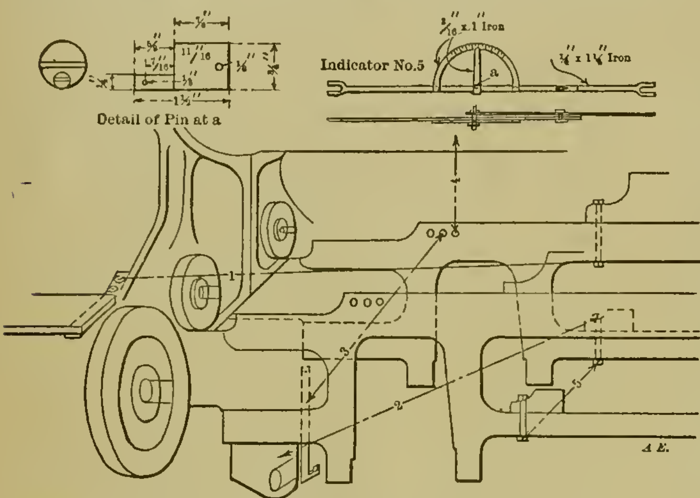
(To be Continued.)

LOCOMOTIVE FRAME DEFLECTIONS.

UNDER SERVICE CONDITIONS.

During the past few years locomotive frame breakages have become very troublesome. On some roads the difficulty has caused great anxiety. It seems to be prevalent with all of the heavier types of engines and is not confined to this country alone. It is argued that vertical deformation or deflection cannot be avoided and that if the structure is made rigid against such deflections the only relief is in fracture. Another opinion is that the lateral movements cause the breakage, as it has also occurred in engines which are flexible at each end, such as the 2-6-2 and 4-4-2 types. Another theory has just been developed with the support of experimental evidence.

The consolidation locomotive of the Lake Shore & Michigan



SKETCH OF INDICATORS USED TO MEASURE LOCOMOTIVE-FRAME DEFLECTIONS IN SERVICE.

Southern Railway (AMERICAN ENGINEER, February, 1900, page 37) recently developed many frame breakages, the defect occurring almost always on the right-hand side and generally in the top bar over the leading driving axle. In an attempt to discover the causes some experiments were made to ascertain the extent of the movements of the frames in service on the road, it being reasonable to suppose that the movements in the frames would indicate the stresses to which they were subjected.

Metallic indicators were applied to one of these engines so made as to multiply the movements of the points of attachment in the ratio of 1 to 24, the pointers being read from a scale attached to the indicator. Mr. G. H. Case, special apprentice, who carried on the experiments, rode on a seat placed over the front axle, in a position from which the movements of the pointers could be watched and recorded. The perspective sketch shows the locations of the five indicators. Rod No. 1 connected the cylinder saddle, on the left side, with the top of the right-hand frame back of the first pedestal. No. 2 connected the bottom of the left-hand frame in front of the first pedestal with the bottom of the right-hand frame back of the first pedestal. No. 3 connected the bottom of the left-hand frame with the top of the right-hand frame in front of the first pedestal. No. 4 connected the top of the right-hand frame with the boiler and No. 5 ran between the bottom sides of the frames just back of the first pedestal.

With these indicators attached, runs were made with the engine in actual service, never pulling less than 40 loaded cars. Indicator No. 1 was 6 ft. 10 in. long and showed a motion of 1-32 in. The vibrations occurred with every revolution and were little affected by roughness in the track. No. 2 was 5 ft. 4 in. long and revealed a maximum deflection of 3-64 in. The vibrations were noted at every revolution and also were affected by the roughness of the track, the latter producing the greatest deflections. No. 3 was 3 ft. 8 ins. long and showed practically no deflection. No. 4, 3 ft. 4 in. long, showed 1-32 in. rise of the frame corresponding to each revolution and was influenced by roughness of the track and rolling of the engine. No. 5, length 3 ft. 7 in., showed a movement of 3-64 in. of the frames with reference to each other. The minimum vibrations occurred when the engine was running smoothly and they corresponded with the revolutions of the drivers. The maximum occurred when the drivers slipped and at rough spots in the track.

In the test the engine was in good condition, being but recently out of the shop. The tests were made on the Lake Shore road where the track was in good condition. In order to determine the effect of rough track and an engine not in the best condition the tests were carried out on another engine of the same class on the Franklin division with the following results:

Indicator.	Movement.
No. 1	3/32 in.
No. 2	⅛ in.
No. 3	Very slight.
No. 4	Very slight.
No. 5	3/32 in.

The motions of Nos. 1 and 2 were in unison and occurred with each revolution. No. 5 was affected most by the rough track and the blows of the flanges of the wheels upon the rails. The severest vibrations were found in working the engine down grade at high speed, and also on up grades.

These tests show that there is a lateral movement of the tops of the frames back of the pedestals, but that there is very little vertical movement between the frames and the boiler. There is also an inward movement of the lower jaw and this would appear to indicate that the movement is largely induced by the lateral forces imparted to the frames from the driving wheels. In engines, as usually braced, there is nothing to prevent the lower bars from swinging sidewise together. As a result of these tests it has been decided to provide for this on future engines, as it is possible that the twisting shown in these experiments, which is not provided for at present, may have considerable influence upon the frame breakages. The movements of the frames also indicate that the leading drivers exert a considerably greater guiding force than is advisable. This is probably due to insufficient initial lateral resistance on the truck used, which was the single point suspension type. This is to be overcome by the use of three-point hangers, having pivots at 3½-in. centers, and swinging links 12 ins. long, which will increase the amount of guiding done by the truck and reduce the stresses on the drivers to a considerable extent, especially when it is considered that the drivers are very close to the center of gravity (or, more correctly, the center of oscillation), whereas the truck is much farther away and consequently acts with more favorable leverage.

We are indebted to Mr. H. F. Ball and Mr. H. H. Vaughan for this information.

STANDARDIZING MACHINE TOOL PARTS.

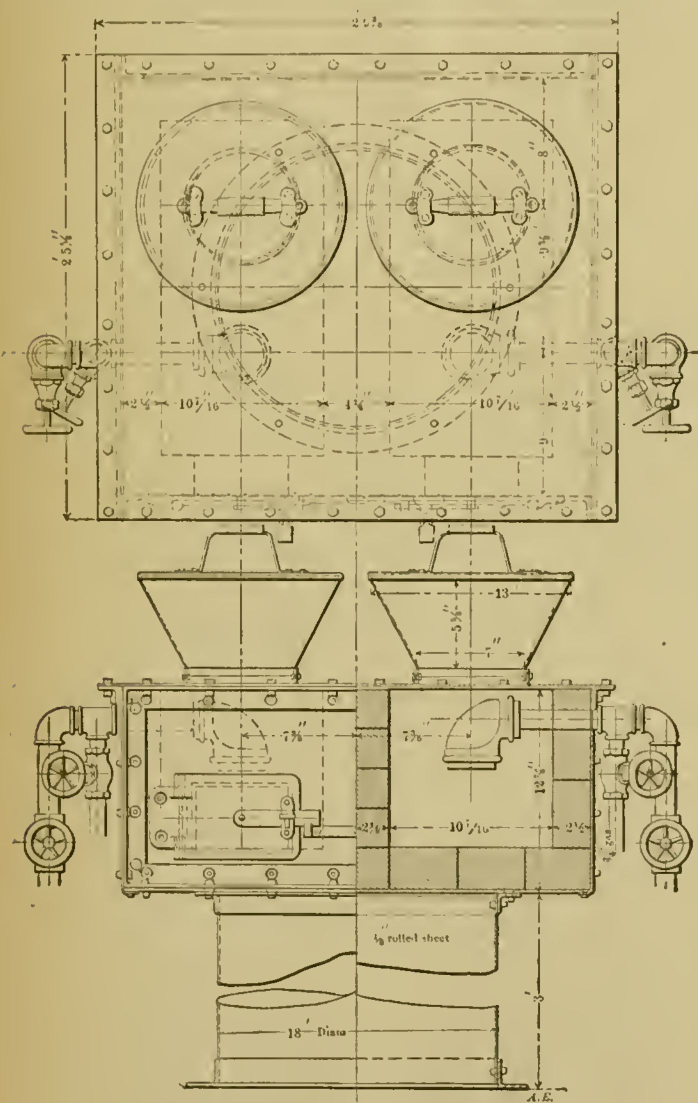
Mr. William Lodge, in his paper recently read before the November meeting of the National Machine Tool Builders' Association in New York, suggested the advisibility and the advantages to the association, if it could possibly be brought about, that some standard be adopted. He questioned why all manufacturers of machine tools might not have the same size of general bearings, the same size of nose for the lathe spindles for the different sizes of lathes, so that customers may find it easy to transfer faceplates, chucks, and tools from one machine to another, irrespective of who may have been the manufacturer. This would be a most important matter, not only to the builders, but to the customers, and it would, at least, have the effect in foreign countries of securing preference for American tools, because of their interchangeability at certain points and because of their uniformity in weight and power. He did not advocate uniformity in the design of the machines throughout, and referred to the utter impossibility to secure uniformity in the quality of the work put into the machines, but he thinks it will be of great assistance to incorporate the features mentioned wherever possible.

GASOLINE GAS RIVET FURNACE.

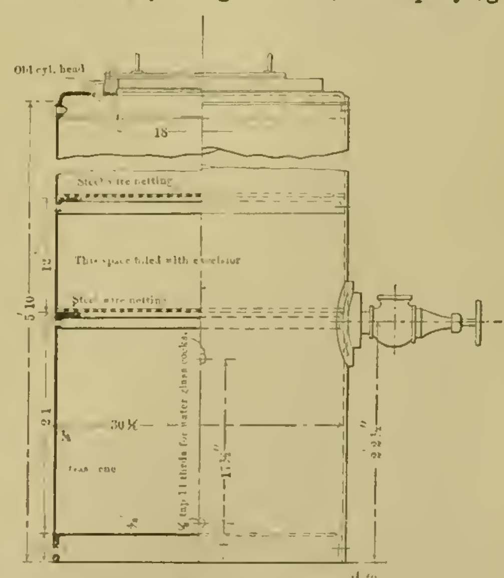
CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA RAILWAY.

For use in connection with the hydraulic riveter in the boiler shop of this road at St. Paul, Mr. R. B. Moore, mechanical engineer, has gotten up an effective and convenient rivet furnace. It is heated by gas generated from gasoline in a tank placed outside of the building. The tank was made from the cylindrical portion of an old pump boiler and holds about a barrel of gasoline. Between the gasoline and the filter is a space for the gas, which passes upward through the nettings and filter of excelsior before passing to the furnace. Air is supplied through a 1-in. pipe to the bottom of the tank at a pressure of 5 lbs. per square inch. A 1¼-in. relief valve guards against excessive pressure. A 1¼-in. pipe leads the gas to the furnace, which has two compartments and two burners. Low-pressure air is brought to the burners through a 1-in. pipe. The burners are simply perforated plates, screwed into the fittings shown in the engraving.

The forge is made with two compartments in order to heat



DETAILS OF THE FURNACE FOR HEATING RIVETS.



DETAILS OF THE GAS GENERATOR.

A NEW GASOLINE-GAS RIVET FURNACE.—CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA RAILWAY.

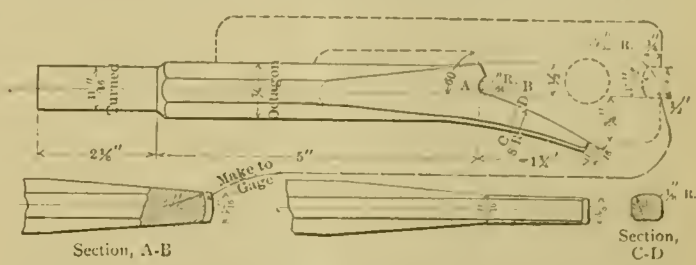
two sizes of rivets at the same time. They may be heated faster than they can be used. Rivets are put into the top of the forge and they bank up at the back end, where they are kept warm, so that but a short time is required to heat them ready for use. It is stated that they are not liable to burn. This forge is located on a platform which has a sliding portion on each side of the riveter jaws, so that the operators need not lean out or use long bars. This sliding portion of the platform is operated by a wheel at the side. This arrangement saves labor and is very convenient for the workmen. We are indebted to Mr. Moore for the drawings.

STANDARD BEADING TOOL AND GAUGE.

NEW YORK CENTRAL RAILROAD.

In order to secure good flue work in locomotive boilers it is necessary to give close attention to the beading tools. In discussing this subject before the Master Mechanics' Association last June, Mr. R. H. Soule said of his experience on the Norfolk and Western.

"It had been suggested that the beading tools used over the road in different roundhouses were not uniform as regards



THE NEW STANDARD BEADING TOOL AND GAUGE.—NEW YORK CENTRAL RAILROAD.

the contour of the curve on the shoulder. Samples of these tools were sent to Roanoke and compared. It was a curious object lesson. They found the most battered-up lot of tools you ever saw; there was no uniformity in them. Some would give flat beads and some circular beads, and there were all the intermediate forms. The conclusion was that what was needed was to establish a standard contour line for the edge of the horn on the beading tool; to provide the necessary number of templates, distribute them over the road, and require that the shoulders should all be ground to these templates."

This has been done on the New York Central, the practice dating from about a year ago. In the accompanying engraving the standard beading tool of this road is illustrated, and in dotted lines the outline of the template is indicated. This template supplies a standard gauge for the angle of the heel, and the curved face of the tool must fit a radius of 9-64 in., as well as follow the established contour which is cut in the end of the gauge, as seen in this engraving at the right.

These gauges are issued to the various shops and the tools are required to be kept in condition to fit them.

RAILROAD SHOP MANAGEMENT.

By William S. Cozad, Norfolk & Western Railway.

II.

Having referred, in the first article of this series, to the harmony and good will which always exists in every well organized shop, and offered some suggestions as to how this end may be attained, it will be the purpose of this paper to examine some of the underlying principles upon which must rest the adoption of such piece-rates as will insure a largely increased output of the shop and also increase the earnings and better the condition of the workmen. The foundation upon which must rest any successful piecework structure is this: that no railroad company or corporation is justified in demanding of its employees an increase in the amount of work turned out, without offering a corresponding increase in the earnings for the extra effort required. It is, in almost every instance, a comparatively easy matter to calculate the capacity of a machine, but long experience has proven that the capacity of men is a variable quantity, and, on a very large part of repair work, much skill would be required to determine the amount of labor which should be performed in any given time. To insure satisfactory results in this respect, the first step which should be taken by the management of any railroad contemplating the introduction of piece-rates is to place the entire problem of rate fixing in the hands of a competent, trained, piece-work expert, who will make a careful study of local conditions, proper organization, pass on each individual price, before it is put into effect, cut out all obselete practices, require strict adherence to all scheduled rates, study methods of increasing output and decreasing cost, and place himself in such close relation to both foremen and men as to make them feel perfectly free to appeal to him in any difference of opinion that may arise in fixing prices. Following this must come absolute and unqualified support of the piece-work principle from the management, and no railroad of any consequence should attempt this work until these preliminaries can be carried out.

It is said there is a standing advertisement all over this country for the man that can do the thing that nobody else can do, or that can do a thing in a way that nobody else can do it—the man that is always looking out for new ideas, improved methods and up-to-date ways of doing things; and without wishing to in any way magnify the responsibility attached to such a position, I believe that road which employs the man who comes nearest the above standard will not only make rapid progress in the introduction of piece-work, but will in the end find that a set of rates have been established which are eminently satisfactory, both to the men and the management.

Occasionally it is argued by men of note in railroad circles that the adoption of piece-work prices that will be fair to the men and the company is largely a matter of guesswork; that adjustments on account of mistakes in fixing original rates are often necessary. From whence come these impressions? Would any competent man be willing to admit that after going into a shop and studying the conditions covering a single item, he could not make a fair and equitable price? And if this can be done on one item, why not on another, and another? Piece-work is a matter of the systematic study of individual operations and as an illustration of the source from which these mistaken ideas are derived let me cite one or two cases. In two different blacksmith shops, the conditions in both of which are perfectly familiar to me, common freight draw-bar follower plates are made as follows:

Shop No. 1.	Shop No. 2.
1. Bar iron brought into shop, cut to length and put into high class oil furnace.	1. Bar iron delivered to shears.
2. Plates heated, taken from furnace, put on bulldozer, 2-in. hole punched through to within ¼-in. leaving dowel on opposite side of plate, and loaded on truck.	2. Plates cut to length and 1⅛-in. hole punched.
3. Plates delivered to storehouse.	3. Plates delivered to smith on open fire.
	4. Round bar iron, 1⅛-in. diameter, delivered to shears.
	5. Iron cut into 6-ft. lengths.
	6. Iron delivered to upsetting machine.
	7. Dowels upset to 2 ins. and cut off.
	8. Dowels delivered to blacksmith.
	9. Dowels heated in ordinary open fire, two or three at a time, put into plate and riveted over on anvil with hammer and sledge.
	10. Plates delivered to storehouse. (The above number of operations are shown because they are either performed by different men or by the same men at different times.)

This is a piece-work job in both shops. In shop No. 1 the work was divided into the elements best suiting the conditions and prices fixed after careful study of the time required to do the work; while in the other case they conform exactly to the guesswork idea mentioned above. In shop No. 1 the rates will remain satisfactory. In shop No. 2 methods and prices are unsatisfactory, both to the men and the management, and will have to be changed.

In the same shops the method of making freight car brake levers is as follows:

Shop No. 1.	Shop No. 2.
1. Bar iron brought in, levers cut off and put into first class oil furnace.	1. Bar iron delivered to shears.
2. Levers heated, drawn out under power hammer, cut to length and loaded on truck.	2. Levers cut off.
3. Levers delivered to drill press in machine shop.	3. Levers put into coke fired furnace.
	4. Levers heated and drawn out under power hammer.
	5. Levers delivered back to shears.
	6. Levers cut to exact length.
	7. Levers loaded on truck and delivered to drill press in machine shop.

In fixing prices on work, such as described above, the following elements, which are not mentioned in these comparisons, must be considered: The location of the iron with reference to the shears; the condition and speed of the shears and punch; the class and condition of furnace; the kind and condition of hammer. With work of this class outlined as indicated above and the time element for each operation carefully considered, no excuse should be accepted for a mistake in fixing an equitable piece-rate.

In the machine department, upon which rests the output of about seventy-five per cent. of the railway repair shops of the country, we have to deal almost exclusively with the capacity of the tools in use, the quality of material used in repairs being a matter of secondary importance. In many cases a large part of the tools are emanations of the forgotten past, nobody remembering when they were put into the shop or where they came from. Usually any request for better facilities is worse than futile, because to the ordinary stockholder all machines look alike as a means of declaring a dividend. The only alternative, then, is to improve on past records. To do this special attention must be given each individual machine to see that it is in the best possible condition. If it is a driving wheel lathe that has been in constant service twenty-five or thirty years, it will, no doubt, need a little touching up in the way of new feed screws, tool post heads planed off and covered with quarter inch plates of rasp-shaped, hardened steel to prevent tools from slipping, new studs and nuts, countershaft put in perfect alignment, machine drawn down to foundation, all boxes closed and bearings examined, and most important of all, a new double belt as wide as the cone will take. A double belt is one of the greatest improvements that can be applied to an old machine. It is a never-failing remedy for the man who has a special tenderness for his lathe, because it at once refutes his argument that the machine will not carry a heavier feed or cut.

As an illustration of the point I wish to make, we have in one of the shops on the road, with which I am connected, a driving wheel lathe which has been in constant service more than thirty years. A short time ago this machine was overhauled about as detailed above and at present the average time required to turn a pair of driving wheel tires on this lathe is from four to five hours. To be exact, this machine is turning the tires on twelve pair of driving wheels every six days.

An inspection of every tool in the shop, from the smallest drill press to the large frame planer, must be made and all necessary repairs attended to before rates can be properly established. With the machine in good condition, the amount of feed and speed will depend largely on the grade of the tool steel and the shape of the tool used for any particular work.

It is not the purpose of this article to examine into the details of feeds and speeds, but it may be remarked that recent tests have demonstrated very clearly that on medium steel a speed of 35 to 45 feet per minute, with a feed of 10 turns to the inch and a 3-16 in. cut, can be maintained. On wrought iron free from slag, 50 to 60 ft. per min. may be maintained; on cast iron about 40 ft. per min.

In the ideal scheme of production, antiquated cutting tools, slow speeds and fine, hair-splitting feeds can have no part whatever. With machines in good condition, tools that will remove the maximum amount of material in a given time with the least frictional resistance and retain their cutting edge, form a necessary part of a perfect combination. The man who runs his machine, instead of letting his machine run him, will soon discover the proper shape of tool for a given operation, and on all forgings that have been roughed out, the amount of feed and depth of cut will then be limited only by the pulling power of the belt.

For every operation there is a best form of tool, (not a half dozen different shapes, one as good as another), and as many of the operations in a repair shop are repeated every day, too much care cannot be exercised in determining that shape. Having adopted a series of standard sizes and shapes, tools should then be forged in dies to within 1-16 in. of actual size and delivered to the grinding room.

Whenever a machinist is kept waiting for a tool, the time so spent is lost beyond recovery, and to insure the maximum output of any shop, such waste of time must be eliminated. To accomplish this, a number of tools of various kinds must be kept ready for immediate use to supply all requirements.

There are three distinct methods of fixing piece-work prices, which may be briefly illustrated as follows:

1st. Mike Maloney faces and rough turns a driving axle, diameter 8½ ins. Day rate, 30 cents per hour. He reports to his foreman that it took five hours to do the job, cost $1.50. Foreman figures that if a piece-work price is put on the job Maloney will do it in less time, so he deducts 25 cents, making the piece-rate $1.25.

2nd. Bill Jones, in another shop, performs the same work outlined above, same rate per hour, requiring the same time. The foreman knows that Jones is a good, honest whole-souled fellow, and, after adjusting his spectacles a few times, he concludes that a man working at a fixed rate for his product must apply himself more diligently to his work and should, therefore, earn more than his day rate, and on this reasoning the price is fixed at $1.75.

3rd. In still another shop Wm. Smith performs the same work. Day rate the same. In this shop, however, an entirely different course is pursued. The lathe and belting are carefully examined and put in good condition. The tool used is made of the best known grade of air-hardening steel and ground on a universal grinder to what is considered the best shape for the work. Carrying out the instructions of a man who has made a careful study of the work and knows what is necessary, the axle is put in the machine and the following time elements recorded:

Time required to change machine.
Time to chuck.
Time to face ends, each end separately.
Time to take rough cut.
Speed, feed and depth of cut.
Time lost, if any, on account of unavoidable delays.

Summing up, the inspector finds that it took two hours to complete the work. A detailed report is made to the foreman, and he is now in a position to recommend a fair and intelligent rate on this work, and when the rate is once fixed, nothing but a panic, requiring a general reduction in wages, or improved methods will ever require a change, and a change for either of these reasons cannot be charged as an element of unfairness in the piece-work principle.

Space forbids the extension of this article to the erecting and boiler shops, in both of which piece-work may be so applied as to be very profitable to both the men and the company. I can only add that in these departments the work must be thoroughly systematized and each individual operation carefully studied by a competent man before any rates can be permanently fixed. Any attempt to work the same gang all over an engine or on different parts of a number of engines will fail far short of securing the maximum output of the shop. Shoes and wedges may be assigned to certain men, guides and pistons to others, motion work to others, and so on. Similar divisions should be made of the work in the boiler shop, assigning all flue work to one gang of men, flanging to another, stay bolt work to another, etc. Here, as in all other departments, sound judgment must be used in wording the schedule in such a plain way that there will be no chance for a misunderstanding as to what any particular price is intended to cover.

(To be continued.)

RAILROAD SHOP MANUFACTURING.

Whether or not manufacturing locomotive parts in railroad shops pays, depends upon circumstances, upon machinery, men and specially upon the competency of the foreman. A decidedly important factor are the prices which can be obtained by the purchasing agent. At the Topeka shops of the Santa Fe, the brass department is fitted up to manufacture repair parts under the direction of an energetic foreman. A certain piece of work, consisting of 8 parts is made complete for $2.12, of which 73 cents is for labor, whereas the makers charge $18.00. This work is done on orders of perhaps 225 in one week. The work goes through in systematic order, each process being completed by itself and the parts passed on for the next step. By use of special undercut tools the work is done both rapidly and accurately and all such work for the entire road is concentrated here. This permits of keeping the department full of work and the machinery operates to good advantage.

One machine is occupied in making metallic rod packing at a labor cost of 5½ cents per set of 6 rings. Three-quarter-inch globe valves are made at a labor charge of 14 cents each. These figures are taken from the statements of the foreman and are understood to cover the actual cost of labor at the machines. Drain cocks are made in lots of 1,800 with a labor cost of 9 cents each, including grinding in on a special automatic machine. Allowing 23 cents for material, the cost is 34 cents each, against $1.19, the manufacturer's price. Hose nuts are made in lots of 200, with a charge of less than 2½ cents each, for labor. This department has the following machinery equipment:

2 20-in. and 1 24-in. American Fox lathes.
1 24-in. Lodge & Shipley brass lathe.
3 American and 2 Warner and Swasey 18 in. turret lathes.
1 15-in. Warner & Swasey Fox lathe.
1 2 spindle Warner & Swasey milling machine.
1 Large Becker-Brainard hand milling machine.
1 15-in. Pratt & Whitney plug lathe.
1 15-in. American engine lathe.
2 Jones & Lamson's turret stud lathes.
3 Niles and 2 Burden & Oliver turret stud lathes.
1 Special drain cock grinder.
1 Tool grinder.
2 Emery wheels.

The department employs 22 men and is located in the gallery of the Topeka locomotive shop.

HEAVY FREIGHT LOCOMOTIVES.

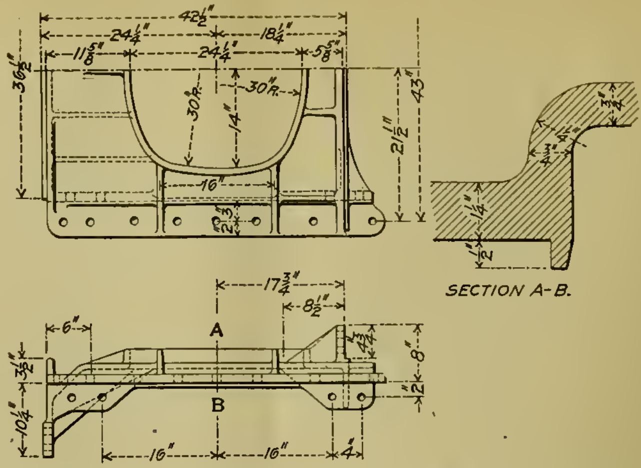
LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

2-8-0 TYPE.

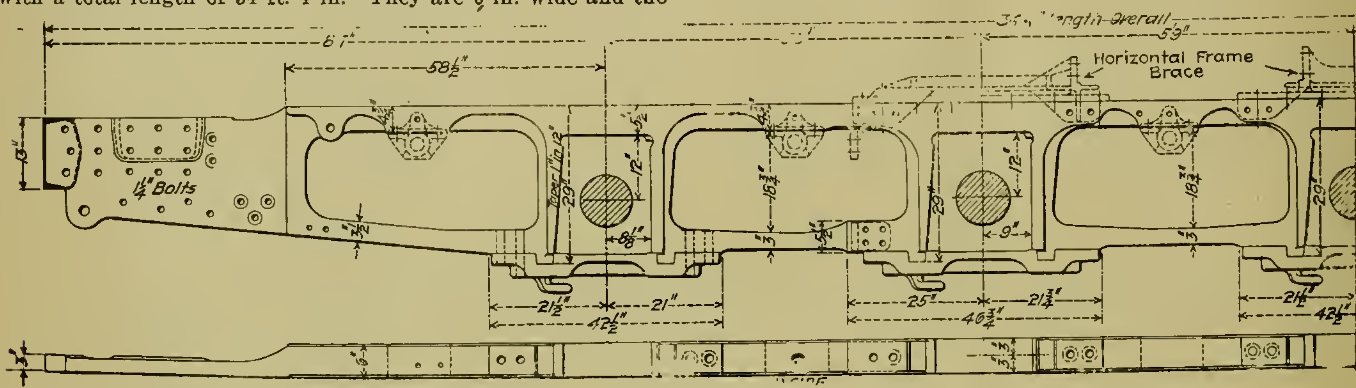
FRAMES, LEADING TRUCK AND ASH PAN.

The previous articles on this locomotive appeared in this journal in November and December of last year. The frames constitute a radical departure from ordinary construction and for that reason are presented in detail, and at the same time an account of some experiments to determine the deflection of locomotive frames in service is given in this number. This investigation, conducted by Mr. Vaughan led to the conclusion that diagonal bracing of the frames is necessary and consequently such bracing has been applied on these engines, such bracing has been sometimes provided at the mud ring, but this is the first application we have seen of this principle between the cylinders and the back end.

These frames are of cast steel and made in a single piece with a total length of 34 ft. 4 in. They are 6 in. wide and the



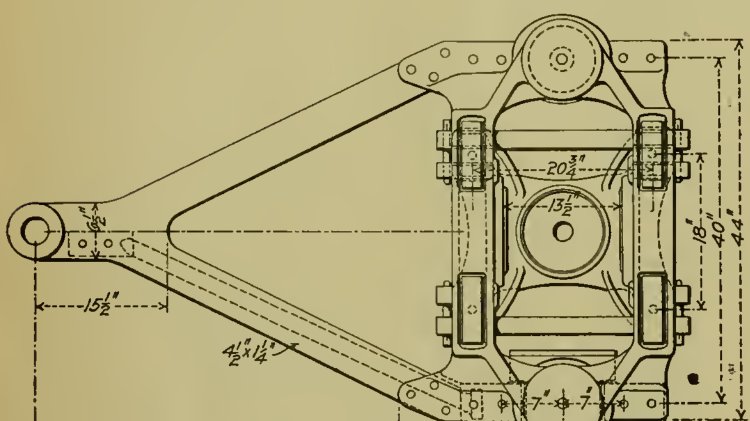
HORIZONTAL FRAME BRACE, OF CAST STEEL, OVER MAIN DRIVING AXLE.

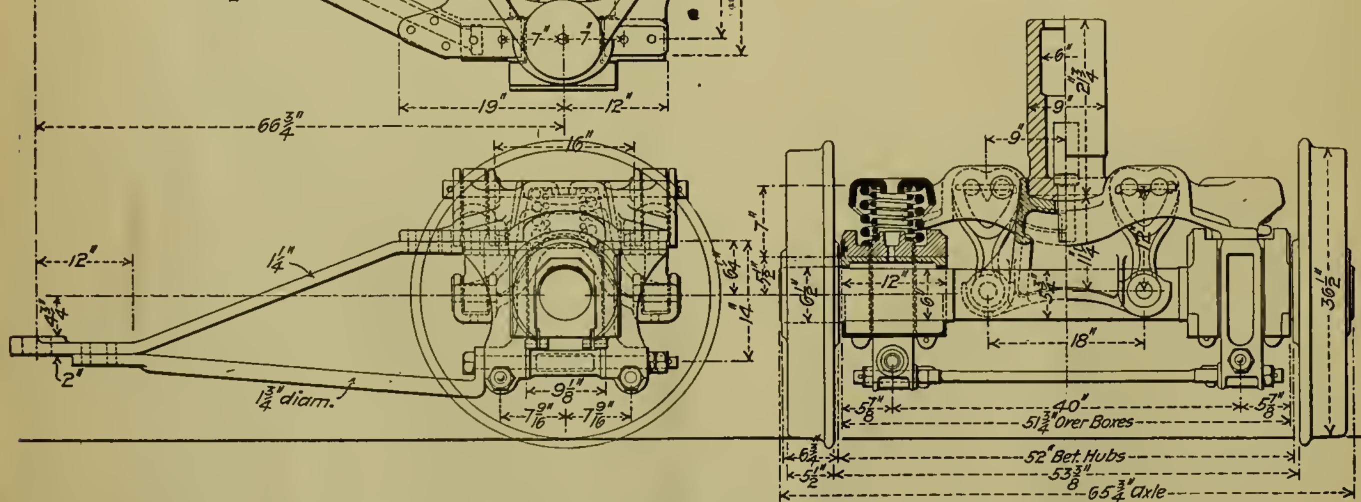


ELEVATION AND PLAN OF CAST STEEL FRAME, MADE ALL IN ONE PIECE.

(Showing location of horizontal frame brace.)

sections were selected with a view of securing good castings. For example the fillets are large and I sections are used pretty nearly the full length of the frames. It is not a new plan for these builders to make frames in one piece, but they have never before, and it is believed that no one else has used a width of 6 in. In the recessed portions which are not machined the width is 5¼ in. This unusual width is given in order to increase the lateral stiffness of the frames and in this respect current practice seems to be deficient. For example, no one would think of raising a full length locomotive frame by a crane with a single sling in the middle of its length. If the





DETAILS OF THE "PONY" LEADING TRUCK, WITHOUT EQUALIZERS.

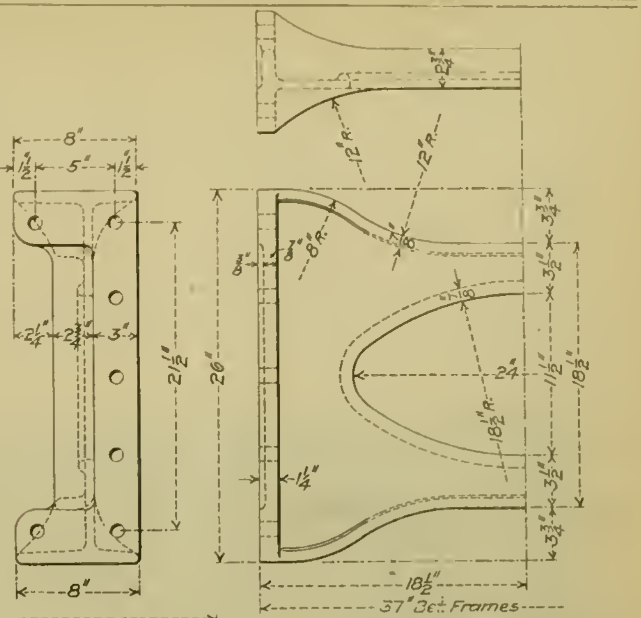
CONSOLIDATION (2-8-0) FREIGHT LOCOMOTIVE. — LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

H. F. BALL, *Superintendent Motive Power.* AMERICAN LOCOMOTIVE COMPANY, BROOKS WORKS, *Builders.*

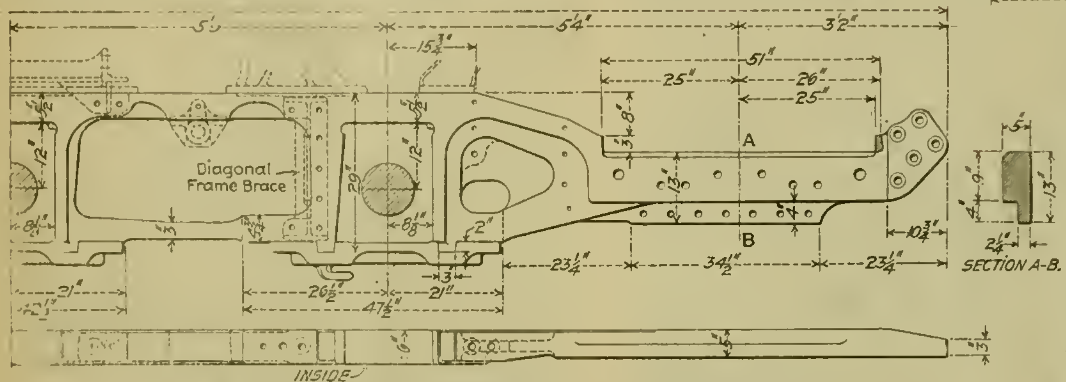
frame did not break it would buckle and spring under such treatment; yet the same frame is called upon to withstand the side thrusts of a heavy locomotive with no diagonal bracing.

While frames are stiff vertically and are tied to the boiler at frequent intervals and are also tied across the engine at the bottom rails, there has been nothing to prevent both bottom rails from moving laterally together and setting up torsional stresses on this account. This design includes a rigid front deck casting embodying the spindle guide and bumper brackets to which the frames are secured; it provides a wide cast steel cross-tie over the main driving axle, another over the third driving axle, a plate brace and cross-tie to support the front end of the firebox, giving diagonal bracing at that point, and a large, deep transversed brace in a vertical plane across the frames at the forward driving axle. Thus transverse, diagonal bracing is provided at the firebox end of the frames, and also at the forward driving axle.

This construction will be watched with great interest. If Mr. Vaughan is correct in the opinion of the importance of such diagonal bracing, as is given to bridge trusses, in the case of locomotive frames this design will mark a new departure in locomotive frame construction. On another page in this issue is printed an account of the experiments which led up to this form of bracing. (See page 8.)



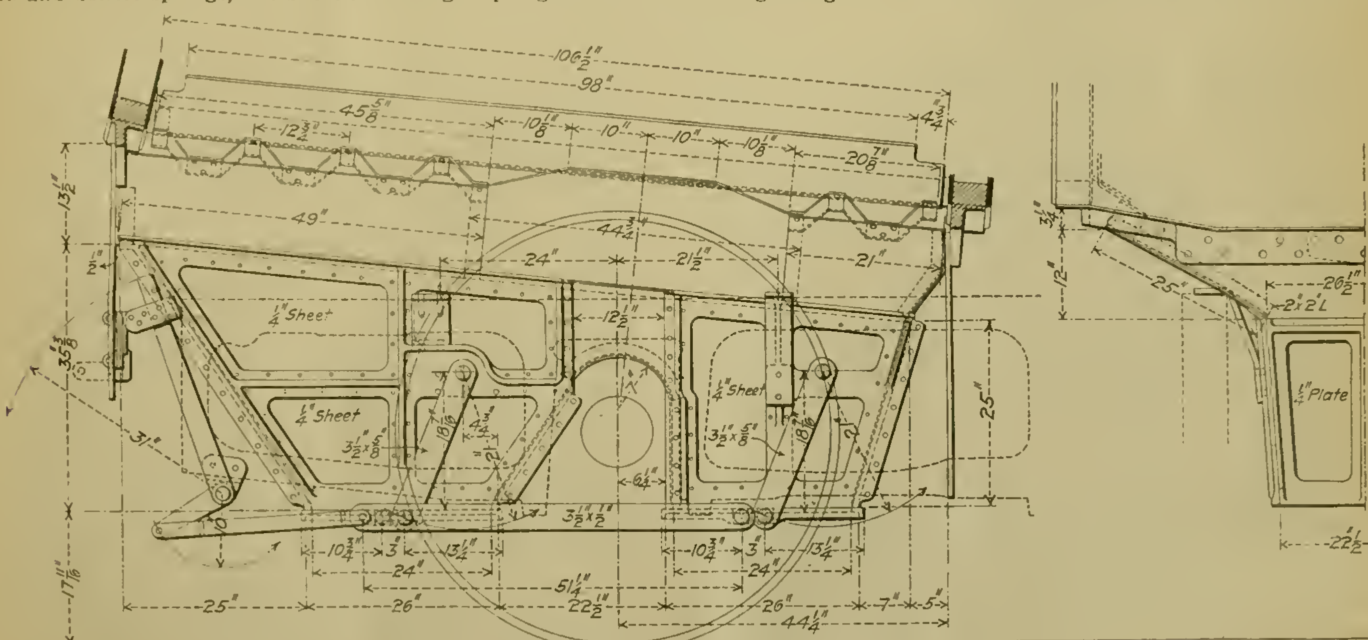
VERTICAL DIAGONAL FRAME BRACE OF CAST STEEL, AT REAR OF LEADING AXLE.



CONTINUATION OF FRAME, SHOWING LOCATION OF VERTICAL DIAGONAL BRACE.

In a two-wheel or "pony" truck, equalizers are useless as far as performing the equalizing function, as in a four wheel truck, is concerned. They serve to transfer the weight of the front end of the engine to points where it may be provided for. As usually applied they necessitate cutting away vital parts of the lateral ribs of the frame and they necessarily complicate the construction. This truck does not use equalizers and double springs, but substitutes single springs over the boxes after the method used in Fox trucks. This permits of securing ample strength in the frame casting, and it does away with a large number of parts. This truck has three point hangers 12 ins. long, calculated to offer an initial lateral resistance ratio of 0.146 of the weight on the truck. The design of this truck seems admirable.

About a year ago this road experimented with a new ash pan in order to avoid the serious trouble of cast iron hoppers cracking under the heat. The result was so satisfactory as to lead to the adoption of the new plan. This construction embodies a cast steel frame, with plate steel side sheets. The frame, being on the outside, is protected from the heat caused by accumulations of ashes inside the pan. All sheets are punched to templets, and if one burns out, it is easily replaced, involving no further injury to the ash pan. With this construction the Brooks hopper slides are applied as indicated in the engraving.



THE NEW ASH PAN CONSTRUCTION, OF PLATE STEEL SHEETS UPON A CAST STEEL FRAME.

THE APPLICATION OF INDIVIDUAL MOTOR DRIVES TO OLD MACHINE TOOLS.

McKees Rocks Shops.—Pittsburgh & Lake Erie Railroad.

By R. V. Wright, Mechanical Engineer.

VI.

Slotting Machines.

The individual motor drive can usually be applied to an old slotter very easily and with very little expense, outside of the cost of the electrical apparatus. The question to be considered, on an old tool of this type, is not so much as to what speed the cutting tool will stand, but rather as to how many strokes per minute the tool itself can stand without excessive vibration.

Figs. 26, 27 and 28 illustrate the application of a motor drive to a 19 in. slotter, built by the Putnam Machine Co., Fitchburg, Mass., which was long in use at the old shops at McKees Rocks. In the case of this tool, the belt cone, which was formerly used for the drive, and to the end of which was keyed the small pinion to mesh with the large gear wheel, was simply replaced by a sleeve which had the small gear cut into its end to serve the purpose of the small pinion. The details of this sleeve, representing the only change in the machine, are shown in Fig. 29. On the sleeve is placed the Morse silent chain sprocket and a 24-in. fly wheel, as shown in the accompanying drawings.

The motor is placed on a railbase, so that slack in the silent chain can readily be taken up whenever necessary, and this base is in turn placed on oak blocking which is fastened to the floor. This raises the motor high enough above the floor to protect it from sweepings, etc., and since it is at the rear of the tool there will be no danger of cuttings falling upon it.

The large chain sprocket and the fly wheel were at first placed near the outer end of the sleeve thus allowing the motor to be brought quite close to the machine, and making the use of a very short chain possible; the vibration caused by the pull on the chain which varies at different parts of the stroke, due to reversal of the cutter head, was so great that it became necessary to move the sprocket and flywheel inward, and as close to the frame of the machine as possible. The distance between chain sprocket centers could be reduced somewhat, however, from that shown on the drawing, by allowing the corner of the motor to lap over the base of the tool. But the chain, as now in use, runs very smoothly and there is no whipping action caused by shocks due to reversal.

The range of speeds required on this tool is not very great, so that, on account of the complication which would be intro-

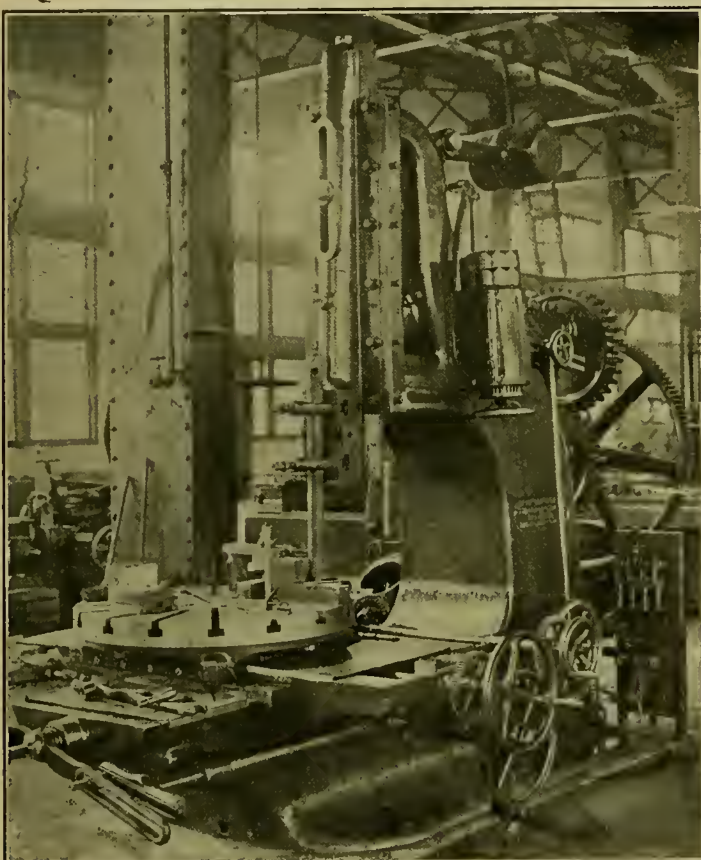


Fig. 26.—View of the 19-in. Putnam Slotter, Showing Arrangement of Controller, Tablet Board, etc.

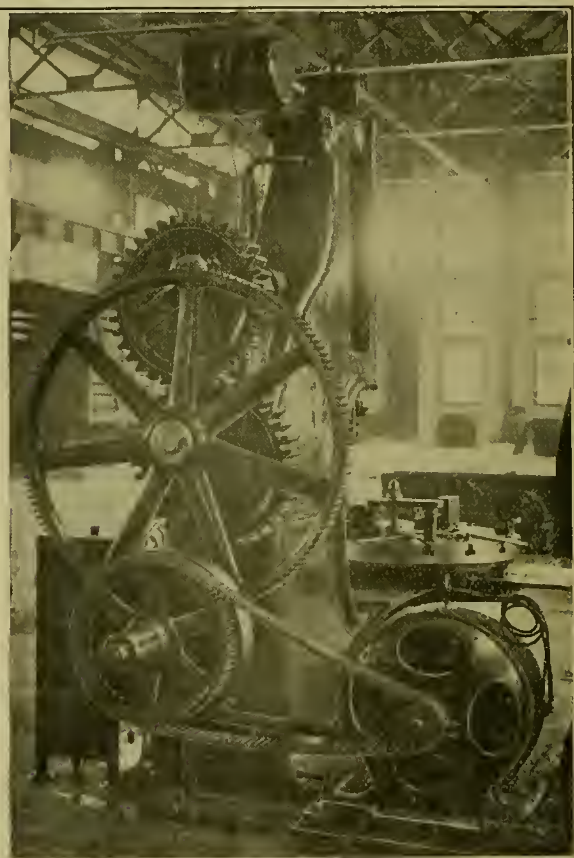


Fig. 27.—View Showing Details of the Motor-Drive Arrangement.—13-H.P. Crocker-Wheeler Motor.

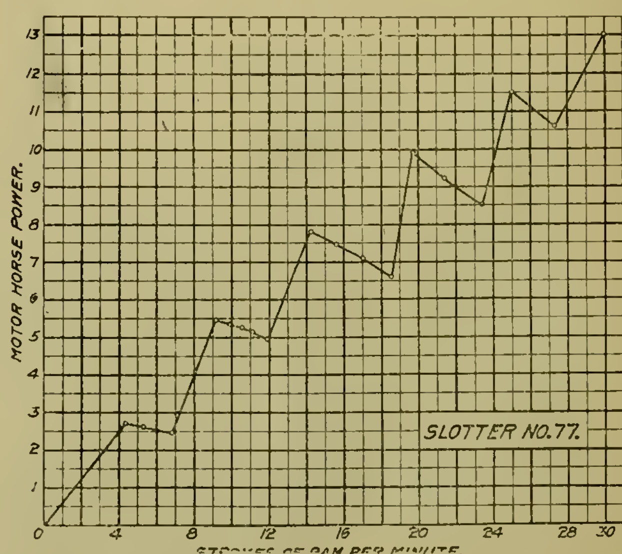


Fig. 30.—Diagram to Show the Variations of Power, as Well as Also the Number of Strokes of the Ram for Each Controller Point.

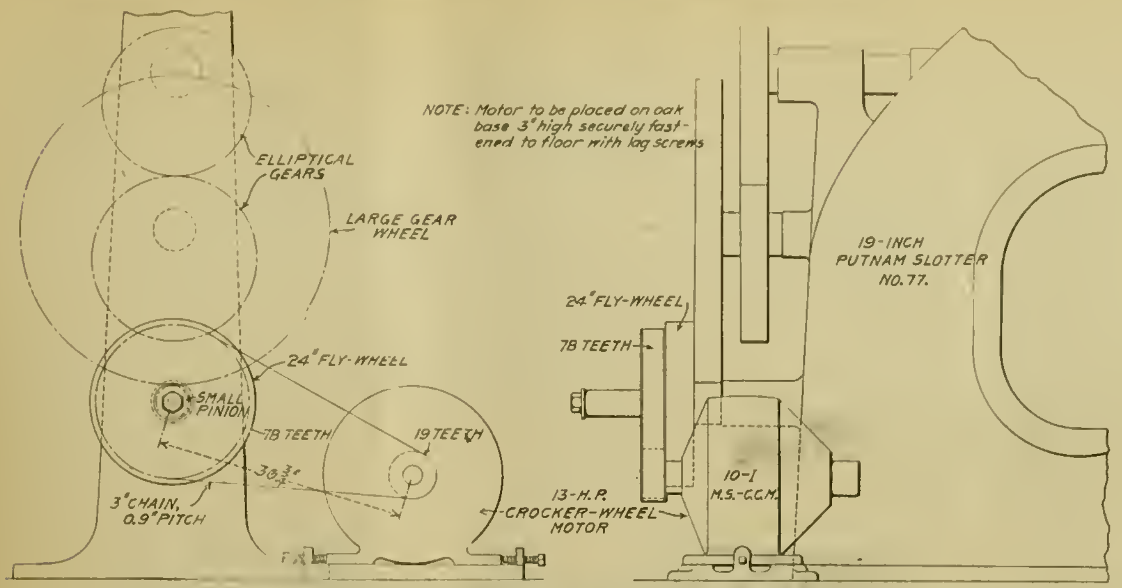


FIG. 28.—PARTIAL VIEW OF THE PUTNAM SLOTTER, SHOWING DETAILS OF MOTOR-DRIVE EQUIPMENT.

FIG. 29.—DETAILS OF THE NEW SLEEVE.

duced by adding another run of gears and a clutch, it was decided to merely use a larger motor—one of sufficient size to cover the entire range of speeds necessary. A multiple-voltage motor of the 10-I, M.S., C.C.M.-type, built by the Crocker-Wheeler Company is used, which will develop 13 h.p. at the full voltage of 240 volts (the term C. C. M. refers to the compound-wound type of motor). Fig. 30 shows diagrammatically the power available at, and also the number of strokes which the machine will make with each controller point. The controller is fastened to the side of the tool, as shown in Fig. 26, at a convenient point for the operator.

A few rough experiments have been made on this slotter, with the flywheel on the drive removed and with it in place, in order to determine its effect in assisting the motor at reversals. On account of the use of the elliptical gears which regulate the ratio of the speed of the return stroke to that of the cutting stroke, the speed of the head as it begins to reverse, accelerates gradually, instead of suddenly, as with the Whitworth motion. For this reason the increase of load on the motor due to the reversal of the head is not as great as it would be with the more sudden change. It amounts to considerable, however, and at long strokes the flywheel reduces the extra load on the motor to some extent.

The effect of the flywheel would be very much greater if it could be placed on an extension of the armature shaft of the motor, but this would necessitate a special armature shaft which was objectionable, since it had been thought best to keep all motor parts standard.

Fig. 31 shows the details of a motor-drive application to a 12-in. slotter, built by the Betts Machine Company, Wilmington, Del., which had also been in use at the old shops. The belt cone which received the drive, was in this case also, simply removed and replaced by the large Morse chain sprocket, as shown.

It was necessary here to place the motor directly under the arm which supported the old cone-shaft, so that the silent chain leading to this sprocket would not interfere with the arm.

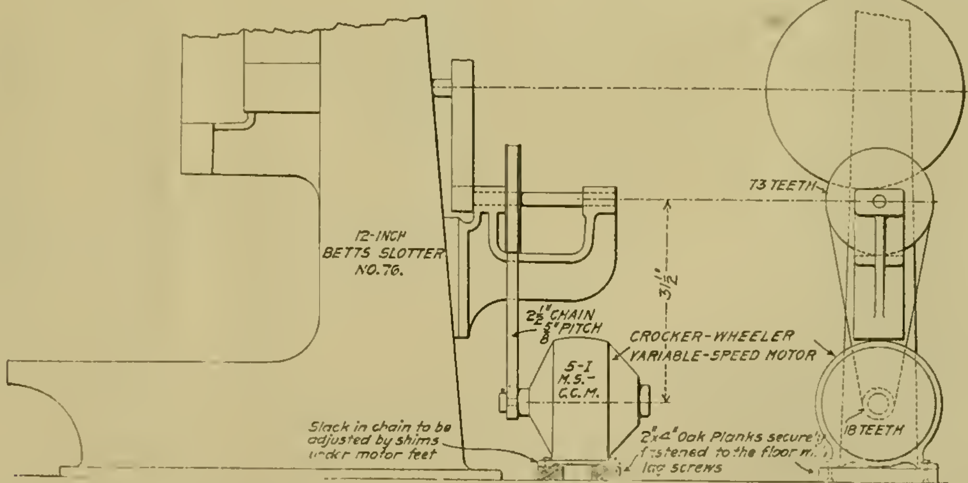


FIG. 31.—DETAILS OF THE MOTOR-DRIVE APPLICATION TO THE 12-IN. BETTS SLOTTER.

The maximum number of strokes which this slotter can make with its new driving equipment is 35 per minute. The other details of this application are shown in the drawing, Fig. 31. No flywheel was used upon this drive.

The Crocker-Wheeler Companies type M. F.-21 controller is used for both of these slotter equipments. It had, at first, been thought advisable to use, for this class of tools, the type M. A.-12 controller, which will be remembered from the second article of this series to be the controller using resistance in the armature circuit to obtain the intermediate speeds. But after a series of tests it was decided to use the type M. F.-21 controller, which obtains the intermediate speeds by field control, although the latter type furnishes a somewhat greater speed range than is necessary for these tools.

HEAVY NEW FREIGHT LOCOMOTIVE.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

2—8—0 TYPE.

With considerable interest comes the announcement that the New York Central is receiving an order of 23 new consolidation locomotives, which are similar to the tandem-compound consolidation locomotives of the class "G-4," described on page 174 of the May (1903) issue of this journal, except that these are simple engines. These are known as class "G-5" in the locomotive classification of this road, and are somewhat lighter than the tandem-compounds. Their tractive effort, which is 45,700 lbs., is relatively high for their weight and heating surface. This gives them a rating of 45.7 on the 100 per cent. basis of 100,000 lbs., which is used on the New York Central. The other interesting details of these locomotives are indicated in the following specifications. It will be noticed that a considerably larger and longer boiler is used on these engines than on the tandem-compounds, and still the heating surface is somewhat less. In the tandem-compounds 507 2-in. tubes are carried in a 77-in. boiler, while in these engines there are only 458 2-in. tubes in an 80-in. boiler; this cannot help but favor the steaming qualities of the boiler, and is commendable practice.

The following ratios and dimensions furnish a basis for comparison with other engines:

Ratios.

Heating surface to volume of cylinders	= 255.8
Tractive weight to heating surface	= 50.2
Tractive weight to tractive effort	= 4.29
Tractive effort to heating surface	= 11.7
Heating surface to grate area	= 69.2
Tractive effort × diameter of drivers, to heating surface	= 737.8
Heating surface to tractive effort	= 8.56%
Total weight to heating surface	= 56.1

General Dimensions.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal
Weight in working order	219,000 lbs.
Weight on drivers	196,000 lbs.
Wheel base, driving	17 ft. 0 ins.
Wheel base, rigid	17 ft. 0 ins.
Wheel base, total	25 ft. 11 ins.

Cylinders.

Diameter of cylinders and stroke of piston	23 ins. x 32 ins.
Horizontal thickness of piston	6½ ins. and 7 ins.
Diameter of piston rod	4 ins.
Kind of piston packing	Cast iron
Kind of piston rod packing	U. S. Metallic with Gibbs Vibrating Cup

Valves.

Kind of slide valves	Piston
Greatest travel of slide valves	6 ins.
Outside lap of slide valves	1 ins.
Inside lap of slide valves	Line and line
Lead of valves in full gear	Line and line at front; ¼ in. lead at ¼ cutoff
Kind of valve stem packing	U. S. Metallic

Wheels, Etc.

Diameter of driving wheels outside of tire	63 ins.
Material of driving wheels, centers	Cast steel
Tire held by	Shrinkage
Thickness of tires	3½ ins.
Driving box material	Cast steel
Section of rods	Main, I; side, I

Boiler.

Style	Straight top, radial stay
Inside diameter of first ring	80 ins.
Working pressure	200 lbs.
Thickness of plates in barrel and outside of fire box	13-16 ins., 9-16 ins., 1 in. ¾ ins., ⅝ ins.
Horizontal seams	Butt joint sextuple riveted
Circumferential seams	Double
Firebox, length	105 1-16 ins.
Firebox, width	75¼ ins.
Firebox, depth	front, 79⅛ ins.; back, 63½ ins.
Firebox plates	Sides, back and crown, ⅜ in.; tube sheet, 9-16 in.
Firebox water space	4½ and 5½ ins. front, 4½ and 6½ ins. sides, 4½ and 6 ins. back
Firebox crown staying	Radial
Firebox stay bolts	Taylor iron, 1 in. diameter W. S.
Tubes, material	Worth charcoal iron, No. 11 B. W. G.
Tubes, number of	458
Tubes, diameter	2 ins.
Tubes, length over tube sheets	15 ft. 6 ins.
Fire brick, supported on	Water tubes
Heating surface, tubes	3,693.3 sq. ft.
Heating surface, water tubes	26.15 sq. ft.
Heating surface, firebox	182.5 sq. ft.
Heating surface, total	3,901.95 sq. ft.
Grate surface	56.43 sq. ft.
Ash pan	Sectional and hopper
Exhaust pipes	Single N. Y. C. standard
Exhaust Nozzles	6¼ and 6½ ins. diameter
Smoke stack, inside diameter	20 ins.
Smoke stack, top above rail	14 ft. 9¾ ins.

NEW SIMPLE CONSOLIDATION FREIGHT LOCOMOTIVE. 2-8-0 TYPE.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

AMERICAN LOCOMOTIVE COMPANY, SCHENECTADY WORKS, *Builders.*

Tender.

Tender style	Water bottom
Weight, empty	54,100 lbs.
Wheels, number of	8
Wheels, diameter	33 ins.
Journals, diameter and length	5½ ins. diameter x 10 ins.
Wheel base	20 ft. 6 ins.
Tender frame	10-in. steel channels
Tender trucks	Two 4-wheel center bearing Fox pressed steel
Water capacity	7,000 U. S. gals.
Coal capacity	12 tons
Total wheel base of engine and tender	60 ft. 6½ ins.
Weight, engine and tender, working order	355,450 lbs.

AN EXTENSIVE WATER-SOFTENING INSTALLATION.

TOTAL CAPACITY, 348,000 GALLONS PER HOUR

PITTSBURGH & LAKE ERIE RAILROAD.

III.

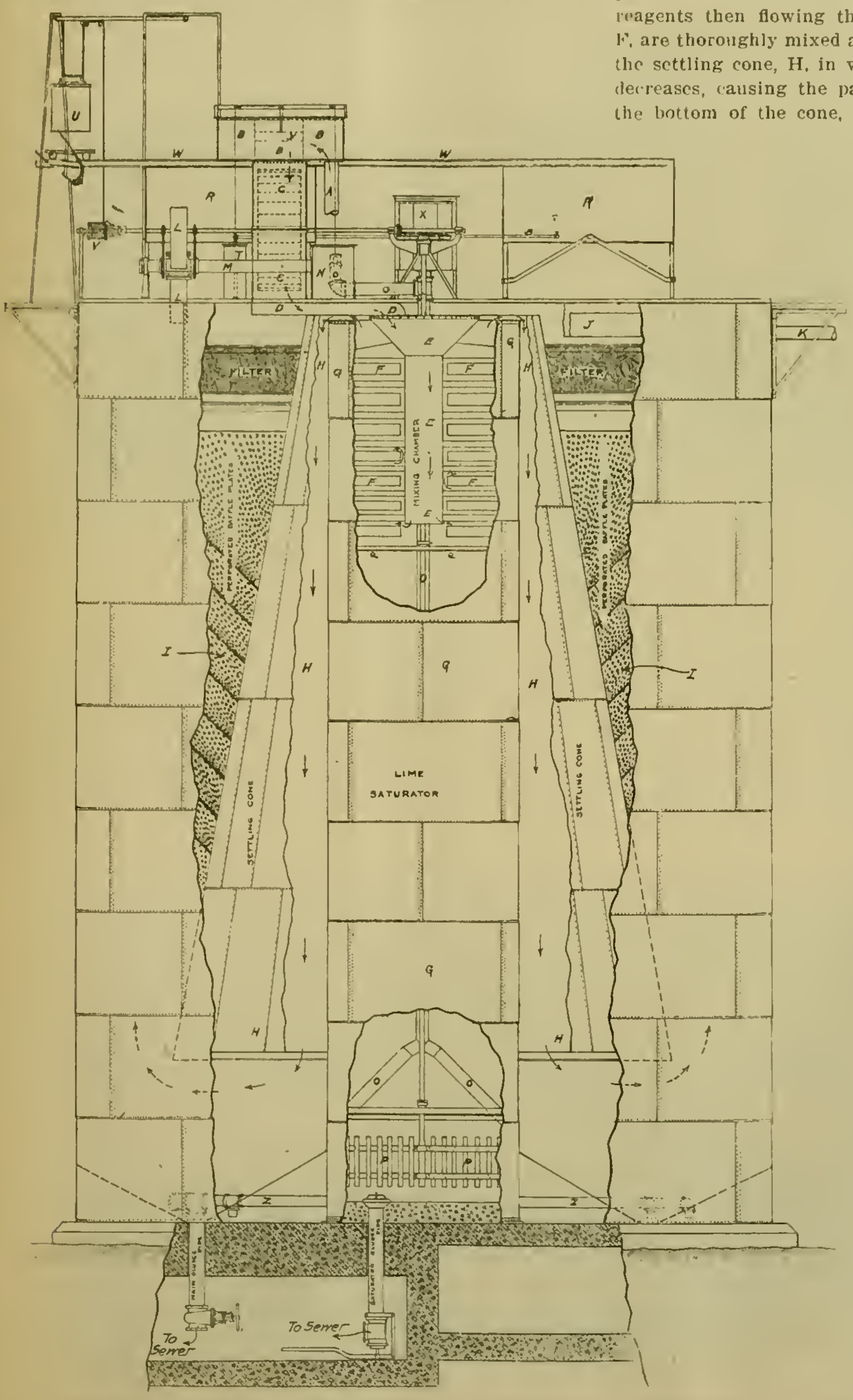
THE MCKEES ROCKS WATER-SOFTENER.

As stated in the first article of this series, the largest and most important of the ten installations upon the Pittsburgh & Lake Erie for locomotive water supply is the softener located at McKees Rocks, adjacent to the roundhouses and new locomotive shops, this being the most important division point and point of heaviest water consumption upon the system. At this time, however, nearly all of the other locomotive water supply stations of the road are equipped with water softeners, of similar design, but smaller, ranging from 21,000 to 42,000 gallons capacity each, for treating the water before entering the storage tanks. In this article will be considered the details of the type of water-softeners used, which were all built and installed by the Kennicott Water Softener Company, Chicago, Ill., special reference being had to the McKees Rocks installation.

One of the water-softeners, built by the Kennicott Company, installed at Buda, Ill., on the Chicago, Burlington & Quincy, was fully described on page 345 of the November, 1901, issue of this journal, but the changes and improvements that have been made upon the mechanical features of the Kennicott softener since that time make it necessary to completely review its construction. The accompanying engravings present a comprehensive idea of the McKees Rocks water-softener; the drawings illustrate its construction, both a diagrammatic view and a detail construction drawing being presented.

As before stated in this series, nearly all systems of softening water consist in the addition of soda and lime solutions of such strength as may be required by the quality of the "raw" water, and this is followed by the sedimentation of the treated water. In this system, the water is delivered from the source of supply through pipe, A, into the hard-water box, B, above the top of the settling tank, from which it passes through a slot in the bottom, the size of the slot being adjusted according to the amount of water to be treated. Within this box is a float, y, with chains passing over pulleys and connected to hinged inlet pipes in the two boxes or small tanks, N and T, which contain soft water, and the soda solution, respectively. The object of this arrangement is to vary the supply of the chemical solutions from these tanks, in accordance with the rate of supply of raw water, for the proper treatment.

The hard or raw water passing through the slot in the bottom of the tank, B, falls upon a water wheel, C, and thence through trough, D, into the mixing chamber, E, at which point the lime and soda solutions are added. The water and reagents then flowing through the revolving deflector plates F, are thoroughly mixed and agitated; next, it enters the top of the settling cone, H, in which the velocity of flow continually decreases, causing the particles held in suspension to fall to the bottom of the cone, the larger particles serving to carry the smaller ones with them. On reaching the bottom of the tank, the current is reversed, and the water then rises through a series of perforated conical baffle plates, I, as shown; at the same time the velocity still decreases, owing to the increasing diameter of the water space. These baffle plates catch and hold any remaining precipitate; the precipitate slides from these plates so that they never need cleaning. On reaching the top, the water passes upward through a filter compartment, filed with wood fiber, and enters a shallow soft-water tank, J, from which it flows through pipe, K, to the storage tank for supplying the boilers. The bottom of the large settling tank is of a conical hopper shape with discharge outlets for blowing out the sediment.



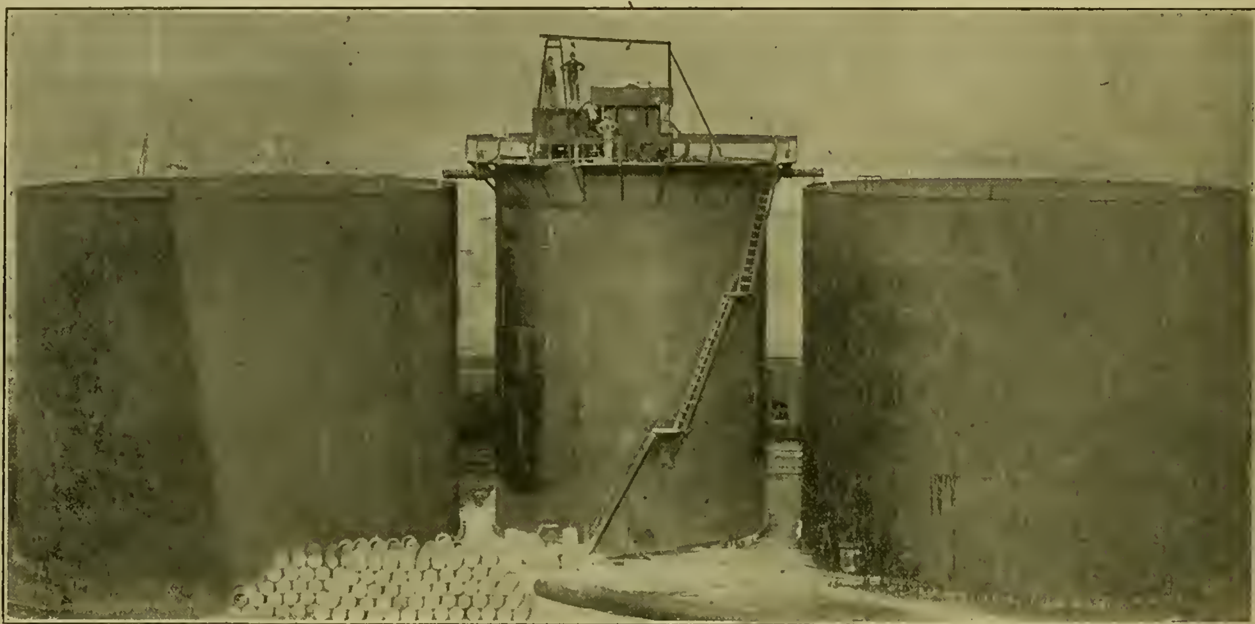
DIAGRAMMATIC VIEW TO SHOW THE METHOD OF OPERATION OF THE MCKEES ROCK WATER SOFTENER.

The lime solution is, in this softener, prepared in the vertical saturator or tank, G, which is located within the settling tank to prevent freezing, instead of outside, as was formerly the practice of the Kennicott Company. The lime is slaked in the box, X, at the top, soft water from the tank, J, being used for the purpose. The water is raised by a wheel, L, having hollow curved arms, open at the ends, which dip into the water, the water flowing through the arms into the hollow shaft, M, and thence into the tank, N, from which its flow to the saturator is regulated by the hinged inlet pipe already mentioned. The soft water is piped through pipe, O-O, to the lime box and thence to the bottom of the saturator, where it is stirred by an agitator or paddle, P, to thoroughly mix it, after which it rises in the cylinder until it enters into the mixing chamber, E, where it is thoroughly agitated with the raw water and the soda solution. The delivery, being by overflow, is always equal to the amount of soft water delivered to the saturator. The soda is placed in wire baskets in two tanks, R, R, from which the soda solution tank, T, is filled by gravity; the supply of water to these tanks, R, is controlled in the usual manner by ball cocks and floats.

The very important features of this type of softeners are easily recognizable in the drawings. The thorough mixture of the chemicals aud the raw water are provided for in the revolving mixing pot and deflector plates, F, in the mixing chamber, and after mixing, a very large storage is provided for the treated water to permit the chemical reactions to take place. The sedimentation chamber is of great size to allow plenty of time to the passing water to precipitate the scale-forming impurities. The cone system of arrangement of tank causes the water to flow with constantly decreasing velocity, so that, in addition to passing through the same in the presence of previously precipitated old sediment and sludge (which is a very important factor, as it favors the precipitation of the impurities), it is comparatively at rest and free from agitation; this condition of precipitation is favored by the deflector plates, F, and also the perforated cone arrangement at I, all of which also tends to prevent any of the raw water from "by-passing," or getting ahead of any of the treated water which has already passed to the settling chamber.

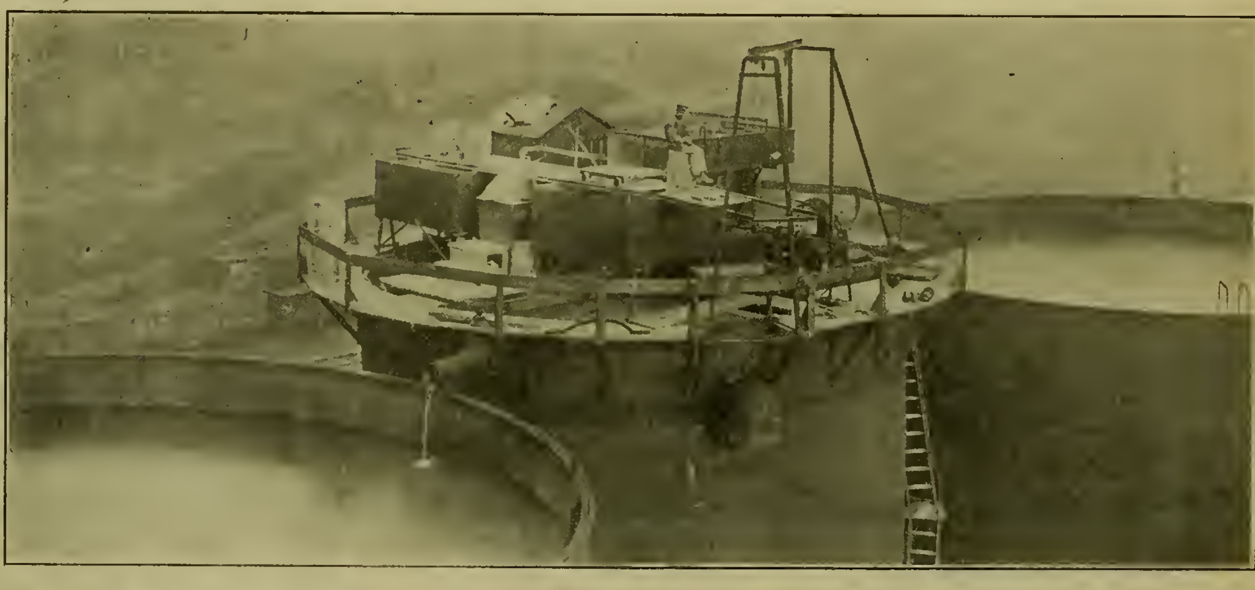
Another of the important features of the Kennicott water-softener is that, while a filter of the most approved type is provided to cleanse the water of the impurities as it is being delivered, it has little to do; the thorough and complete sedimentation process takes care of the greater part of the precipitation, or sludge, by favoring its gradual settling to the bottom of the tank, from which it may be drawn off periodically through the sewer connections. It is interesting to note in this connection that the main sludge-valve is opened twice a day, at each of which times over a ton of scale-forming matter is discharged in the form of a soft sludge. The filter is easily cleaned and practically no water is wasted in cleaning it; it is only necessary to draw off the sludge, which drops the water level in the tank down below the filter, which causes the water to flow backwards through the filtering material, thoroughly cleaning it. This material is usually wood fiber, or excelsior.

A most important feature of the Kennicott softener is the apparatus for regulating the flow of the chemical solutions into the mixing chamber for action upon the raw water. The chemicals used, which are lime (for the removal of carbonates of lime and magnesia) and soda ash (for the removal of sul-

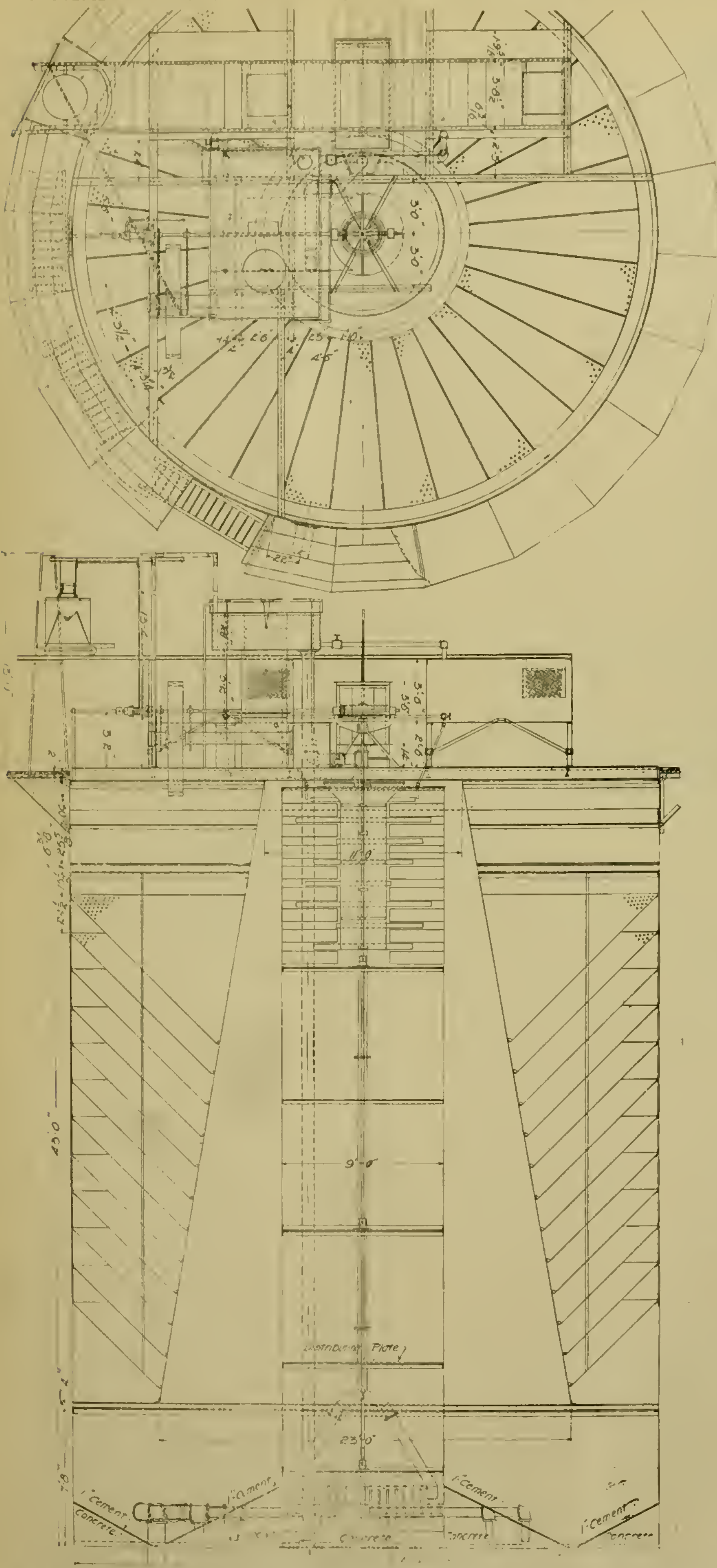


GENERAL VIEW OF THE LARGE KENNICOTT WATER SOFTENER.——CAPACITY 60,000 GALS. PER HOUR. ON EITHER SIDE IS A 500,000 GAL. STORAGE TANK FOR THE TREATED WATER SUPPLY FOR THE LOCOMOTIVES.

WATER SOFTENING INSTALLATION AT McKEES ROCKS.—PITTSBURGH & LAKE ERIE RAILROAD.



AN INTERESTING VIEW OF THE TOP OF THE McKEES ROCKS WATER SOFTENER (TAKEN FROM ROOF OF THE ERECTING SHOP), SHOWING ARRANGEMENT OF APPARATUS. LARGE SQUARE SODA TANKS AND HOISTING APPARATUS IN FOREGROUND.



PLAN AND ELEVATION VIEWS OF THE MCKEES ROCKS WATER SOFTENER, SHOWING DETAILS OF CONSTRUCTION.

phates of lime and magnesia), are automatically mixed and agitated, and are fed into the raw water at a rate depending upon the flow of raw water into the apparatus. If the water is entering rapidly, the flow of the chemical solutions increases, and vice versa. The details of the apparatus for accomplishing this end will be fully illustrated and described in the next article of this series.

A few of the interesting features of construction of this large softener at McKees Rocks should be here referred to. As may be noted from the detail construction drawing, the main tank is 32 ft. 7 ins. in diameter and 43 ft. high. An idea of the size of this tank may be gained from the view of the plant on page 18. The large storage tanks for treated water, one of which is located on each side of the softener, are each 50 ft. in diameter and 40 ft. high, each having a capacity of 500,000 gals. of water.

The lime saturator tank, which is located within the main tank to prevent freezing, is placed concentric with the outer tank and is 9 ft. in diameter. The upper end of this tank is utilized for the mixing chamber and the deflecting and mixing vanes, F. Then around this tank is the cone which forms the settling chamber; this cone, which is 35 ft. high, is 11 ft. in diameter at the top and 23 ft. in diameter at the opening at the bottom.

The bottom of the main tank is filled in with a concrete filling, surrounding the lime saturator tank, to provide sloping conical surfaces directed toward the large sludge-discharge outlets. These outlets are of large pipe with projecting nipples pointing down to the lowest portions of the slude pit, so that in discharging all the sludge will tend to be removed first.

The interesting details of the automatic features of this apparatus will appear in full in our next issue. The entire installation of water softeners upon the Pittsburgh & Lake Erie was designed and huit by the Kennicott Water Softener Company, Chicago, Ill.

(To be continued.)

PERSONALS.

Mr. P. H. McGuire has been appointed master mechanic on the Great Northern. He will have charge of the Superior & Mesabi divisions, with office at Superior, Wis., vice Mr. G. A. Bruce, promoted.

Mr. T. M. Ramsdell, who was recently appointed master car builder of the Chesapeake & Ohio, will have his headquarters for the present at Richmond, Va. He will look after matters pertaining to car building and repairs, and will report to the superintendent of motive power.

Mr. Thomas Roope has been appointed to the position of assistant superintendent of motive power on the Chicago. Rock Island & Pacific, with headquarters at Topeka, Kan. This office has just been created. He was formerly general master mechanic on the Great Northern.

(Established 1832.)

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

CONTENTS.

On page 6, of this issue, appears an account of some of the interesting experiences which Mr. Basford is meeting on his trip through England, where he is at present. From there he will go to France. Further selections from his correspondence will appear in the next issue.

THE ECONOMY OF THE RAPID DRIVER-TIRE BORING OPERATIONS.

On another page of this issue appears an interesting communication from Mr. J. H. Pattison referring to the article on page 420 of our November issue, relative to the remarkably rapid tire-boring performance in daily practice at the Albany shops of the New York Central. Mr. Pattison discusses the economy of this practice, in relation to the number of helpers required, in a very interesting way; the tabular comparison showing the actual cost of this work per tire is valuable and will prove a revelation to a great many who have previously been satisfied with the old methods of performing this work.

The striking feature of this comparison is, however, that at the Roanoke shops one helper only is required for placing tires on two boring mills, with the aid of adequate crane facilities. This seems to be a decisive argument, backed up by the convincing proof of actual saving, in favor of liberally providing railroad repair shops with crane facilities. It is seldom that we are enabled to present the result upon a particular machining operation, in dollars and cents, of furnishing crane service for the tools.

We hope that these articles will prove of sufficient interest to bring forth further comments from those who have had experience along these lines. In the two articles referred to, most excellent results have been obtained from the machining processes, but, as shown by Mr. Pattison, there is another question to be decided in this connection, and that is, as to whether the conditions under which the machines are being operated are favorable to the greatest economy, or not.

THE ADVANTAGES OF THE WATER SOFTENING PROCESS FOR LOCOMOTIVE WATER SUPPLY.

Criticisms have been offered to the statements, made in our recent article relative to the Extensive Water Softening Installation upon the Pittsburg & Lake Erie Railroad (page 449, December, 1903), as to the loss of fuel due to the effect of scale in the boilers. The statement is sometimes made, and is believed by some, that a crust of scale covering the heating surfaces of a boiler does not retard the transfer of heat from the fire to the water; this belief has its origin in a single set of experiments, crudely conducted some years ago to determine the relative heat conductivity of boiler tubes when clean and when covered with scale. These experiments were, unfortunately, limited by the gross error of having been conducted at a low temperature, so that a true comparison could not be made with the conditions that exist in boiler practice.

In the tests referred to, the above-mentioned, and rather odd, conclusion was arrived at from the length of time which was required by two bodies of water, one surrounding a clean tube and the other a scaled tube, to be raised from cold to the temperature of boiling; inasmuch as the times required were in both cases about the same, it was concluded that no retarding effect was offered by the scale to the transfer of heat. That this is erroneous is evident from the fact that a high temperature was used in heating the cold water, so that a great difference of thermal potential was offered; furthermore, no quantitative test was made. The conditions in a locomotive boiler are far different from the simple conditions offered in such a test, in that the thermal potential difference is much less—particularly so with the high steam pressures that are now being used—and also in that heat is transferred into the water in immense quantities per unit area of the heating surface.

We are not aware that any such experiments have been performed under the true conditions of modern boiler practice, which will indicate anything but the fact that scale on heating surfaces has a great retarding effect upon the transfer of heat; this has certainly been proved beyond all possibility of doubt by the experience of the Pittsburg & Lake Erie Railroad Company. The above-mentioned absurd conclusions from a single set of laboratory experiments have been quoted and re-quoted by various authorities without thought of questioning their validity.

The statement in the above-mentioned article that ⅛-in. of scale upon the heating surfaces of locomotive boilers may be taken as representative of average conditions in this country, may be affirmed by the following remarks of a prominent motive power official of one of our Western railroads, which uses waters comparatively free from scale-forming impurities. He states: "The scale conditions which we meet in operating our locomotives vary according to the waters used. In some districts where we have proportionately very large quantities of carbonate of lime in the water, we are running up as high as 3-16-in. scale on our flues, and on other roads where the water conditions are worse, the scale thickness will go even higher than that. On some other division we will not have, at the end of a year, more than probably the thickness of an egg shell. Of course ⅛-in. of certain kinds of scale is worse than 3-16-in. of some other kinds of scale; where it may happen to be straight carbonate of lime, a scale of 3-16-in. on the flue, will, with the water boiling around it, soften, and the heat penetrates, while with some other scale, where we have sulphate of lime, it is so hard that hot water has no effect on it, and it causes a complete insulation of the tube, to which the water does not get very easily. In the case of crown sheets, where the old crown bars were used, we would sometimes find ½-in. scale there and in cases of excess, ¾-in.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The forty-eighth meeting of the American Society of Mechanical Engineers was held from December 1st to 4th, last, at the society's headquarters, 12 West 31st street, New York. It began with an informal reception on Tuesday evening, December 1, at which time the president delivered the annual address. The various sessions between this opening and the most instructive closing were full of interest, and were attended by the usual features of a pleasant and enjoyable nature. Many interesting papers were presented, and the discussions were interesting and instructive. An interesting feature of the meeting on December 3d, which was held at Steven's Institute, at Hoboken, N. J., was an illustrated lecture upon "Thermit."

Further reference will be made to the papers presented at this meeting. The paper, entitled: "What are the New Machine Tools to Be?" by John E. Sweet, is reproduced in abstract on page 33 of this issue.

The feature of the closing day was the trip to the De Laval Steam Turbine Co., at Trenton, N. J., who placed a special train at the disposal of the society. The most interesting exhibit there was a test under way of one of the new De Laval two-stage series centrifugal pumps which was pumping 400 gallons of water per minute against a delivery pressure of 200 lbs. per sq. in., requiring 58 horsepower to do so.

COMMUNICATIONS.

THE RECORD-BREAKING TIRE-BORING OPERATION

To the Editor:

On page 420 of the November, 1903, issue of your journal, there appeared an article from Mr. Albert H. Reese, of the New York Central Railroad shops at West Albany, N. Y., relative to a remarkable record in boring driving-wheel tires. This work, we have since been informed, was performed on an extremely large and heavy boring mill, built by the Betts Machine Company, Wilmington, Del., having a bed about 11 ins thick and other parts built in proportion. This is surely a very extraordinary machinery record for this class of work and Mr. Reese is entitled to much credit for his efforts in running this tool up to its maximum capacity.

Since reading the article referred to above, however, we have given this subject some little attention, and the following table shows in detail some of the results we have been able to accomplish on 56-in. Latrobe steel driving tires:

ECONOMICAL TIRE BORING.—NORFOLK & WESTERN RAILWAY.

Number.	Cutting Speed (Ft. per Min.).	Feed per Revolution, Rough Cut.	Feed per Revolution, Finish Cut.	Time of Rough Cut (Minutes).	Time of Finish Cut (Minutes).	Time to Set Tire (Minutes).	Time to Remove Tire (Minutes).	Time Lost in Changing Tools, Etc.	Total Time (Minutes).
1	28	¼	⅜	7	8	9	4	3	31
2	22	¼	¾	9	10	6	4	2	31
3	33	¼	⅝	6	8	7	2	3	26
4	28	¼	⅝	7	8	7	4	2	27
5	22	¼	⅝	9	10	6	3	2	30
6	22	¼	⅝	9	5	7	3	2	26
7	28	¼	11-16	7	4	6	3	3	23
8	37⅓	1-6	1-6	15	..	8	3	4	30
9	37⅓	1-6	1-6	14	..	6	2	2	24
10	37⅓	1-6	9-16	7	3	6	4	3	23

The first seven tires, referred to in the above statement, were bored on a Niles boring mill which has been in constant use for more than 20 years. The bed on this machine is now less than 3 ins. thick at the edge. The feed gear, with which it is equipped, is so arranged that the tools will not follow each other, but meet in the center of the work, one feeding upward while the other feeds down. This, however, is no objection for this particular class of work, as any machine operator can soon demonstrate to his entire satisfaction that the quickest way to bore a tire is to rough out with both tools and then finish with a wide tool and a feed of ½-in. to 1-in. per revolution. The finish cut on the tires in tests, Nos. 6 and 7, was fed by hand, as a ⅝-in. feed is all that we can get on this tool by means of the feed gear. It will be noted that the rough cutting speed on the tire in No. 3 was 33 ft. per minute and while the tool will do good work at this speed, on account of the age and worn condition of the machine, we were not able to maintain it.

The last three tires referred to in the table were bored on a Niles boring mill that has been in service at the Roanoke shops about three years. On this machine we were able to run at a rough cutting speed of 37 1-3 ft. per minute—a safe speed for the Allen tool steel which we are using on these machines; but on account of the countershaft being located very close to the main shaft we were not able to take the proper amount of feed in roughing out on account of the belt slipping.

There remains one element to be considered, however, which is not mentioned in the above table, and that is the time necessary to bring the tires into the shop and remove them again. As our tires are unloaded from the cars at some distance from the shop, it requires about five minutes per tire on an average, for each of two men to bring them into the shop, and about two minutes per tire to take them out, as they are dropped just outside the shop where they are afterward put on the wheels. It requires but one helper in our shop to assist in setting and removing tires on the two machines referred to above, his time being about equally divided between the two, as all lifting is done by pneumatic hoist and walking crane.

Assuming, then, that the mechanics in both the Roanoke and the West Albany shops are paid $5.00 per day, and helpers $1.25 per day, a comparison of the actual cost per tire in the two shops would, on a basis of finishing 10 tires, be as follows:

Roanoke Shops.—Norfolk & Western Railway.

Time of mechanic, 4⅔ hrs., at 50c. per hr.	$2.33
Total time of one helper, 4⅔ hrs., at 12½c. per hr.	.58
Total	$2.91
Average cost per tire	.29

West Albany Shops.—New York Central.

Time of mechanic, 3⅔ hrs., at 50c. per hr.	$1.83
Total time of the four helpers, 14⅔ hrs., at 12½c. per hr.	1.83
Total	$3.66
Average cost per tire	.37

J. H. Pattison, Foreman Machine Shop.
Roanoke Shops, Norfolk & Western Railway.

Roanoke, Va.

NEW LOCOMOTIVE AND CAR SHOPS.

McKEES ROCKS, PA.

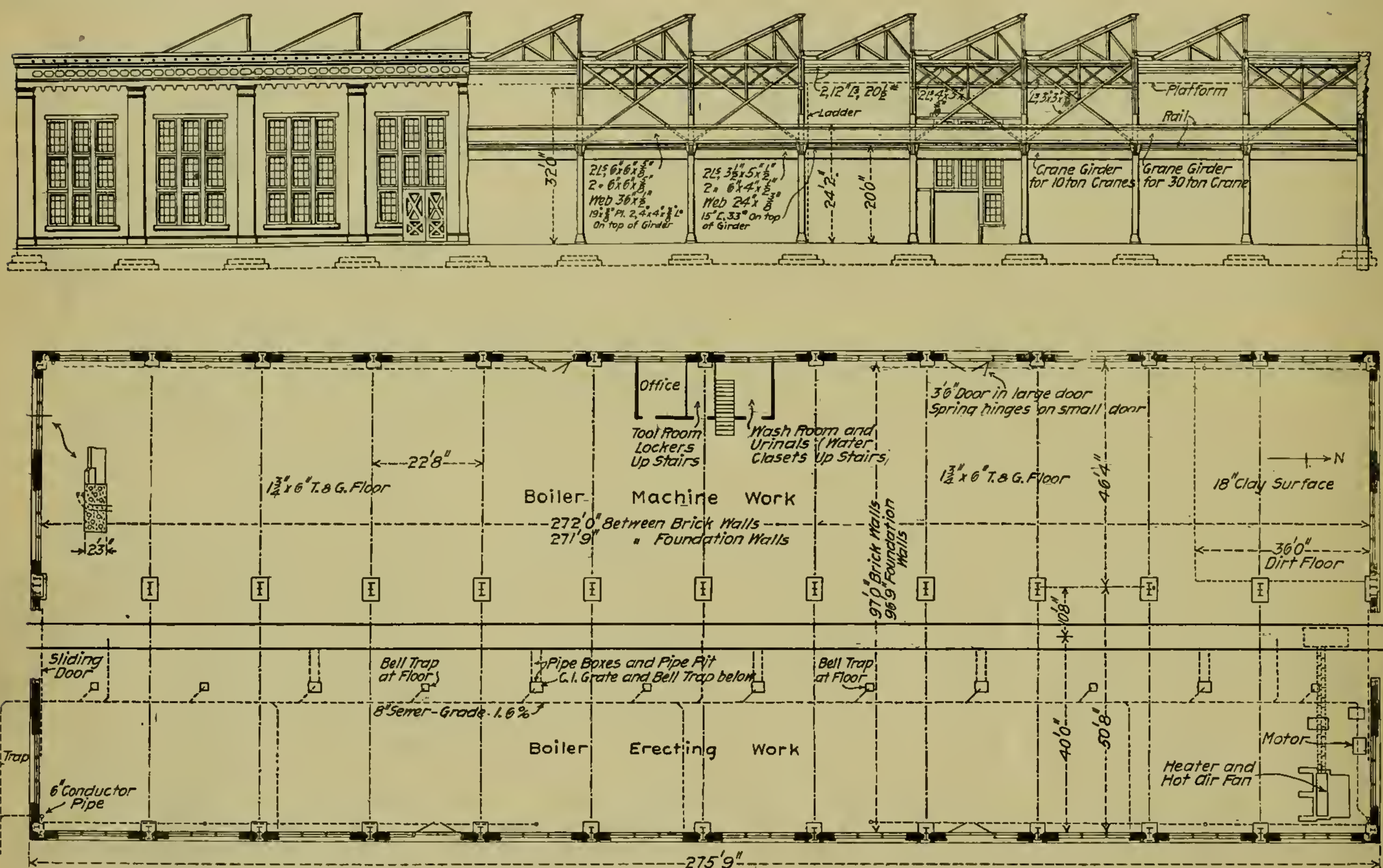
PITTSBURGH & LAKE ERIE RAILROAD.

III.

THE BOILER AND THE BLACKSMITH SHOP BUILDINGS.

In the preceding article the steel work and constructional details of the erecting and machine shop building were illustrated. In this article will be presented the interesting features of the boiler and tank shop building and the blacksmith shop building. We are fortunate in being able to procure, through the courtesy of the engineering department of the system, excellent photographs of the various buildings, which were taken by Mr. R. T. McMasters of that department, the views were well selected to illustrate the interesting features of the shop buildings.

VIEW OF THE BOILER SHOP BUILDING FROM THE EAST.



PART ELEVATION AND PART LONGITUDINAL SECTION, AND PLAN OF THE BOILER AND TANK SHOP BUILDING.

NEW McKEES ROCKS LOCOMOTIVE SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

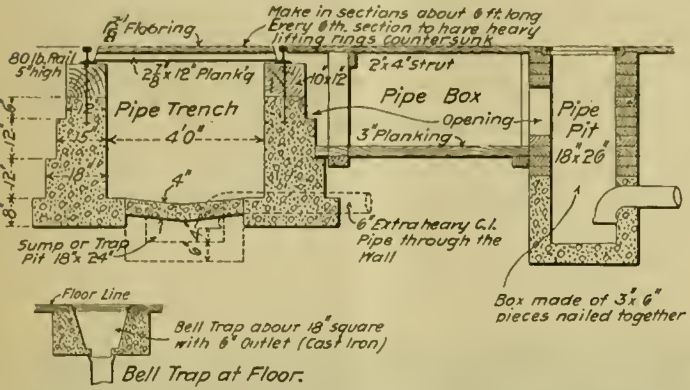
CONSTRUCTION VIEW OF THE BOILER SHOP BUILDING.

These buildings are both of the steel skeleton construction, similar to that used in the main shop building, with the brick work merely tied to the frames for stability. They are of unusually strong and heavy construction and yet, like the erecting and machine shop building, are designed to present symmetrical lines and a pleasing appearance. The design of cornice used is the same on both buildings as upon the main shop building, which serves to unify the appearance and add the neatness of exterior which offsets the extremely plain and business-like design of these structures. Excellent provision for daylight lighting also characterizes these buildings, as may be seen in the exterior views.

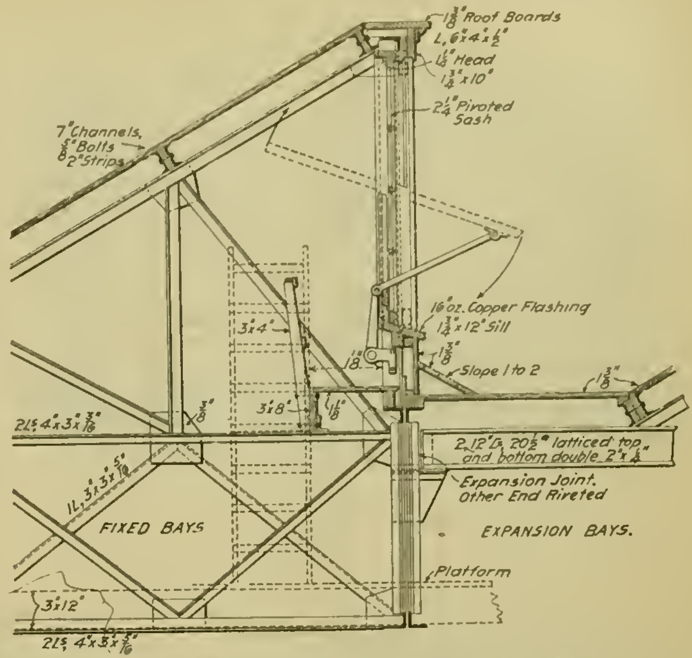
The steel work for these two buildings was also designed by Mr. Albert Lucius, consulting engineer of New York, and it was erected by the McClintic-Marshall Construction Company, Pittsburg, Pa., who erected the machine and erecting shop building.

THE BOILER AND TANK SHOP.

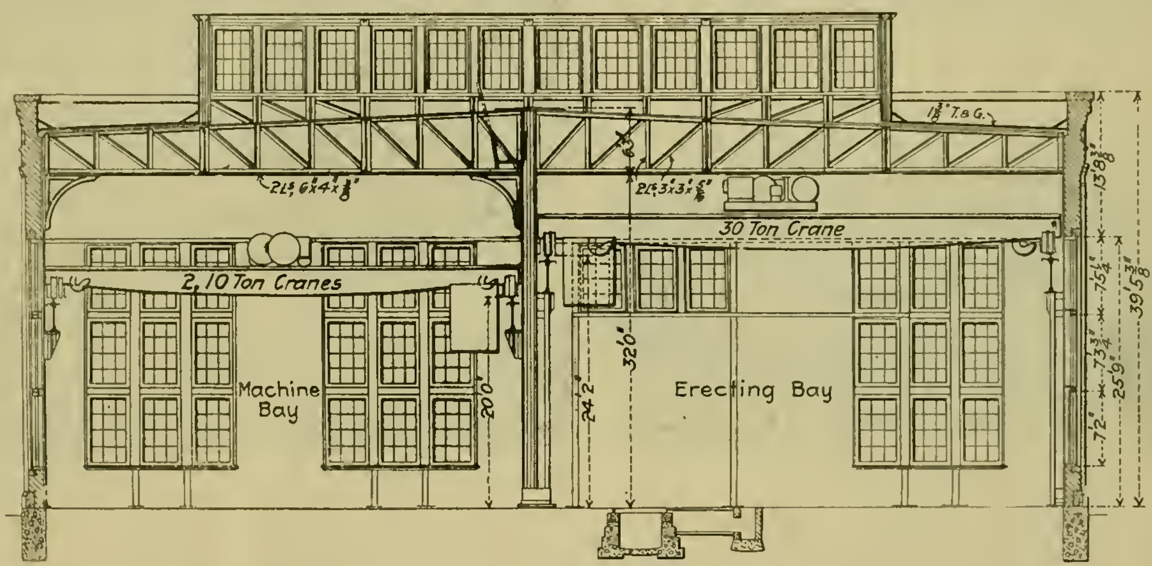
This building is conveniently located to the north and extending at right angles to the main shop. It clears the main shop by 24 ft. between exteriors, thus leaving an ample passageway and yet reducing the distance for carrying material to a minimum. Direct communication is afforded between the two buildings by a track running lengthwise of the boiler shop just to the east of the center line of columns, which extends through and connects with engine pit No. 5 (from the east end) in the erecting shop, so that boilers may be transferred to and from the boiler shop with the greatest possible facility. A considerable space is left open at the east side of this building, for a wheel unloading platform and an entrance track to the main shop; on the west is a space of 50 ft. which separates this shop from the blacksmith shop (see layout plan of the shops, November, 1903, issue, page 396).



CROSS-SECTION OF THE PIPE TUNNEL, SHOWING DETAILS OF CONSTRUCTION AND THE DRAINAGE SYSTEM.



PART VERTICAL LONGITUDINAL SECTION THROUGH THE BOILER SHOP ROOF, SHOWING DETAILS OF SAW-TOOTH CONSTRUCTION.



CROSS-SECTION VIEW OF BOILER AND TANK SHOP BUILDING, SHOWING ARRANGEMENT OF TRAVELING CRANES.

NEW McKEES ROCKS LOCOMOTIVE SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

INTERIOR VIEW OF THE BOILER AND TANK SHOP, IN BOILER MACHINE BAY. (LOOKING NORTH.)

The boiler shop is 275 ft. 9 ins. long and 100 ft. 9 ins. wide, outside, and 272 ft. x 97 ft. inside the walls. The building is divided into two bays by a line of columns extending lengthwise through the shop; the bay on the west side, which is used for the boiler machine tools and plate machinery, is 46 ft. 4 ins. wide, and the erecting bay on the east side, which contains the longitudinal entering track, is 50 ft. 8 ins. wide. The center columns, which are symmetrically located in relation to the side wall columns, are placed 22 ft. 8 ins. between centers, and as shown in the longitudinal elevation view, each span between columns carries one of the saw-tooth sections of the roof. The longitudinal track through the building is located close to the center row of columns, the nearest rail clearing them by 6 ft. 5 ins.

The general plan of the steel work in this building does not differ greatly from that of the main shop buildings. The weight of the roof and of the cranes, is here also provided for solely in the columns, and construction was simplified by making all columns similar, in detail, as far as possible. Longitudinal bracing is provided for in this structure in the two end spans between center columns, and alternately thereafter in groups of two spans each, as indicated in the longitudinal section. An excellent idea of the character of the steel work is to be had from the interior view of the boiler shop, and also the construction views which were furnished by the courtesy of the engineering department.

The floor in this building is made up of 1¾-in. yellow pine plank, dressed and matched, laid on 4 x 4-in. sleepers, which are bedded in sand on earth filling. In this building, however, the electrical distribution system is carried overhead along the side wall, reference to which arrangement will be made in a later article. In the north end of the boiler machine bay the floor is interrupted for a space of 36 x 45 ft. A dirt floor is here provided to accommodate the flue work furnaces and other furnaces required in this shop; this dirt floor is faced with 18 ins. of clay, both the filling underneath and the clay surface having been thoroughly tamped in place.

The roof on this building is one of the most important features. The saw-tooth arrangement of skylighting is used, and in this case it was necessary to locate the windows crosswise of the roof in order to obtain the desired north light. The saw-tooth construction is carried by longitudinal lattice girders built in between the roof trusses in the rigid spans, being omitted in the expansion spans, as shown in the longitudinal elevation. The remaining interesting details are made clear in the detail cross section of one of the saw-tooth skylights. Liberal provision for platforms and connecting walkways has been made, each set of windows having a platform and railing for cleaning, etc. Inside rain conductors are provided for the roof drainage, to eliminate troubles from freezing in cold weather, and the roof covering used is identical with that on the machine shop.

Liberal crane facilities have also been provided for in the boiler shop, the erecting bay being covered by a 30 ton crane, with tracks 24 ft. 2 ins. above the floor, and the boiler machine bay by two 10 ton cranes, with tracks 20 ft. above the floor. The runways for the 30 ton crane are 3 ft. plate girders located for a crane span of 47 ft. 10¼ ins. between centers, and for the 10 ton cranes 2 ft. plate girder runways are used, located 43 ft. 10¼ ins. between centers and supported by structural bracket construction. For the 30 ton crane rails weighing 80 lbs. to the yard are used, and for the 10 ton crane rails weighing 60 lbs. to the yard. The cranes were built by the Shaw Electric Crane Company, Muskegon, Mich., who also supplied the cranes used in the erecting and machine shop building. In general, all the cranes used at the shops, except those in power house, were built by the Shaw Electric Crane Company, and furnished by Manning, Maxwell & Moore, New York.

Another interesting feature of this building is the pipe tunnel and drainage system in the erecting bay. The details of this construction are shown in the building cross section and also in the detail drawing. This tunnel is located beneath the longitudinal track and extends the entire length of the building. The details of the concrete construction, together with the arrangement of the sumps, or trap pits, for drainage, is clearly indicated in the detail sketch. At five points cross pipe box connections are made to the pipe pits, as shown, which serve as outlets for all pipe connections from the tunnel, and also for drainage for the erecting bay floor. At seven other intermediate points along the floor, bell-trap boxes are also provided for additional drainage; one of these bell-traps is also shown in sectional detail. Besides making an excellent outlet system for steam, water and air supply pipes, this arrangement provides a most complete and convenient drainage system, which is so necessary in this shop.

VIEW OF THE BLACKSMITH SHOP BUILDING FROM THE WEST, BEFORE COMPLETION OF STOREHOUSE BUILDING.

INTERIOR VIEW IN THE BLACKSMITH SHOP, SHOWING PROVISION IN THE ROOF STEEL-WORK FOR THE JIB CRANE SUPPORTS.

NEW McKEES ROCKS LOCOMOTIVE SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

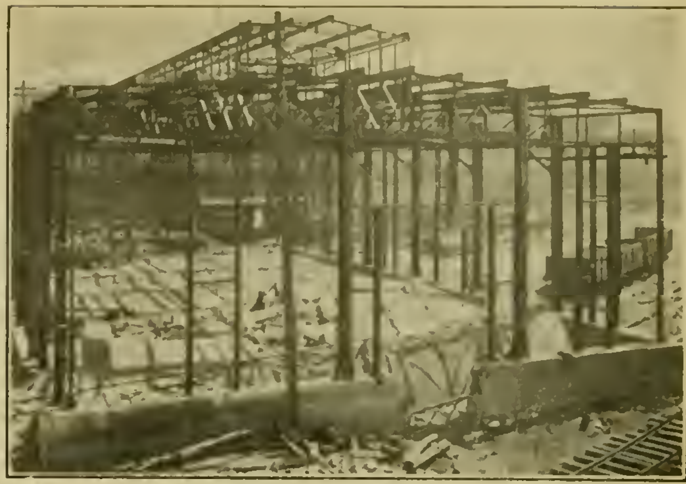
THE BLACKSMITH SHOP BUILDING.

This building is located to the west of the boiler shop and north of the erecting and machine shop, clearing the same by the same distance, of 24 ft., as the boiler shop. It also has direct communication with the main shop by a track extending longitudinally through it and connecting with the track on pit No. 12 in the erecting shop; this affords a convenient means of transferring forgings to the machine shop and also facilitates the handling of frames to and from the smith shop.

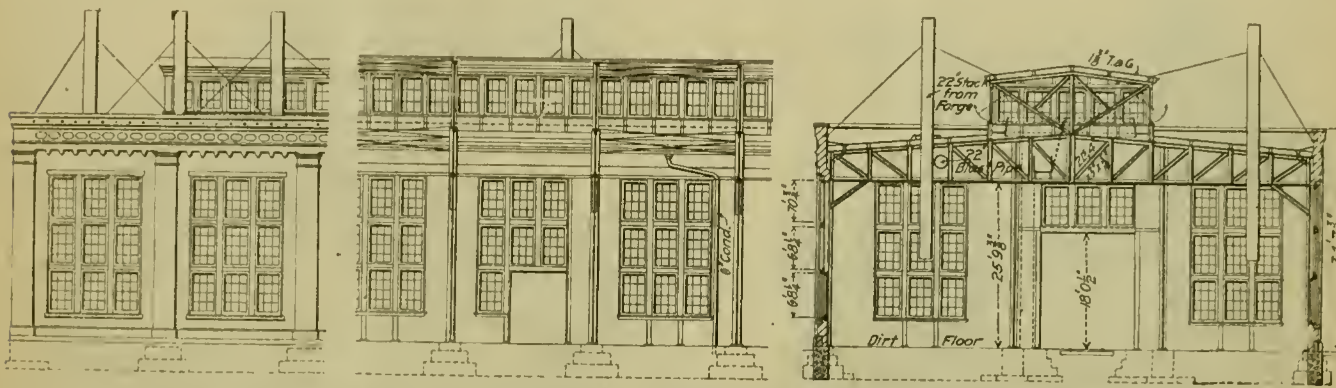
The blacksmith shop building is 201 ft. 9 ins. long and 77 ft. 9 ins. wide outside, and 189 by 74 ft. inside the walls. The longitudinal track is not located in the center of the building, being set 8 ft. to the west of the center line; this arrangement permits a better division of the work. The forge fires, of which there are ten double forges of a new and novel design, are located on the east side of the building, as indicated by the inclined rectangles; this inclined arrangement provides much more room for the handling of pieces in the fires and is much more convenient for the workmen.

The steel work of this building was rendered simple by the use of the single span permitted by the width of 74 ft. The roof, which is of the monitor type, is carried by simple trusses, which are spaced at intervals of 22 ft. throughout the length of the building. The details of the steel construction, as well as of the monitor, are made clear in the cross section and elevation views. The roof construction and covering is similar to that used upon the boiler shop. Liberal provision for ventilation is provided by this monitor arrangement, the side windows of which can be operated from the floor, so that, with the side windows, any desired combination of openings for draft may be made to clear the shop of smoke; walkways are provided on either side of the monitor for access to the windows for cleaning, etc. Inside roof drainage is provided in this building also.

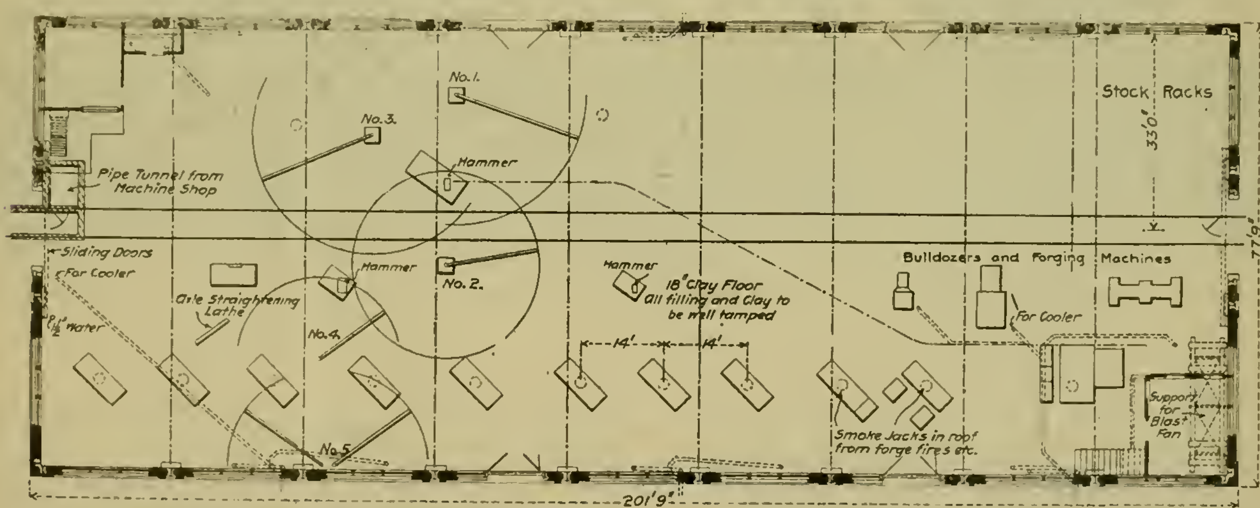
The floor in the blacksmith shop is a clay floor throughout. It is composed of a filling well tamped, and a covering of 18 ins. of clay, which is also tamped solid, thus making a very substantial floor. Ample drainage is provided. The pipe tunnel supplying this building does not extend through; it enters from the machine shop beneath the connecting track and ends just inside the south wall of the building. From that point the piping is carried overhead. The arrangement of apparatus upon the floor is indicated upon the plan drawing. The forge fires extend along the east side of the building, while in the center, and within the radii of the jib cranes, are the steam hammers for heavy forging. At the north end is located the blast fan equipment and the bulldozers and forging machines, on one side, and the stock racks on the other side of the track; in the southwest corner is located the foreman's office. The curved dotted line near the middle indicates the location of a trolley hoist that will be installed for handling material and heavy pieces.



CONSTRUCTION VIEW OF THE BLACKSMITH SHOP BUILDING.



PART ELEVATION AND PART LONGITUDINAL SECTION, AND CROSS-SECTION OF THE BLACKSMITH SHOP BUILDING.



PLAN OF THE BLACKSMITH SHOP BUILDING, SHOWING ARRANGEMENT OF THE FORGES, STEAM HAMMERS, ETC.

NEW McKEES ROCKS LOCOMOTIVE SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

The crane facilities provided in this building are jib cranes, the locations of which are shown on the plan at Nos. 1 to 5, crane No. 5 being a double jib crane. The hammers are thus served in a most complete manner and crane No. 5 serves two of the forge fires for heavy work. Especial provision was made for the jib cranes in the roof steel work; each crane has a heavy concrete foundation and has its top bearing in a heavy gusset specially arranged on the lower side of the roof trusses, in line above the foundation bearing. These cranes are all operated by hand, having been supplied by the Whiting Foundry Equipment Company of Harvey, Ill. Other interesting features of this shop will be presented in a later article.

(*To be Continued.*)

A subscriber writes us as follows in renewing his subscription: "I am much pleased with the American Engineer and Railroad Journal. It fills the bill completely. I desire to say that I agree with your estimate of Mr. W. O. Thompson's paper on 'The Apprentice Question' on page 436 of the December issue. He takes a very common sense view, especially is the point of contact between the foreman and the apprentice well taken."

Germany desires to enter four locomotives for testing on the Pennsylvania Railroad testing plant at the St. Louis Exposition next year. Three of those which are offered are equipped with superheaters.

A NOVEL DESIGN OF ELECTRICALLY-DRIVEN MILLING MACHINE.

WITH DETACHABLE CLUTCH DRIVE.

That a satisfactory solution has been made of the difficulties met with in the problem of designing a successful arrangement for motor driving on a milling machine is evident from a study of the accompanying engravings. This problem has been found quite complex because of the peculiar service to which milling machines are put. The principal points to be considered in the design of such an arrangement are:

(a) the wide range and great number of speeds that are now a necessity for economical milling;

(b) the large amount of power consumed, which requires a motor that is very large as compared to the size of the machine;

(c) the fact of the large number of times a milling machine must be started and stopped in a day.

That these conditions have been thoroughly provided for in this design may be seen from the illustrations, which show a No. 4 plain Cincinnati miller, with motor drive, which was recently brought out by the Cincinnati Milling Machine Company, Cincinnati, O. This is by no means an experiment, but is the result of over four years of careful study of the problem of electric driving as applied to millers. A number of this company's smaller machines on which a similar arrangement is used, are now in successful operation in this country and in Europe.

The design of this machine is based on the conclusion, which is now very general, that the only satisfactory arrangement of a direct connected electric drive for machine tools is obtained by the use of some type of variable speed motor; and in this particular case the builders strongly advocate the use of a shunt-wound direct-current motor arranged for variable speeds by field control. The variation in speeds being obtained from the motor, obviates the use of the usual mass of gearing; and the field rheostat has the advantage that when once set to give the desired speed for a particular job, it need not be disturbed when again starting the machine or motor, and thus eliminates the trouble that arises from setting the lever to the wrong notch, as may happen when the street car type of controller is used.

Reference to Fig. 2 shows the manner in which the motor is mounted on an extension which is cast to, and forms part of, the base of the machine. This brings it near the floor, thereby adding to the stability of the machine, and as the entire motor arrangement is at the rear, it occupies space which would not be available for other purposes because it much be kept free to accommodate the table travel. .

Any one of several well known makes of motor can be used with this arrangement, providing it is shunt-wound and is capable of a speed variation of 2½ to 1. This range is multiplied by the double back gears, giving at the spindle a range of speeds suitable for cutters of 5-16-in. to 6 ins. in diameter at a surface speed of 20 ft. per minute, and for cutters from ⅝-in. to 12 ins. in diameter at a surface speed of 40 ft. per minute, for use with cast iron. It is, of course, evident that such a machine fitted with a shunt-wound motor is thoroughly adaptable for installation in shops employing the multiple voltage system, in which case the motor need only be arranged for that system.

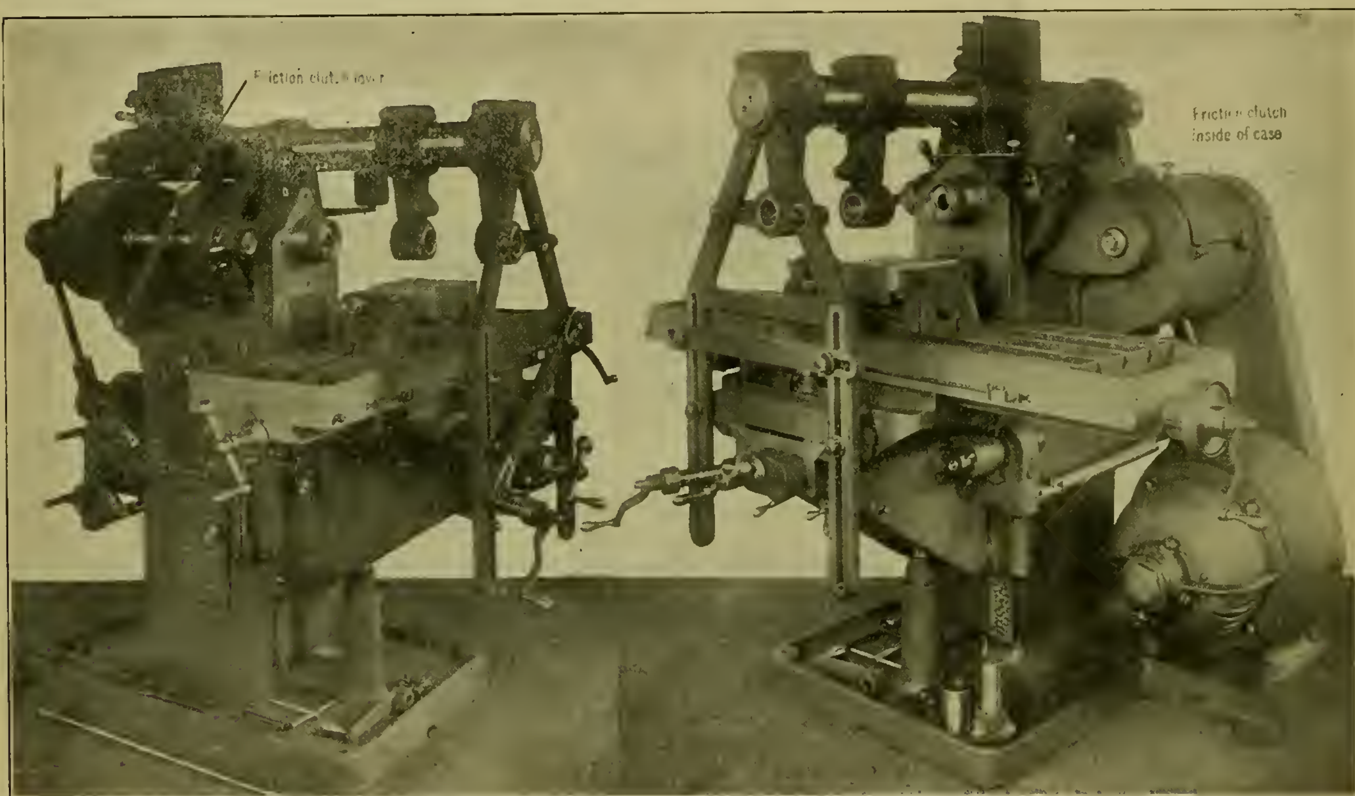


FIG. 1.—FRONT VIEW OF TOOL, SHOWING CONVENIENT ARRANGEMENT FOR OPERATING HANDLES.

FIG. 2.—REAR VIEW OF TOOL, SHOWING ARRANGEMENT OF MOTOR AND FRICTION CLUTCH FOR THE DRIVE.

NEW DESIGN OF MOTOR DRIVING.—CINCINNATI MILLING MACHINE COMPANY.

Power is transmitted from the motor to the spindle through, first, a friction clutch, and then by a Morse silent chain. This interposition of the friction clutch between the motor and spindle, is the most novel feature of the design. By means of it the machine may be started and stopped quickly without stopping the motor, thereby saving that considerable amount of time that would otherwise be lost in waiting for the motor to come to a stop, and, when starting, in waiting for the motor to come up to speed. This is an item that is usually overlooked. It amounts to a great deal as compared tc the cost of running the motor alone while the machine is making short stops for chucking work. The motor can, of course, be stopped at any time by cutting off the current in the usual way.

Fig. 1 shows the arrangement of the automatic no-load-release starting box, the field rheostat, the friction clutch lever, the back gear lever, and the double back gear, as well as all feed-changing and adjusting levers at the front of the machine, within easy reach of the operator, who need never go to the rear of the machine except for oiling.

Fig. 3, a sectional plan through the spindle, shows the arrangement of the double back gears and the details of construction of the clutch drive. The chain from the motor drives the wheel A, which transmits power through the friction clutch to shaft B; shaft B drives through a chain, and chain wheels C and D, to the main spindle, E.

The back gears F and H are both keyed onto a sleeve I, which is arranged to revolve with and slide on back gear quill J; when used in the position shown in Fig. 3, back gear, F, is driven by the smaller gear, P, on the main driving quill, K, on the spindle, which gives the first series, or slow, back gear speeds. When it is desired to use the second back gear, or faster speeds, the gears are thrown out of mesh in the usual way, the sleeve is merely pulled along the back gear quill to

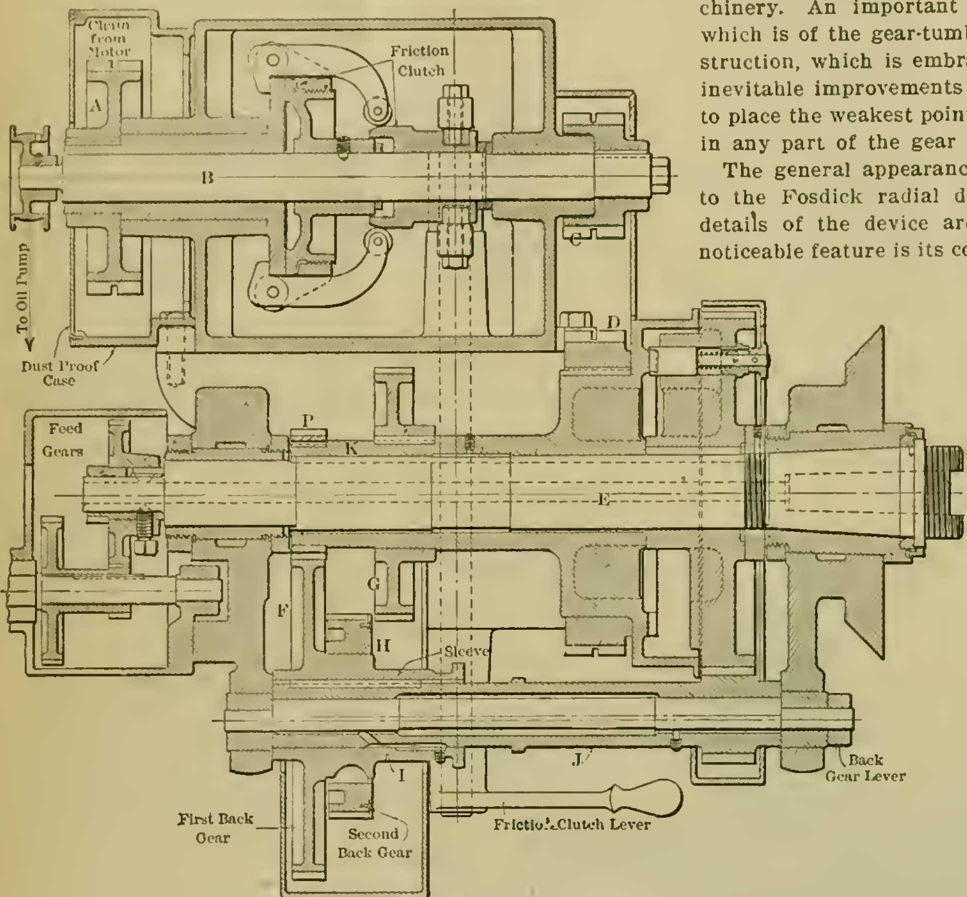


FIG. 3.—HORIZONTAL SECTION THROUGH SPINDLE OF THE NEW MOTOR-DRIVEN CINCINNATI MILLER, SHOWING DETAILS OF CLUTCH, DOUBLE BACK-GEARS, ETC.

bring gears, H and G, in line, and then the back gear again thrown in. The gear, H, is provided with a flange, so that there is no possibility of this gear sliding into mesh with gear G when the other pair are in mesh.

The friction clutch lever gives the operator as complete, and a very much more convenient control of the spindle, than he has when driving from a countershaft in the usual way, and it is also convenient for throwing partially in to make a partial revolution of the spindle, the advantage of which is at once apparent to one used to operating machine tools.

The Cincinnati Milling Machine Company who are prepared to supply any of their back geared machines with this arrangement of driving, are to be congratulated upon this excellent design. It will mark an important advance in motor driving and its success seems to be assured.

The directors of the Midland Railway of England have appointed Mr. Richard Mountford Deeley, locomotive works manager at Derby, to be chief locomotive superintendent to succeed Mr. S. W. Johnson, who is retiring. Mr. Deeley recently visited the United States to inquire into the engineering methods on American railways.

MACHINE TOOL PROGRESS.

Feeds and Drives.

XII.

By C. W. Obert.

A novel and interesting design of variable-speed geared driving mechanism has recently been developed by the Fosdick Machine Tool Company, Cincinnati, Ohio, which is a departure from former practice along this line and which embraces important improvements. It was designed for use as the main drive of the Fosdick radial drill, in place of the cone pulley and belt drive, in order to give the wide range of driving speeds which are so necessary for the best results with drilling machinery. An important feature of this driving mechanism, which is of the gear-tumbler type, is the especially strong construction, which is embraced in the design to provide for the inevitable improvements in the tool steel; the desire has been to place the weakest point in the main driving belt, rather than in any part of the gear mechanism.

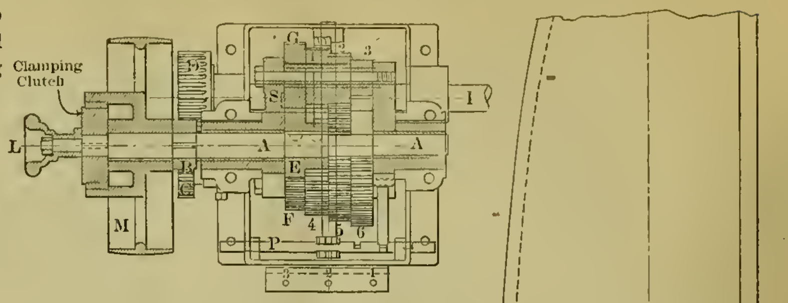
The general appearance of this mechanism, as it is applied to the Fosdick radial drill, is shown in Fig. 54, while the details of the device are made clear in Fig. 55. The most noticeable feature is its compactness; it requires even less room than did the cone pulley which it has replaced, and no change of design of other portions of the drill have been made necessary. The most important feature of this speed mechanism is that it is so arranged that, no matter what speed the machine is to be run at, the driving gear is always started up at a slow speed at first, a special initial-speed attachment being arranged to permit the inertia of the gears and shaft to be overcome and to prevent the strain that might be caused by throwing in the shifting gears suddenly on a high-speed.

The drive for the mechanism is received on belt pulley, M, (see Fig. 55) which is located on shaft, A, the main driving shaft of the mechanism. Upon this shaft is keyed a gear, E, within the box, which drives two cones of gears with which it meshes, each of which gear cones is carried at one of the forked ends of the rocker frame, S; this construction is made clear in the end view, with pulley M, removed (Fig. 55) which shows the rocker set with cone, G, in mesh with the driven gear, H. In this way, cones of gears, F and G, always revolve with shaft, A, and it is only necessary to shift rocker frame, S, by handle, N, after having moved gear, H, along to the proper position by handle, J.

The gear, H, which operates the drive to the drill directly, is splined to the shaft, I, and is moved along by fork, K, which is operated by handle, J. To prevent accident from careless handling, the movements of handle J are interlocked with those of handle N, so that J can not be moved unless N is in a central position and thus both cones, F and G, are lifted out of mesh with gear H.

In starting up the mechanism, however, the rocker, or tumbler, frame is merely thrown to the proper position and the gears mesh accurately at once; no shock is given the drill by abruptly throwing over the handle, as the initial self-acting speed clutch, previously referred to, has already brought shaft, I, into motion, but nevertheless, as soon as one of the cone gears commences to drive gear, H, it releases automatically from shaft, I. This is accomplished by a special design of automatic clutch contained within gear, D. Gear, D, is always driven through pinions, B and C, from the driving shaft, so that whenever the gear cones are thrown out of action and shaft, I, slows down, the clutch in D acts and keeps it moving at a slow speed. This is an important and very effective feature, and it is a scheme that works excellently in practice.

Shaft, A, is driven from pulley, M, through an interesting clamping clutch which permits the drive to be started and stopped with the utmost facility. This clutch is located within the hub of the pulley and is operated by merely turning hand wheel, L. When shaft A is at rest it is merely necessary to turn wheel, L, to the right and the drive starts instantly; when



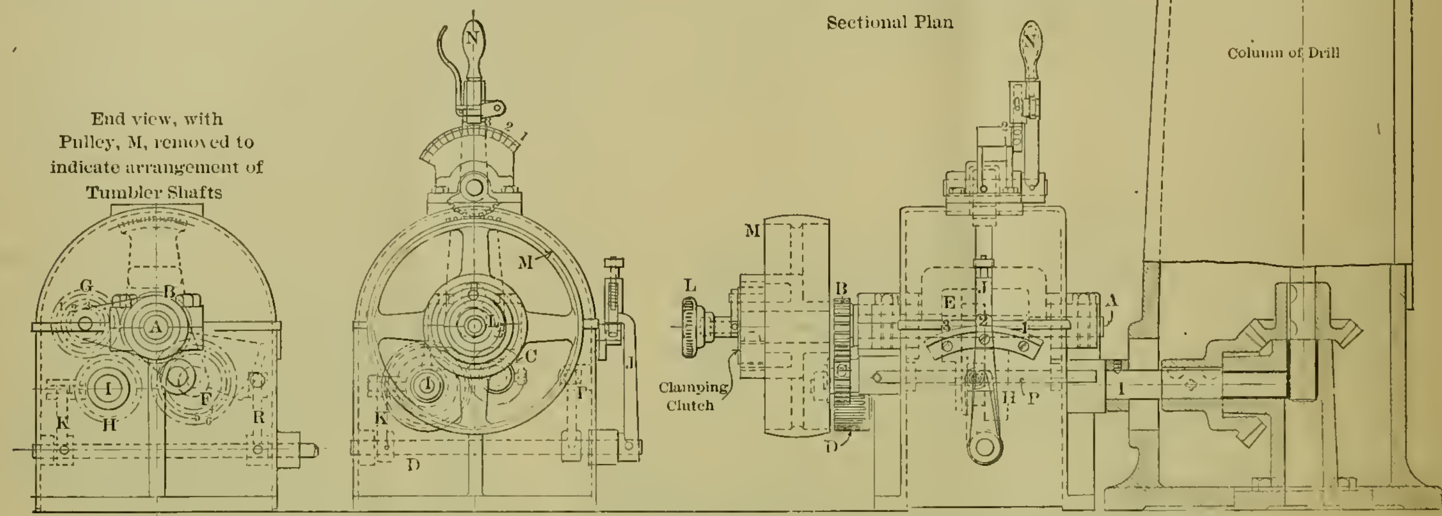


FIG. 55.—DETAIL DRAWINGS OF THE VARIABLE-SPEED DRIVING MECHANISM UPON THE FOSDICK RADIAL DRILL.

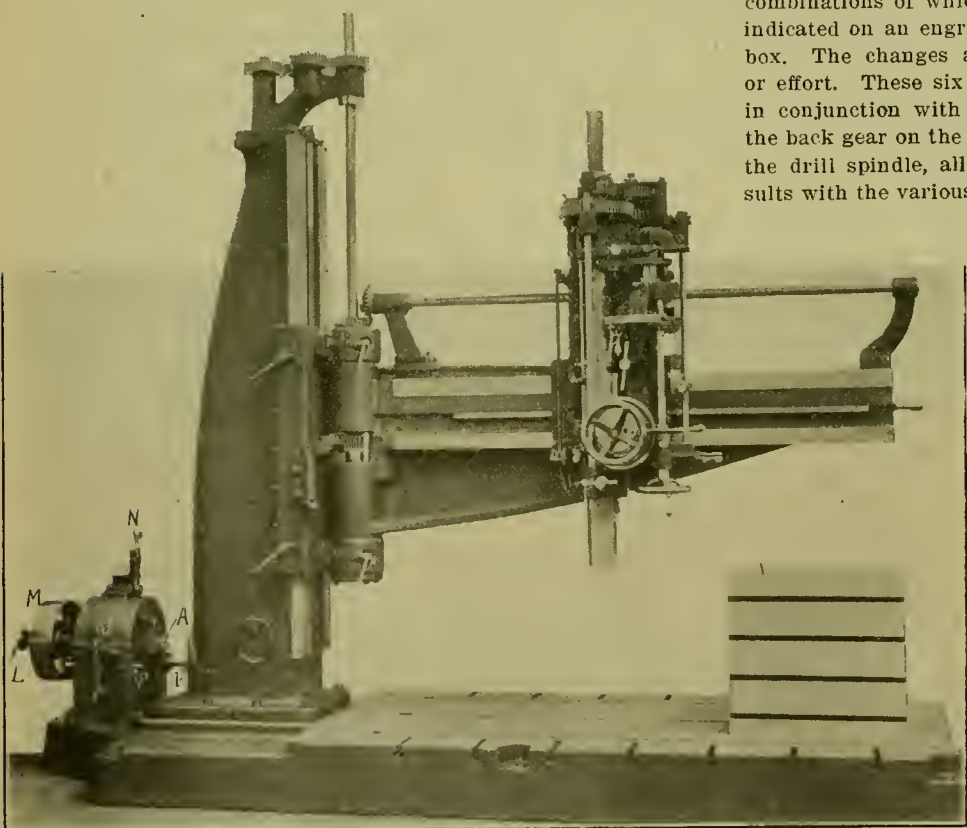


FIG. 54.—VIEW OF THE 6-FT. FOSDICK RADIAL DRILL AS EQUIPPED WITH THE NEW VARIABLE-SPEED GEARED DRIVING MECHANISM—FOSDICK MACHINE TOOL COMPANY.

the drive is in motion, it is only necessary to slightly retard wheel L and the clutch releases at once. This is another important factor of the drive, as it not only eliminates the necessity of the belt shifter, but also is infinitely quicker and easier to operate.

Both handles, J and N, have index plates with numbered positions in which they may be set for the different speed combinations of which there are six. These combinations are indicated on an engraved index plate which is attached to the box. The changes are easily made and require no thought or effort. These six speeds available at the speed box, taken in conjunction with the three additional speeds provided by the back gear on the arm, make 18 changes of speed possible at the drill spindle, all of which are calculated for the best results with the various sizes of drills.

PERSONALS.

Mr. B. R. Moore, the mechanical engineer of the Chicago, St. Paul, Minneapolis & Omaha Railway, has been appointed assistant superintendent of motive power and machinery, with headquarters at Sioux City, vice F. M. Dean, resigned.

Joseph Stehlin has been appointed mechanical engineer of the New York Central & Hudson River, with headquarters at New York, succeeding A. J. Slade, resigned. Mr. Stehlin will report to E. B. Katte, electrical engineer, on designing and construction of power stations except those in the electric traction system, and to Olaf Hoff, engineer of structures, on designing and installation of heating and lighting plants, water and coaling stations.

Mr. H. F. J. Porter who has been associated with Westinghouse interests since the first of the year and has held the position of assistant manager of the Publishing Department, has been made second vice-president of the Nernst Lamp Company, of which enterprise Mr. George Westinghouse is president. His duties will be that of general manager and his headquarters will be at Pittsburg. He assumed charge on December 1. This appointment does not, however, affect Mr. Porter's present relations with the Publishing Department at this time.

THE PENNSYLVANIA RAILROAD LOCOMOTIVE TESTING PLANT FOR THE ST. LOUIS EXPOSITION.

FIRST BULLETIN OF ANNOUNCEMENT.

In our July, 1903, issue, brief mention was made of the locomotive testing laboratory of the Pennsylvania Railroad, which is being constructed for permanent installation at Altoona, Pa., but which will be temporarily erected at the Louisiana Purchase Exposition as a part of the exhibit of the road. The Pennsylvania Railroad has now issued a bulletin which describes very fully the work that will be carried out, referring to the organization and to the plan and scope of the work. The history of the organization of the Advisory Committee is given in detail in the introduction, together with copies of the letter addressed to the Master Mechanics' Association and to the American Society of Mechanical Engineers, and also the resolutions passed by both of these bodies in accepting the invitation to participate in the tests.

The organization of the work is as follows:

For the Pennsylvania Railroad System:

J. J. Turner, third vice-president, Pennsylvania lines west of Pittsburg.

Theo. N. Ely, chief of motive power, Pennsylvania Railroad System.

F. D. Casanave, special agent, Pennsylvania Railroad System.

E. D. Nelson, engineer of tests, Pennsylvania Railroad Company, Altoona, Pa.

For the Louisiana Purchase Exposition:

Willard A. Smith, chief of the Department of Transportation Exhibits, Louisiana Purchase Exposition.

Advisory Committee: On Behalf of the American Society of Mechanical Engineers:

W. F. M. Goss, dean of the Schools of Engineering, Purdue University.

Edwin M. Herr, general manager, Westinghouse Air Brake Company.

J. E. Sague, mechanical engineer, American Locomotive Company.

On Behalf of the American Railway Master Mechanics Association:

F. H. Clark, superintendent of motive power, Chicago, Burlington & Quincy Railroad.

C. H. Quereau, superintendent of shops, New York Central & Hudson River Railroad.

H. H. Vaughan, assistant superintendent of motive power, Lake Shore & Michigan Southern Railway.

Officers:

F. D. Casanave, special agent of the Pennsylvania Railroad System.

(W. F. M. Goss, chairman of the Advisory Committee.)

(H. H. Vaughan, secretary of the Advisory Committee.)

These officers were elected at a formal meeting of the joint committees at the annual conventions of both societies at Saratoga in June. The committee has held a number of meetings and formulated complete plans for carrying out the tests. This first bulletin gives the plan and scope of the work in such an accurate and complete manner that it is printed in full below. Further bulletins issued from time to time will give the results of the work as it is being carried on.

PLAN AND SCOPE.

The Pennsylvania Railroad will design and cause to be constructed a suitable plant for testing locomotives, and, in co-operation with the Department of Transportation Exhibits, will install the same at St. Louis. The plant will be ready for preliminary running by the first of March next, and in perfect running condition by the first of May, at which time formal work will commence. The purpose of the whole work is to be comprehensive, and the endeavor will be to determine by the use of locomotives presenting different characteristics, the effect of the latter upon the economic performance, and the limits of the tractive power and boiler capacities.

The Pennsylvania Railroad system will organize and maintain, under the direction of its Engineer of Tests, a staff of laboratory attendants and computors, to the end that the plant and the locomotives thereon may be safely and properly operated and the experimental data promptly handled. It will also provide supplies of fuel and oil, and will meet all other fixed charges incident to the progress of the work.

The Pennsylvania Railroad, having called to its aid an Advisory Committee to assist in all matters of scientific interest, will in consultation with this Committee make selection of locomotives to be tested, determine conditions under which tests are to be run, specify as to the observations to be taken and the methods to be employed, and determine the manner in which the data shall be handled and the form in which the final results shall be presented.

The Advisory Committee. While the communication of the Pennsylvania Railroad, in response to which the members of this committee were appointed, clearly contemplates additions to the membership of the committee, those already appointed have organized, and have been required to act in formulating the provisions of this program. To avoid confusion, therefore, those already appointed will be regarded as "Members" of the Advisory Committee. Foreign representatives and others who may be hereafter appointed will be designated as "Affiliated Members." Members and Affiliated Members of the Advisory Committee shall have voice and vote alike.

The Advisory Committee will devote such time as may be necessary to the general plan of the work, and may be called together at any time by the Chairman, or by an authorized representative of the Pennsylvania Railroad.

The Testing Plant. The details of this plant are now being worked up by the Pennsylvania Railroad. It is to consist of supporting wheels upon which will be carried the drivers of the locomotives to be tested, with friction brakes on the shafts of the same, a registering dynamometer of 80,000 lbs. capacity, to which the drawbar of the locomotive will be attached, together with all necessary accessory apparatus for operating the plant and obtaining the desired data therefrom. As soon as practicable it is intended to issue a bulletin which shall completely describe and illustrate the details of the plant.

Locomotives To Be Tested. In selecting locomotives for test, an endeavor will be made to secure variety in the essential principles of design. Since the time is necessarily limited, no considerable attention will be given in attempts to analyze the action of minor details. On the contrary, the effort will be to establish the economic performance of a number of typical locomotives when operating under a wide range of conditions.

No locomotive or type of locomotives will be acceptable, the value of which has not been proven by successful service on the road.

Locomotives to be acceptable must have weight and power which will make them comparable in these respects with the modern American machine. It is proposed to test no locomotive which has less than 2,000 ft. of heating surface in its boiler, excepting that in case of locomotives having superheaters the superheating surface may be regarded as heating surface, and in the case of locomotives having Serve tubes, credit for the surface of the ribbing will be allowed.

The gauge of the supporting wheels will be 4 ft. 8½ in., or the same as the standard gauge of American railroads, and the gauge of the locomotive offered for test must be such as to run safely thereon.

It is planned to test twelve different locomotives, and it is hoped that a portion of this number can be of foreign design and construction. The time to be allowed to each locomotive will vary from 20 to 14 working days, the longer time being allowed those which are tested early in the season when both men and equipment will be new to the work. The intervals proposed are as follows:

1904.

1. May 2 to May 23, inclusive.
2. May 24 to June 13, inclusive.
3. June 14 to July 1, inclusive.
4. July 2 to July 19, inclusive.
5. July 20 to August 5, inclusive.
6. August 6 to August 22, inclusive.
7. August 23 to September 7, inclusive.
8. September 8 to September 23, inclusive.
9. September 24 to October 10, inclusive.
10. October 11 to October 26, inclusive.
11. October 27 to November 11, inclusive.
12. November 12 to November 30. inclusive.

It is not possible at this time to present a complete list of the locomotives which will be tested, but this is now under careful consideration, and will be announced in a later bulletin.

It is considered advisable that the owner of each locomotive presented for test should furnish a man thoroughly familiar with its working to look after the lubrication, and in general, render such assistance as will insure the tests being run without interruption. The owner should also, if found necessary, provide a man thoroughly familiar with the mechanical details of the locomotive, who can advise in regard to any repairs that may be necessary during the series of tests.

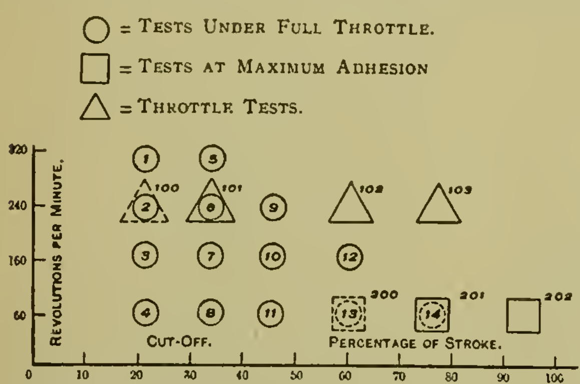
FUEL. The Pennsylvania Railroad Company will supply for all participants, two grades of coal of high quality, one an anthracite and the other a bituminous. The quality of each of these grades will remain unchanged throughout the progress of the work. This composition will be approximately as follows:

	Anthracite, per cent.	Bituminous, per cent.
Volatile matter, including water......	8	20 to 22
Fixed carbon	86	69 to 74
Ash	6	9 to 6

FIREMEN. The Pennsylvania Railway will supply men whose experience on the road will have been supplemented by special training for their work upon the testing plan. Unless otherwise arranged, these men will fire all locomotives under test. Exhibitors may, however, furnish one of their own men to give necessary instructions to the regular firemen.

THE TESTS. It is proposed to make from 16 to 20 formal tests of each locomotive put upon the plant, these to be preceded by one or more preliminary runs for the purpose of checking the valve setting, and of proving all accessory apparatus.

Each formal test will involve a run of approximately 100 miles, and throughout its duration the speed, load, steam pressure and other conditions of running will be maintained as nearly as possible, constant. The conditions represented by the several tests upon each locomotive will be so chosen that the results will fall into sets, and when so plotted will serve to disclose the performance of the locomotive under the full range of speed and cut-off for which it can be properly worked. The conditions which have been chosen for the formal tests are set forth diagrammatically by Figs. 1 and 2.



Compound Passenger Locomotives will be tested under conditions which are comparable with those specified for simple locomotives.

Fig. 1—Simple Passenger Locomotives.

Referring especially to Fig. 1, the circles show the speed and cut-off at which it is proposed to run the tests under a fully open throttle. Tests 1 to 4 represent a set at constant cut-off under speeds varying from 80 to 320 revolutions, the cut-off for these tests to be about 20 per cent. of the stroke. All tests of this set will be well within the capacity of the locomotive. Tests 5 to 8, inclusive, represent a second set, the cut-off for which will be made such as to make the power for test 5, the highest which can be developed at a speed of 320 revolutions. A third set at longer cut-off is made up of 9, 10 and 11. In this case the cut-off of the set is to be made such that No. 9 will give the maximum power which can be developed at a speed of 240 revolutions. Similarly, test 12 is to be made at such a cut-off as to demand the full power of the boiler at a speed of 160 revolutions, and with it will be grouped test No. 13, provided the adhesion of the drivers will permit a fully open throttle under so long a cut-off.

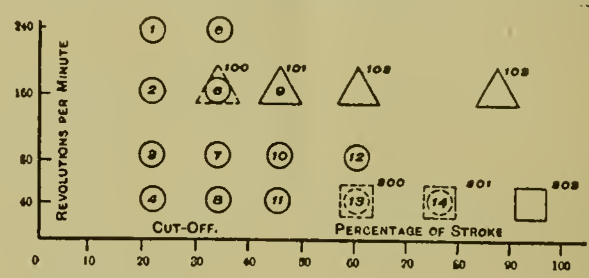
In case test 13 can be run, then another at a still longer cut-off, as, for example, test 14 at a speed of 80 revolutions, will be attempted. It will be apparent that tests under conditions thus chosen cover the entire range under which the locomotive may be operated with the throttle wide open. Thus, at any particular speed, an attempt to use the longer cut-off would result in a failure of the boiler to supply steam, or possibly, at the lowest speed, in the slippage of drivers. Similarly, at any particular cut-off, an attempt to operate at a higher speed would result in a failure of the boiler to supply steam. By combining the results the effect of either changes in speed or changes in cut-off in the performance of the locomotive can be readily shown.

To determine the performance of the locomotive under varying throttle openings the series 100, 101, 102 and 103 will be run. This series will be at a constant speed. The power for all tests and, consequently, the drawbar pull will be constant, and will be the same as that developed under a wide open throttle in test 2. For test 101 the cut-off is lengthened and the throttle closed sufficient to make the power the same as when with the shorter cut-off the throttle was wide open. Test 102 is at a still longer cut-off, for which the throttle will be still further closed, and test 103, the longest cut-off and the throttle of the least opening for the series. It is evident that the results of this series will show the relative performance of the locomotive in doing a given amount of work under a varying degree of throttling.

Tests 200, 201 and 202 are under starting conditions. The speed of all is to be the same. For test 202 the reverse lever is to be in its extreme forward position, and the throttle opening as wide as can be allowed without danger of slipping the drivers. Test 201 is with a shorter cut-off and wider opened throttle, and test 200 with a full open throttle.

It should be evident from the explanation which has been given that the diagrams Figs. 1 and 2 do not attempt to show the actual cut-offs which will be experimented upon, nor the precise number of tests which will be necessary to define the performance of a locomotive, but rather the principles which will underlie the selection of conditions, and the relation which the several tests bear each other. The limits of performance will be different for different locomotives, and one of the tests will be to establish values for these limits.

The several speeds employed for all passenger locomotives will be those set forth in Fig. 1, so that the data for the several different locomotives will be strictly comparable.



Compound Freight Locomotives will be tested under conditions which are comparable with those specified for simple locomotives.

Fig. 2—Simple Freight Locomotives.

The conditions under which freight locomotives will be tested will involve the several speeds given in Fig. 2. A comparison will show that while the range of speed for the freight locomotive is lower than that fixed for the passenger locomotive, the two sets of conditions supply ample opportunity for the inter-comparison of results which may be obtained from the two classes of locomotives.

The conditions specified for testing compound locomotives are necessarily more general than those with reference to simple locomotives, since it does not appear that any single diagram can be made which will serve to define the conditions of running with reference to compounds. For example, some of the compounds submitted for test may be of such design that a single movement of the reverse lever will change the cut-off in both the high-pressure and low-pressure cylinder (or cylinders). Others may be so arranged that the cut-off remains constant on the low-pressure cylinder until after that upon the high-pressure cylinder has been reduced to half stroke, and still others may have the control of the high-pressure cut-off quite independent of that of the low-pressure cut-off. No simple statement as to cut-off, or even as to number of expansions, will have the same force when applied to locomotives of these different types. Again, some of the locomotives may have no provision for using high-pressure steam in the low-pressure cylinder, while others may be equipped with a by-pass for use at low speed. Obviously, machines thus designed should be tested with the by-pass in use, as well as without it.

In view of these facts, it seems wise in case of compound locomotives, to reserve a specific statement of the conditions which are to prevail until the characteristics of each locomotive to be tested are known. The conditions which will then be proposed will be submitted to each exhibitor interested, for criticism, and finally for approval.

In the meantime, it can be said that compound locomotives will be tested under conditions which are comparable with those specified for simple locomotives. The speeds will be the same and the several tests for each speed will be under such conditions of cut-off as will disclose the performance of the locomotives under a similar range of action. The conditions to be specified for each compound locomotive will have due regard for peculiarities in its design, to the end that the power and efficiency of each machine may be demonstrated under all conditions of running which may have been contemplated in its design.

METHODS TO BE FOLLOWED IN RUNNING A TEST. In preparation for a test, the locomotive will be started and gradually brought to the conditions of running which are to prevail throughout the test. When these conditions have been secured the preliminary running of the locomotive will be continued until the rate of firing becomes uniform and until all portions of the locomotive have become warmed to their work. When these conditions have been secured two strokes of a bell will give a preparatory signal. Thirty seconds later a single stroke of the bell will mark the beginning of the test. Upon this stroke all water levels will be observed, the ash pan cleaned and all observations taken, and thereafter all water and fuel used will be taken from a weighed supply. Throughout the test all conditions of running will be maintained as nearly constant as possible, observations being taken on the stroke of the gong at ten minute intervals. The duration of the test will vary from two to six hours, depending upon the rate of speed and load. The element of control in fixing the length of the heavy power test will be the amount of water evaporated, no test being ended until the evaporation equals 30 lbs. for each square foot of heating surface. The lighter power tests may end after from four to six hours.

A test will be ended as it began. The fire which, throughout the test will have not changed greatly in its condition, will be brought as nearly as possible to the condition it had in the beginning, the ash pan will be cleaned, the water level in the boiler will be made to agree with that of the beginning of the test, and upon signal the final observations will be taken, and the use of water and fuel from a weighed supply will cease. As soon as practicable after this the locomotive will be stopped, the front end cleaned, and the data of the test collected and made of record.

A test will be started not earlier than 8 o'clock on each day, and when the conditions are such as will permit them to be of short duration, two tests may be run on the same day.

To avoid chances for error all important observations will be taken in duplicate by the use of independent instruments and observers. For example, the feed water will be metered and afterwards weighed, the weighings constituting the real record, and the readings of the meter the check record. The speed will be indicated by a Boyer or other speed indicator, and also by a counter which will register the revolutions, the latter supplying the real record, and the former the check record. Pressures will be observed from dial gauges, and registered by a Bristol recording gauge, the observed pressures constituting the real record; the recorded pressures the check. An indicator will be used on each end of each cylinder.

The smoke discharge above the locomotive will be so arranged as to entrap all solid matter or "sparks" passing out of the top of the stack. A chemical analysis will be made of the coal employed for each test, and of the smoke-box gases.

In the case of locomotives designed with special reference to the balancing of reciprocating parts, and in the case of others, the performance of which may contrast with them, an effort will be made to study the motion (rocking, nosing, etc.) of the locomotive as a whole while running at speed, in the hope that a definite relation will be found between the motion of the locomotive and its condition of balance.

In the case, also, of certain locomotives which will be selected with reference to their type of boiler, an effort will be made to secure a record of the direction and activity of the water currents circulating within several portions of the boiler when the latter is delivering steam, and especially of the cooler currents discharged from the injectors.

There will be obtained for each test, by direct observation, the following facts:

Position of reverse lever.
Position of throttle.
Revolutions per minute.
Total revolutions.
Pounds of coal fired.
Pounds of non-combustible material collected in ash pan.
Pounds of sparks passing out of the top of the stack.
Time when one or both injectors are in action.
Pounds of water weighed to injectors.
Pounds of water lost by injector overflow.
Record of calorimeter giving quality of steam in dome of boiler.
Indicator cards from each end of each cylinder, and from the valve box on one side.
Drawbar stress as shown by dynamometer.

Pressures as follows:
Of steam in boiler.
Of steam in branch pipe leading to cylinder.
Of air in the laboratory (barometric pressure).
Of air in ash pan.
Of gases in furnace.
Of gases in front-end.

Temperatures as follows:
Of the laboratory.
Of the feed water.
Of steam in branch pipe (for throttling tests only).
Of smoke-box gases.
Of water within the lower portions of the boiler at points systematically arranged.

CALCULATED OR OBSERVED RESULTS. The organization will be such as will allow the work of the computing room to keep pace with the development of observed data in the laboratory. The data will be presented in such form as will show the facts in three different relations.

1. The performance of the locomotive as a whole, under which relation general comparisons will be based upon the work developed at the drawbar.
2. The performance of the boiler.
3. The performance of the engines.

By having a separate presentation of the engine and of the boiler performance it will be possible to trace the effect of each modification in design, whether in the boiler or engine; that is, changes in boiler performance resulting from changes in proportions or forms, will readily be traced, and changes in engine performances resulting from difference in design can be accredited to their proper cause. Moreover, it will be possible in the final analysis of results to interchange the boilers and engines of different locomotives, and to predict with certainty the general results which would have been obtained from a locomotive made up of any such combination.

LOCOMOTIVE ACCESSORIES. Locomotives submitted for test must be equipped with such accessory apparatus as may be necessary for the attachments of all instruments of observation, so that there need be no delay in getting the locomotive into operation after it is received at St. Louis. Such accessory apparatus will consist chiefly of indicator plugs for cylinders and valve box, a water gauge glass for locating the height of water in the boiler, reducing motions for indicators, plugged openings into the boiler front-end, pipe connections which will serve in the attachments of gauges, thermometers and gas samplers, a light return crank for the attachment of a Boyer speed recorder and a registering counter, a drilled coupling pin hole in the foot plate, with a pin turned to fit, and provision for lubricating all journals when the locomotive is in motion. The exact character of each of these details will be made the subject of a later announcement.

PUBLICATION OF RESULTS. In order that the results may serve the largest purpose possible it is proposed to issue publications as follows:

1. Bulletins of Announcement. These will constitute the communications of the Pennsylvania Railroad and its Advisory Committee to the public, with reference to their plans and purposes. They will give information to those who may exhibit locomotives for test, and it is hoped that they will draw from those who are interested, such suggestions or criticisms as will assist in furthering its work.

2. Bulletins of Results. These will be issued from time to time, and will constitute formal reports of the performance of individual locomotives. It is expected that when tests upon a given locomotive have been completed, the results obtained, and such analysis of performance as may be based thereon, will be entirely set forth in a bulletin.

3. A formal publication to be issued at the conclusion of the whole work, presenting in such form as may be hereafter determined, the facts and conclusions developed by the whole study.

[Copies of this first Bulletin, and other information pertaining to the tests may be had upon application to F. D. Casanave, Special Agent, No. 910 Penn Square Building, Philadelphia, Pa.]

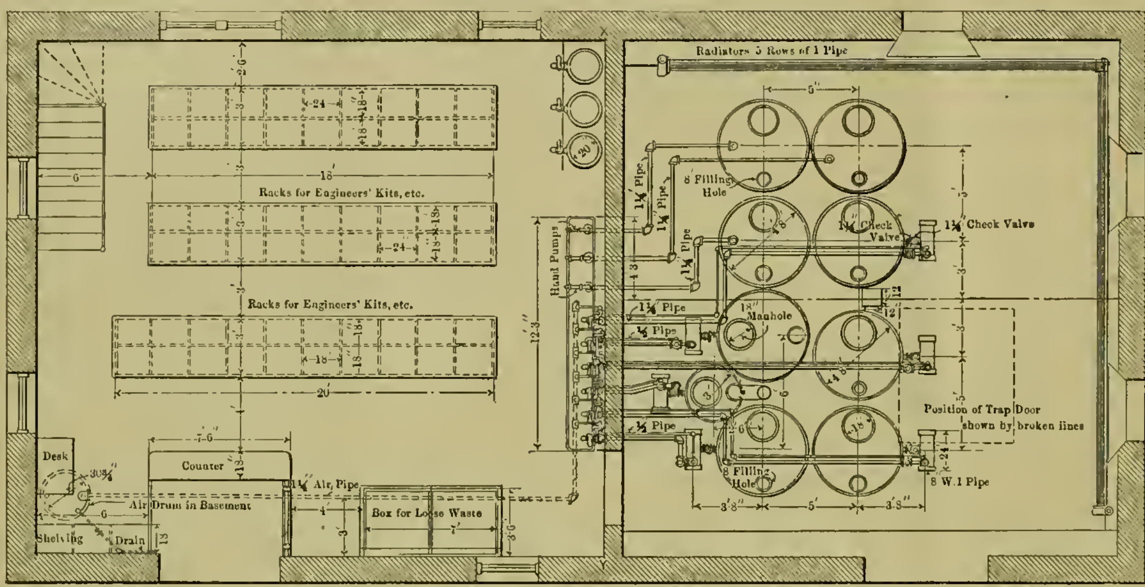
A contract for forty-eight 625-horse power water tube boilers has been awarded the Babcock & Wilcox Company by the New York Central & Hudson River Railroad, for installation in their new power stations, which will be used for generating power for the electric locomotive service, as noted in our last issue. The boilers will be of the Babcock & Wilcox forged-steel construction, designed to carry 200 lbs. working pressure, and will be equipped with the new patent superheaters of this company, proportioned to give a superheat of 200 degrees above the temperature of saturated steam at that pressure.

THE OIL HOUSE AT THE DU BOIS SHOPS.

Buffalo, Rochester & Pittsburgh Railway.

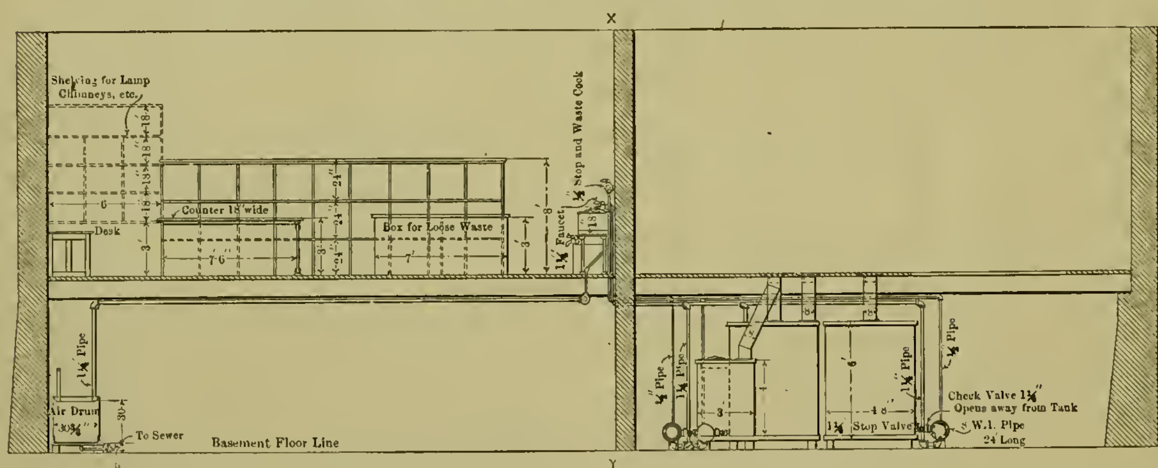
The plans for the oil house at the Du Bois shops of the Buffalo, Rochester & Pittsburg Railway, as indicated in these engravings, are the result of an extensive study of the practice of other railroads in the disposal of this important factor of the service. The description of these shops will be found in the April and May numbers of this journal for 1902.

The arrangement here shown permits of unloading oil and placing it in the storage tanks by gravity. The storage is in the basement of the building, the tanks having a capacity of 15 barrels each. Compressed air is used to raise the lubricating oils, while because of the possibility of some, if even slight, mixture with water from the air pipes, the coach, kerosene and signal oils are raised by pumps which are operated by hand at the delivery stand. In order to avoid placing the large tanks under air pressure, the oils which are raised by air are delivered by gravity into small reservoirs made of 8-in. wrought iron pipe, 2 ft. long. Check valves opening inward allow these small reservoirs to fill. When full, air pressure is admitted to them and the oil is forced to the outlet, the check valve in the pipe from the large tank closing against a return of the oil. Another check valve in the delivery pipe prevents the oil from running backward from this pipe and

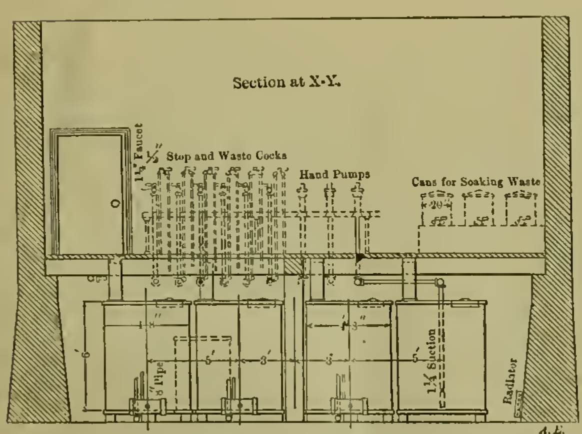


Plan of Ground Floor　　Plan of Basement

OIL HOUSE AT THE DU BOIS SHOPS. — BUFFALO, ROCHESTER & PITTSBURGH RAILWAY.



LONGITUDINAL SECTION OF OIL HOUSE. — DU BOIS SHOPS.



CROSS SECTION OF OIL HOUSE.

filling the small reservoir, which can be filled only by gravity from the large storage tank, when the pressure is off.

The tanks have 8-in. filling holes piped to openings in the floor above and each tank also has an 18-in. manhole. This building also furnishes storage for waste and lamp chimneys and contains lockers for the tools of the engine men. The size of the building is 60 by 30 ft., outside.

The extending use of aluminum for electrical purposes and the wide prospective use for it in the manufacture of thermit, makes the report that a St. Louis man has discovered a pyrochemical process of manufacturing aluminum from clay of considerable interest, especially so as he claims the metal will be greatly cheapened by the new process. The process, discovered by Mr. Schwahn, is claimed to effect the reduction in much shorter time than now required and to reduce the cost from $500 to $100 per ton.—*Machinery.*

WHAT ARE THE NEW MACHINE TOOLS TO BE?

BY JOHN E. SWEET.

(A Paper Read Before the American Society of Mechanical Engineers. New York Meeting, December 2, 1903.)

It is a fact quite apparent to users of machine tools (and first among them are the machine-tool builders themselves) that the new high-speed tool steel calls for a re-designing of our machines if we are to get even a fair share of the ultimate possibilities which the new steel offers. I think the machine-tool builders will admit that their machines must be re-designed; but to the most of them will this mean anything but just to make the driving elements more powerful and the machines stronger, which is as much as to say that everything has been all right, and all that we need to do is to change the strength and power. But have they been all right, or even half right?

It can be shown by figures, I suppose (I know it to be a fact by a trial with models), that a complete box is thirteen times more rigid against torsion and four times more rigid against bending than the same amount of material is in the form of side plates and thin cross girts. It is probably from four to eight times more rigid than the cross-girt plan in any form, and yet in the case of lathes, the whole business of whose heds is to resist torsion, only one or two builders have had the courage or audacity to adopt the box form.

All planer beds can just as well be box beds with half the cost in patterns and foundry work, and so, too, the tables which are sprung by bolting down work, can just as well be box tables four times as strong with the same material, and with a saving of half the cost in patterns and something in the foundry. The whole tendency of the cut is to slide the work endwise of the planer bed; but who has ever tried putting the slots crosswise in a way to offer the greater resistance and prevent the bending of the bed by the peening of the upper surface, as now occurs, which, with the springing by bolting down the work, are the primary causes of cut ways?

Some planer and boring mill cross rails are of box section in the center, but are thinned down at the ends when fastened to the housings. The most of them are three sides of a box only, or one-tenth the strength of a box, where a plain square box straight through is infinitely better and cheaper. Of course, the boxes are not to be proportioned from what is in use now, but from what is to be made to meet the new conditions. To select enough material to meet the new demands, and then put the material in so that it will be four times more rigid, will be something like it. Housings of box sections will be just as rigid fore and aft, and much more rigid against side strain.

Milling machines of the planer style are constructed like planing machines, seemingly without a thought but that the conditions are identical, while they are not. If the bed of a planing machine and the table were of the same length, the weight of the table and the load over-running the end of the bed would soon wear the top of the bed crowning and the under side of the table concave to fit, and it is to counteract this tendency of gravity to wear them out of true that the beds are made longer than the tables. With the milling machine the load is less, more of it in the middle of the table because there is less gained by putting on small pieces end to end, and the down pressure of the big cutter always in the middle partially, if not wholly, neutralizes the tendency to wear out of true by gravity. When such a machine has side cutters or a vertical spindle the pressure is always in the middle, first in one direction and then in the other, exactly the reverse from the gravity action, and instead of the side-guide of the bed being longer than the table it should be shorter, by just about the same amount as the bed of a planer needs to be longer.

Many times the sliding piece and its guides can be the same length and keep straight. The things which do not tend to wear out of true do not wear much, and the things which do wear out of true and have to be refitted are never just right but when new and when so refitted. Where a short block slides on a long guide, if the scraper marks wear out sooner along the middle than at the ends, the ends of the guide need cutting off, however much over-run it gives to the sliding block.

The draughtsman dare not make a drawing of an engine cross-head over-running the guide one-third of its length at each end; the builder would hardly dare to build it if he did, and no user has the courage to take out the guides and cut them off or cut away the surface, even when he knows it would be money in his pocket, but *it is the thing to do.* We find that in the case of a slipper guide, owing to the effect of inertia and momentum giving a twisting action to the crosshead, it is necessary to cut away the guide so that the crosshead will over-run very nearly one-half its length before the scraper marks will show uniform wear. This, of course, is subject to modification according as the center of gravity is higher or lower, or the speed of the engine is greater or less. We are building engines with the crossheads over-running that way, and people buy them.

To get the best out of machines, they not only want to be rigid and true, but the drive needs to be powerful. In this respect a worm gear is about as perfect as can be, or cutting spur gear teeth spiral accomplishes about the same result. What appears as an objection to spiral teeth is end thrust against the shoulders—this does not amount to much, and when the shaft runs in reverse directions and end play in the journals is permissible, the journals keep in much better condition. The mention of a worm gear is like the flaunting of a red rag to some people, but it has its place and a good many more places than it has been used in. The claimed objection is excessive friction and loss of power, but the results do not seem to justify the claim.

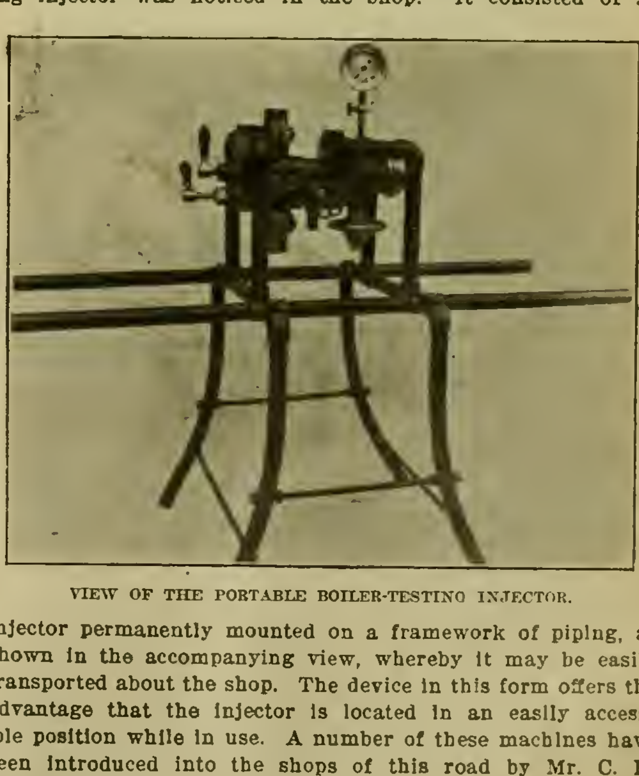
The most perfect worm gear we have (theoretically) is a screw and nut, and they do waste enormously in friction, and in proportion to what they do they wear out the most of any piece of mechanism. The most imperfect worm gear we have (theoretically) is the Sellers planing machine drive, and yet they never wear out, and hence cannot lose much in friction.

In the writer's opinion, two of the things which never need to have been invented are the Hindley worm gear and a machine for hobbing worm gear. Experience convinces the writer that a liberal pitch worm skewed around so as to properly mesh with a plain spur gear, or one with the teeth at such an angle as to skew the worm a little more, will run more easily and last longer than the other sort. A machine driven with the worm is positive, and if there is any chatter it comes from elasticity in the spindle or the work itself.

If the designer will analyze every detail, he will find that many of the old features were not right to meet the old conditions and not half right for the new. While manufacturing is going to call for many more simple machines—that is, machines to do one thing rapidly and well—the machines which will do a variety of work will be still in demand for the sparsely settled sections of the country, and the colonies will call for the country machine shop as of old. It is the hope of the writer that this tirade will bring out an interesting discussion on machine-tool design and the capabilities of the high-speed steel, for that is the object of its presentation.

A CONVENIENT BOILER TESTER.

During a visit to the Du Bois shops of the Buffalo, Rochester & Pittsburg Railway, which were described in the April and May, 1902, issues of this journal, a convenient boiler testing injector was noticed in the shop. It consisted of an



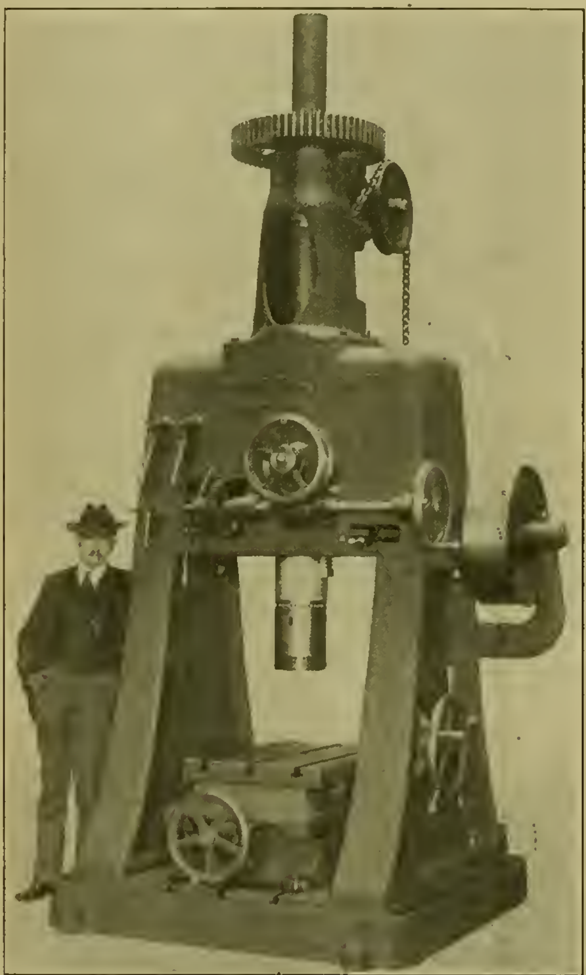
VIEW OF THE PORTABLE BOILER-TESTING INJECTOR.

injector permanently mounted on a framework of piping, as shown in the accompanying view, whereby it may be easily transported about the shop. The device in this form offers the advantage that the injector is located in an easily accessible position while in use. A number of these machines have been introduced into the shops of this road by Mr. C. E. Turner, superintendent of motive power.

A NEW 3-FT. TREPANNING MACHINE.

THE BICKFORD DRILL AND TOOL COMPANY.

We are pleased to learn that the Bickford Drill and Tool Company, Cincinnati, O., have recently completed another large trepanning machine for the Pennsylvania Railroad, which will be installed at the Altoona shops for service similar to that performed by its predecessor. This machine has been improved somewhat over the former trepanning machine which they built for the Altoona shops, but does not differ in principal details and dimensions; the more important change is that of a larger number of feeds provided, giving double the number available in the former machine.



THE NEW BICKFORD TREPANNING MACHINE FOR THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

This tool is illustrated in the accompanying engraving. The particular advantage of this type of machine is that it performs the various operations of drilling, boring, facing, tapping and trepanning, under conditions as nearly ideal as it is possible to attain; the very heaviest operations can be handled in this tool with no fear of springing, or lack of rigidity. The head and cross rail are, as shown, made in one piece, so that the usual overhang of the spindle (which is the limitation of other forms of drilling machinery), is entirely eliminated.

The table of the tool is adjustable both transversely and longitudinally, and may be slid back out of the way when not needed, for which purpose an extension is cast on the base. The spindle has sixteen changes of speed, ranging in geometrical progression from 6 to 60 revolutions per minute, each of which is instantly available without having to shift a belt. It is also provided with both hand and power feed and quick advance and return. The driving mechanism is located on the back of the head and is operated by levers which project to the front of the machine, and, by being made to receive its power from a constant speed pulley, gives the greatest attainable economy of power. To obtain any one of the sixteen speeds with which the machine is provided, the operator has but to manipulate the levers, the proper position to give the correct speed for different metals and diameters of tools being shown by a table attached to the head.

The new feed mechanism provides sixteen feeds, ranging in geometrical progression from .01-in. to .25-in., instead of the eight provided on the former machine. The design of this mechanism does not differ however from that of the other, any feed being instantly obtainable by merely shifting two feed levers, which are conveniently placed on the front of the tool.

PRINCIPAL DIMENSIONS:

Diameter of spindle, least section	6 ins.
Spindle bored to fit P. R. R. taper	No. 8
Traverse of spindle	3 ft.
Maximum distance under spindle over base	4 ft.
Size of table, working surface	24 x 36 ins.
Height of table	18 ins.
Transverse movement of table	6 ins.
Longitudinal movement of table	12 ins.
Distance between housings	3 ft.
Minimum revolutions of driving pulley to one rev. of spindle	6.6 revs.
Maximum revolutions of driving pulley to one rev. of spindle	66 revs.
Distance from floor to highest point of machine	14 ft.
Floor space required	6 ft. x 5 ft.
Weight, net	18,300 lbs.

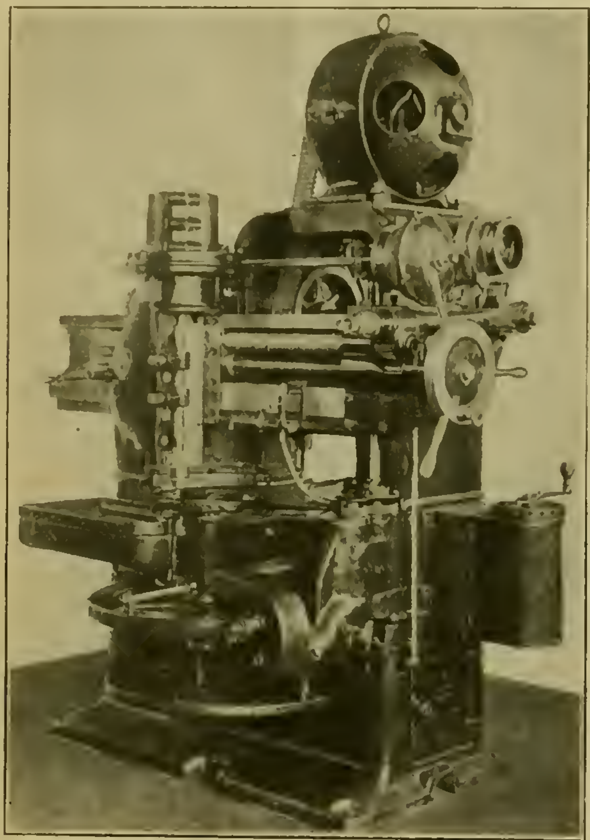
What is said to be the most dangerous railway in the world is that recently completed up the side of Mount Vesuvius for the benefit of the many tourists that annually visit this famous volcano. It is a cable railway of the mono-rail type, the one car comprising the active rolling stock being supported by two wheels, one at each end of the car. The center of gravity of the car is below the top of the supporting rail, so that it balances without the aid of supporting wheels at the sides. The railway line runs to within nominally 1,000 feet of the crater mouth, but the distance changes from day to day on account of the rapid changes that take place; accretions to the sides of the crater may materially increase the distance one day, and the fall of a huge slice into the seething gulf 500 feet below may considerably lessen the distance the next day. The maintenance of the line in proper alignment is a difficult matter. Fissures opening, the flow of lava, falling cinders, and sliding of the roadbed require constant watchfulness and labor by gangs of laborers who constantly patrol it during the periods of operation. The "train" has no fixed time-table, the trips depending on the activity of the volcano and direction of the wind; some days they are entirely abandoned.—*Railway Machinery.*

A GEAR SHAPER WITH AN INDIVIDUAL MOTOR DRIVE.

In the few years that the Fellows gear shaper has been before the public it has achieved widespread recognition for its merits as evidenced most convincingly by the large number now in use. To-day nearly all shops that engage in gear cutting to any extent, have one or more of these machines and it is thus hardly necessary to enter here into a description of its details; for that the reader is referred to the builders, the Fellows Gear Shaper Company, Springfield, Vt., for information relative to the construction and operation of the machine. However, it may be briefly stated that the gear shaper differs from the other forms of gear-cutting machinery in that it replaces the rotating milling cutter usually employed by a reciprocating tool having the form of a spur gear. This planes the teeth and at the same time is caused to revolve with the blank intermeshing precisely as its finished mate is intended to. In degree of accuracy this scheme compares with the hobbing method of forming worm wheels, and also corresponds very closely to the latter in principle. The cutters for both may be produced with extreme precision, especially for involute gearing, the only type now in common use, as both then depend on generation by straight lines. For instance, a hob is cut as a perfect V thread, and the Fellows cutter is finished by being caused to roll against the carefully trued face of an emery wheel with a motion simulating that of a pinion tooth against a rack tooth.

It is the present desire to call particular attention to the machine as now provided with an individual motor drive. The only special work necessary was the casting of a plate to span the pillow blocks of the regular driving gear to afford a support for the motor, and the substitution of a sprocket wheel for the cone pulley used with belt drive. With these changes a standard form has been evolved as shown in the accompanying illustration.

A 5-horse power Crocker-Wheeler semi-inclosed motor supplies the power, transmitting it with a reduction in speed through a Renold silent chain to the spindle which usually carries the cone-pulley. The speed is further reduced through either of the two regular gear combinations which may be used alternately, making two speeds possible mechanically. In addition, the motor is supplied with current on the Crocker-Wheeler four-wire multiple voltage system giving it six independent speeds, and with the use of resistance twelve intermediate ones. The upper ten of the motor's eighteen speeds constitute its working range, within which, through the faster gear combination it drives the ram at from 94 to 45 strokes per minute, or with the slower gear combination, 43 to 20 strokes per minute. The lower eight available motor speeds may be used to extend the range down to six strokes per minute, though 20 is the minimum in ordinary practice.



A NOVEL ARRANGEMENT OF INDIVIDUAL MOTOR-DRIVING FOR A FELLOWS GEAR SHAPER.

The machine is capable of cutting external gears up to 36 ins. in pitch diameter by 5 ins. face and internal gears 28 ins. in pitch diameter by 3 ins. face, allowing any diametral pitch up to four.

A SERVICEABLE DESIGN OF UNIVERSAL SAW BENCH.

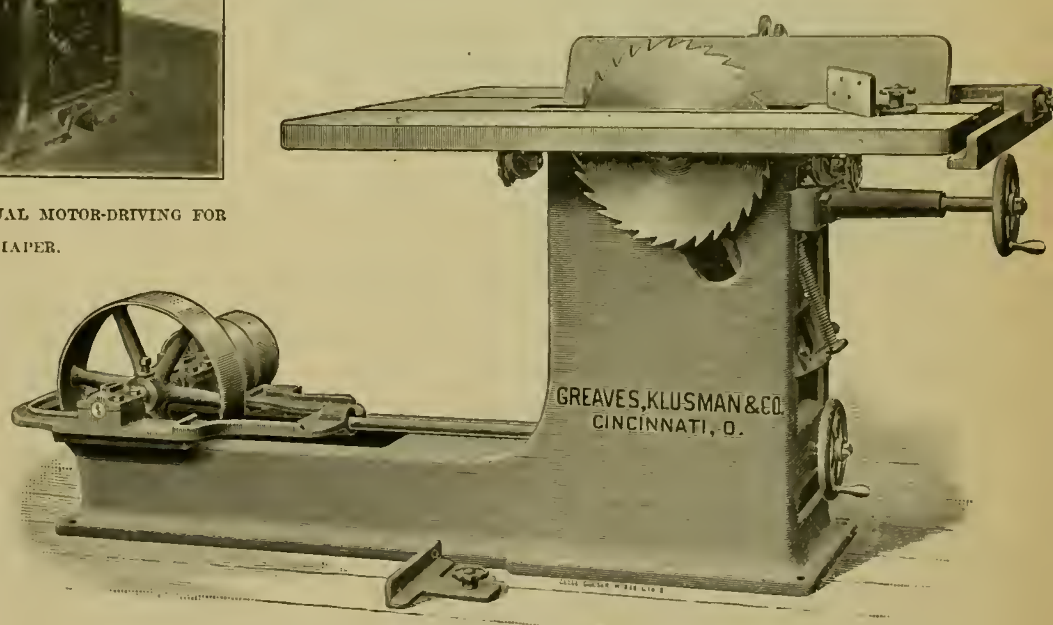
WITH TILTING TABLE.

GREAVES, KLUSMAN & COMPANY.

The accompanying engraving illustrates a particularly valuable design of universal saw bench, with tilting table, which will be found a most desirable and useful tool for any woodworking establishment. It has several special advantages as follows: The great variety and the accuracy of the work it will do; the ease and quickness with which it can be changed from one class of work to another, and particularly the length of the belt, which is longer than on any other machine of this class that we know of.

An important feature of the design of this tool is that the frame proper and the extension carrying the countershaft are cast in one piece, which greatly simplifies the machine and also keeps the countershaft and saw mandrel always in line with each other; the distance from countershaft to mandrel is thus such that all belt slipping is avoided, even when doing very heavy work. By means of the improved belt tightener, any slack can be instantly taken up by simply turning the lower hand-wheel, which is shown at the front of the machine.

The table is of iron, 38 x 48 ins., ribbed and braced and planed perfectly true. The whole table tilts for bevel sawing, and it can be clamped firmly at any angle up to 45 degrees. The opening in the table, which is 4¼ ins. wide and 21¼ ins. long, is filled in with a wooden piece, so that more than one saw, or any style of cutter head, up to 3½ ins. wide, can be used. The mandrel, together with pulley in the center between boxes, is accurately balanced and the bearings are long and lined with the best babbitt. The mandrel is 1¼ in. in diameter between the collars and is raised and lowered by the hand-wheel conveniently placed just below and in front of the table.



THE UNIVERSAL SAW BENCH, WITH TILTING IRON TABLE. — GREAVES, KLUSMAN & CO.

The ripping gauge is thoroughly adjustable, and can be set at any angle up to 45 deg. This gauge can be set on either side of the saw, the table being provided with slotted ways on both sides, for ripping stock up to 16 ins. wide on the left of the saw and 20 ins. wide on the right side of the saw.

The countershaft is placed on a movable frame which is dove-tailed into the main frame, as shown, for longitudinal movement, and adjusted by the lower hand-wheel shown in front of the machine. This makes a most convenient and easily maintained arrangement of driving.

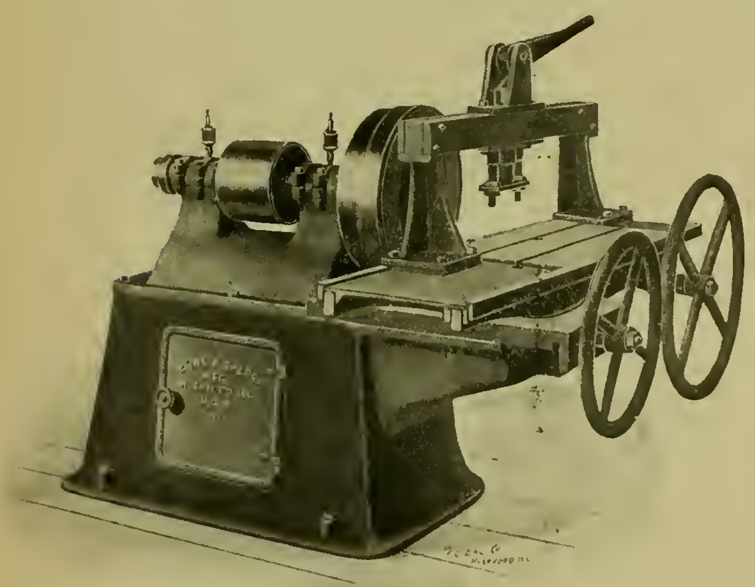
The extended experience of Greaves, Klusman & Company in the manufacture of iron-working tools has placed them in an enviable position to make the most valuable applications of the laws governing machine tool design to the various types of woodworking machinery, which they build. One of the most noticeable features of this machine is its rigidity—this together with its simplicity and compactness make it a most desirable tool. The application of these sensible principles to the design of woodworking machinery appears to be a step in the right direction, and will render them invaluable to users who desire the maximum output and freedom from repairs.

AN IMPROVED CYLINDER EMERY-WHEEL FACE GRINDER.

With Hand and Automatic Feed and Travel.

The accompanying engraving presents a comprehensive illustration of the improved cylinder face grinder, designed for either flat or concave face grinding, which is built by Chas. F. Spery, Rockford, Ill. This tool is a very substantial and well built machine and is adapted to the heaviest grindiug where absolute rigidity is a requirement.

This tool will handle work 30 ins. long and 6 ins. wide, and is adapted for grinding surfaces on steel or iron, whether soft or hardened. The table has three tee slots to facilitate fastening jigs, for the rapid setting and clamping of dupli-



THE SPERY CYLINDER EMERY-WHEEL FACE GRINDER.

cate pieces of work. As shown in the engraving, the tool is equipped for grinding small castings of a special shape, being provided with a special clamp operated by an adjustable toggle lever so that the work may be clamped absolutely rigid and with the utmost rapidity.

The grinding wheels used upon the Spery grinder are of the cylindrical type, the range of sizes being from 12 to 20 inches, so that all classes of work may be accommodated. The chuck is of cast steel, of a special design and with a screw flange to set the wheel out when worn down even with its face. The arbor is of hardened steel, 2 7-16 ins. in diameter and runs in journals of extra length. A phosphor-bronze end thrust bearing is provided at the outer bearing to take care of the thrust imposed by the grinding operations

The table is provided with adjustments in either direction, the hand wheels for the same being shown at the front of the machine. The adjustment is thus universal to permit of concave grinding, but can be easily arranged for flat grinding. In addition to the hand adjustment an automatic feed is provided for both motions of the carriage. The rigidity made possible by the design of this tool may be estimated from the fact that its total weight complete is 2,800 lbs.

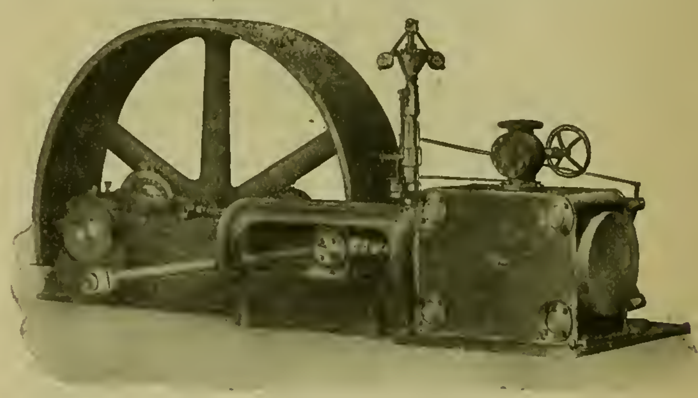
NEW STANDARD REYNOLDS-CORLISS ENGINE.

Allis-Chalmers Company.

In the accompanying engraving we illustrate a new type of Corliss engine which is being brought out by the Allis-Chalmers Company from the designs of Mr. Irving H. Reynolds. The field of the Corliss engine design has been so fully worked over in the past, and the accepted designs have become so simple, that no strikingly novel designs are to be expected; this new engine, however, represents the experience of twenty-six years in building of Corliss engines, and combines all of the more desirable elements of the best designs.

Engines of the type illustrated are being built in seven sizes, ranging from 50 to 500 horse-power, and are designed for steam pressures up to 150 lbs. A novelty is introduced in that they are built of somewhat shorter strokes than have heretofore been customary in Corliss engines, with the idea of economizing in space and making the construction more rigid. The speeds are also somewhat higher than usual, ranging from 110 to 150 revolutions per minute, although these speeds are not higher than those at which the Reynolds-Corliss engines of older design are frequently operated.

The frame is cast in one piece with the slide, the construction being of the box type, resting on the foundation for its entire length. The main bearing shells are bored into the frame, thus insuring a solid bearing and also permitting the easy removal of the shells by rolling them out around the



THE NEW DESIGN OF HORIZONTAL REYNOLDS-CORLISS ENGINE.

shaft. The slide is of the barrel type with bored guides. The cross head is fitted with babbitt-faced shoes with wedge adjustment. The piston rod is screwed into the crosshead and held firmly with a steel lock nut. The cylinder is of the round cornered type, lagged with planished steel, and is fitted with double ported steam and exhaust valves. The cylinder is set on a cast iron base plate, which extends under the valve gear, serving as a drip pan.

The valve gear is of the usual Reynolds-Corliss type, the wrist plate being of skeleton pattern and fitted with a new type of disconnecting device which, while clamping the hook rod firmly, is very easily detached by hand. The dash pots are of a differential plunger type without leathers or packing of any kind. The regulator is of the high-speed weighted type, designed to control the engine within narrow limits of speed variation.

The connecting rod is of steel with solid forged ends, and is fitted with bronze boxes, adjustable by means of screw actuated wedges. The box on the crank pin end is babbit-lined. The crank is of a plain type, polished on the face, and is protected by a planished steel oil guard, which, however, is not shown in position in this view. The crank and crosshead pins and main journals are of the liberal size ordinarily used with the heavy duty Reynolds-Corliss engines.

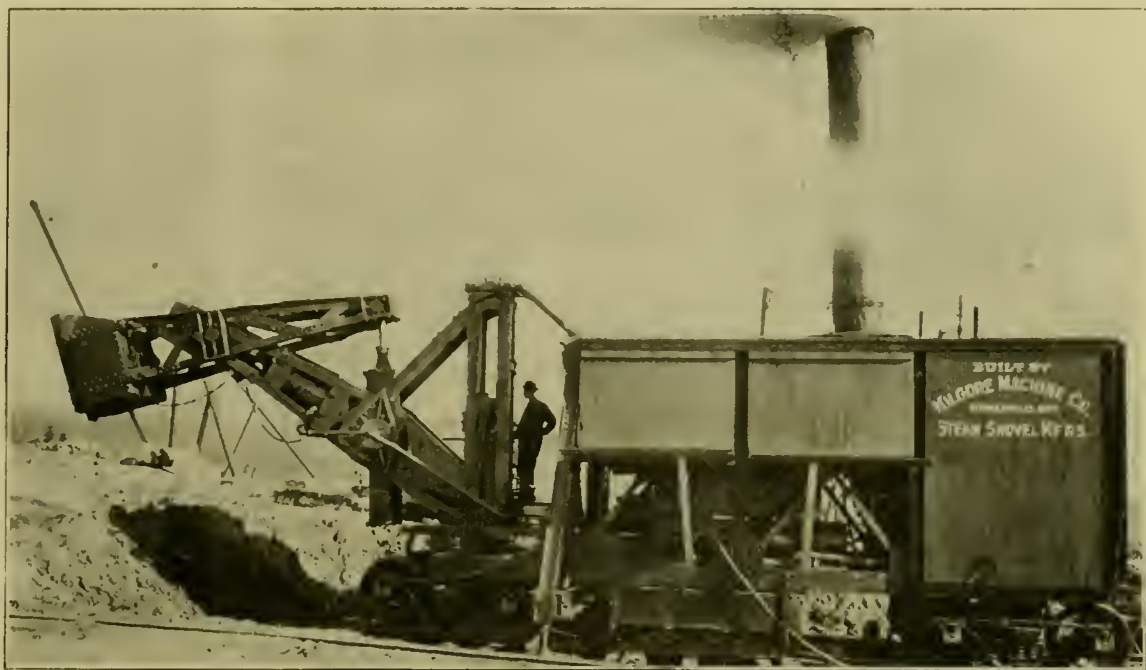
In brief, the engine is strong, simple and compact, and while nothing has been added for ornamentation, nothing contributing to economy or durability has been omitted, and the machine should find a large sale among power users who appreciate quality.

THE KILGORE DIRECT-ACTING STEAM SHOVEL.

The new Kilgore direct-acting steam shovel, herewith illustrated, possesses some features that are distinctly in advance of the practice for machines of this character. The record made by this type of machine is now attracting considerable attention to its way of doing business, which is peculiarly its own.

These shovels are direct acting, all movements of the dipper are controlled by four powerful steam cylinders, operated by steam used for one motion of the dipper is that to fill each cylinder once only. All motions of the dipper can be reversed instantly and with equal power.

This shovel is self-propelling, and can be taken to and operated in places where it is impossible to use large shovels. It has all means within itself to accomplish results that are usually obtained by extraneous aids. If the front trucks are derailed, the dipper can be lowered to the ground, and by using the lifting and swinging cylinders, the front end of the car can be easily and quickly raised and swung on the track.



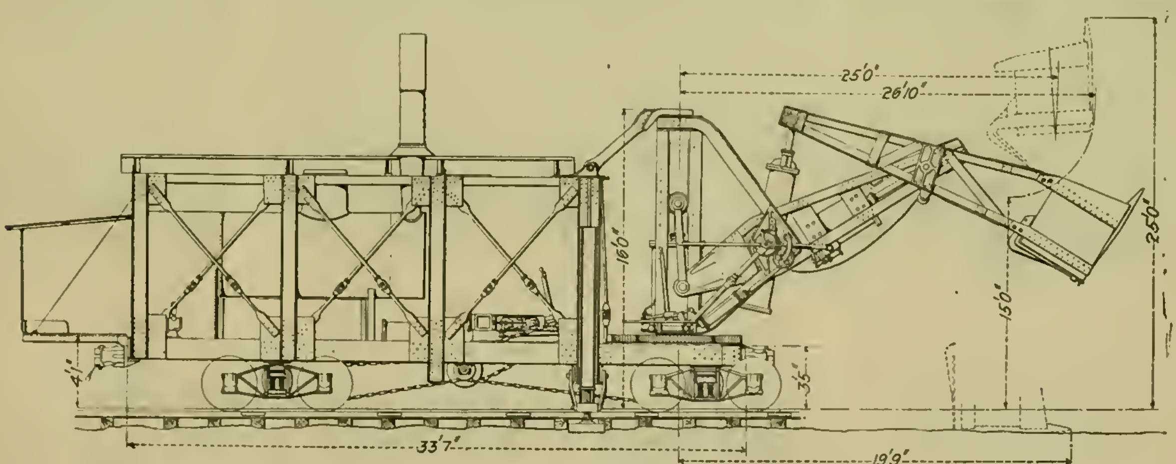
GENERAL VIEW OF THE NEW KILGORE DIRECT-ACTING RAILROAD STEAM SHOVEL.

only two levers, which gives a range of action not possessed by any other shovel, responding to every move of the levers and always in the direction of the motion of the hand.

A distinct advance in the operative construction of these machines is in the absence of all chains, chain sheaves, winding drums, friction clutches, gears or cables. All small details seen on other machines of the kind are eliminated, and all the machinery is direct connected and direct acting. In fact, this machine stands alone in the application of first principles of mechanics to rapid and effective work in its field.

The construction is almost entirely of steel, and therefore up-to-date from the designers' standpoint. The steam consumption is low, since the steam is used expansively and in accordance with the amount of work done, the point of cutoff always being under control of the operator. The maximum amount of

The dipper is arranged to be moved forward or back by means of the forcing cylinder, thus giving a chance to withdraw the dipper from the bank when full, and dump without going clear through to top of the bank. This movement may also be used to spot cars when dumping. The dipper may be shaken violently to toss off sod or any large objects too large to pass through dipper opening. By working the two pistons at once, the dipper can be moved in a direct line to any point desired, it will also dig in any material, or nose around a root or rock. These features are a recounting of only a few of the favorable things that may be said about the machine, which is set up to conform to standard railroad clearances and can be used in any place where rails are laid. The capacity of the shovel is from 1¼ to 2½ yards. This machine is built by the Kilgore Machine Company, Minneapolis, Minn.



DETAILS OF THE 2½-YARD KILGORE DIRECT-ACTING SHOVEL.

ACME GAS, A NEW FUEL.

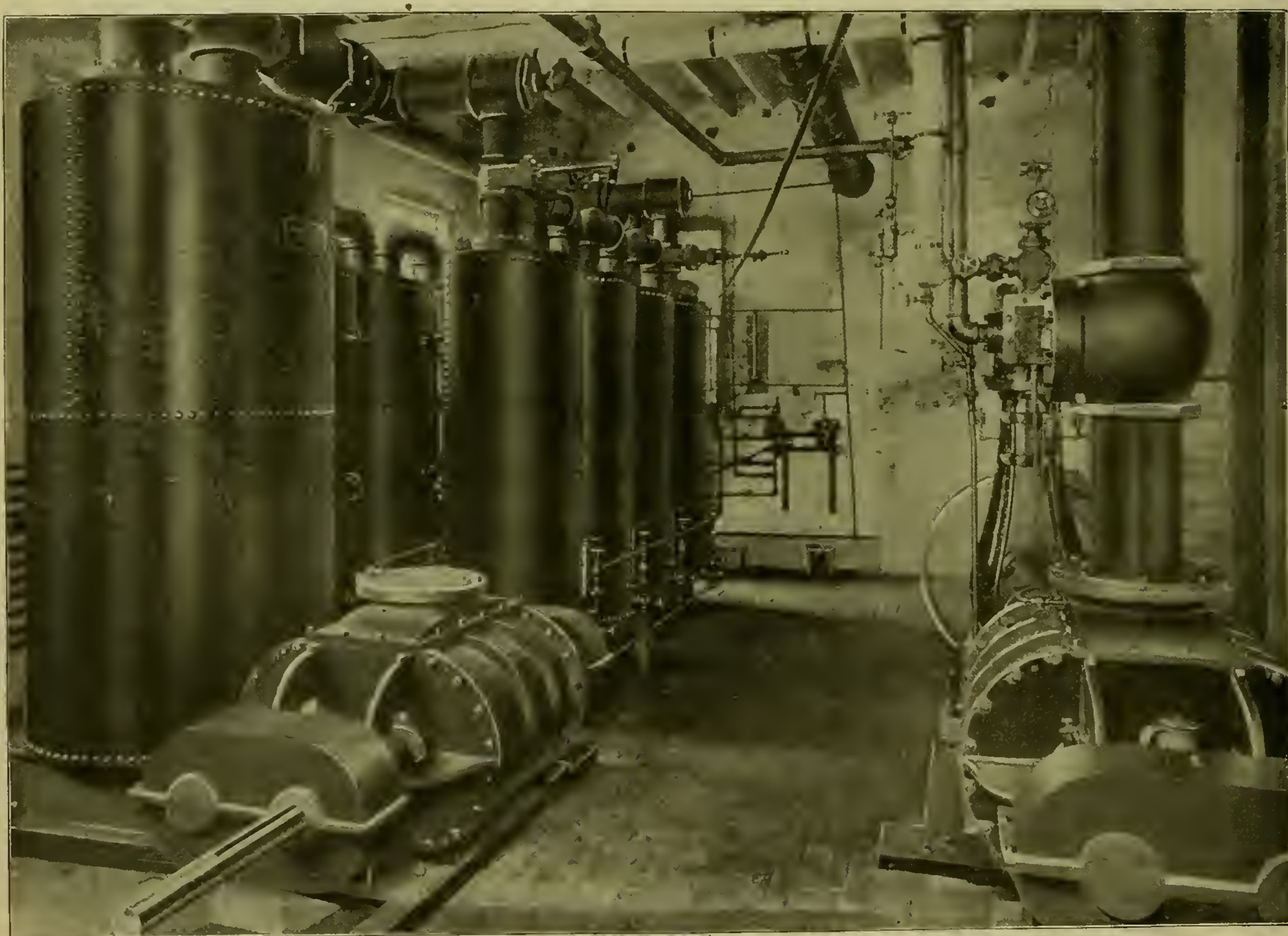
For Forging and Heating Purposes in Railroad Shops.

The most modern development in the engineering world in the direction of fuel application to furnaces for the heating of iron and steel for forging purposes and general furnace work, is in the conversion of crude fuels into gas. Fuel experts have always agreed that gas is the most efficient as well as the ideal fuel, both because in gasifying crude materials a far greater percentage of the heat units are made available, and because fuel when gasified is converted into a form which can be applied to furnaces to the greatest advantage, and the most perfectly controlled.

The problem before the engineering world has been to develop a system with which gas could be manufactured at a sufficiently low cost to make its use as fuel in furnaces practicable and economical, and to discover a process of generation which would produce gas from an apparatus of simple and compact enough construction to enable the individual manufacturer and railroad shop to install a gas plant inside their own premises. The advent on the market of Acme gas and Acme gas plants, which are manufactured by the Acme Gas Company, Monadnock Building, Chicago, has offered a solution to these problems which is altogether feasible and extremely simple.

Acme gas is made from crude distillate of petroleum at a cost of from 8 to 12 cents per thousand cubic feet. It is a gas of high calorific efficiency, and more similar in character to natural gas than any other product. It is made by forcing air under pressure through crude distillate of petroleum. No heat or retorts are required in its generation and it is entirely free from impurities. The plant is of simple construction, automatic in its action, requiring but little attention and only a small amount of floor space. The plant is so constructed that it manufactures gas as fast as required and no faster, so that no gasometer or holder is required. Another point that adds greatly to the efficiency of Acme gas is that the process of generation is such that any required pressure can be secured from 7 lbs. down to 2 ozs.

Acme gas is particularly adapted to forging and welding, and general furnace work. It has been used to the exclusion of all other fuels in the Government Navy Yard at Washington, D. C., for the past four years, in large ingot furnaces, open blacksmith forges, etc., and since the plaut was installed at Washington, this system has been adopted by the Government in the yards at Charleston, Brooklyn, Portsmouth and Mare Island. It is particularly serviceable and economical for annealing, tempering and hardening, galvanizing, crucible work, japanning, brazing, etc. It is now being used by many of the largest manufacturers of tools, railway equipment, implements and machinery of all kinds, in place of coke, coal and fuel oil.



VIEW OF A LARGE ACME-GAS GENERATING PLANT. ACME GAS COMPANY.
Capacity—25,000 cubic feet per hour.

This gas is used as fuel in the car shops of Armour & Company and Swift & Company at Fort Worth, Texas; also by the Buda Foundry and Manufacturing Company, Harvey, Ill., for forging car axles, arch bars, construction work in connection with the manufacture of hand cars, switches, frogs, crossings, etc. The accompanying illustrations show an Acme gas furnace for heating car axles and a large Acme gas plant.

The economy of Acme gas above the use of coke and coal is very great, not only on account of the cheapness of the gas as fuel, but on account of largely increased output over coal and coke furnaces and forges. The increase in output ranges from 50 to 300 per cent. and is brought about by the fact that the fire in Acme furnaces and forges is continuous and perfectly uniform, that the men's time is wholly given to their work and

VIEW OF AN ACME GAS FURNACE SPECIALLY DESIGNED FOR HEATING CAR AXLES.
(In this furnace two 6-inch axles are brought to a dripping heat in 20 minutes.)

not to tending their fires, that the delays of building and rebuilding coal and coke fires are entirely eliminated, and that the degree of heat can be absolutely regulated by simply turning on more or less gas.

Other advantages not possible with the use of coal are, the absence of the fire box; the freedom from the expense of the firemen; the freedom from the annoyance and cost of removing ashes. Gas is also desirable because of its cleanness, there being, with its use, an entire absence of smoke, fumes and the unsightly hoods and uptake pipes, so common in shops in which coal is used as fuel.

Acme gas furnaces are very much smaller than those necessary for coke and coal, or even fuel oil furnaces, and consequently a great saving of floor space is secured. They are ready for work ten minutes after they are lighted. When they are not being used, the gas is turned off and there is no waste. They are constructed with a slot opening, to enable a number of pieces to be put in at once. When one piece is taken out to be forged or bent, a cold piece is put in in its place, so that there is no waiting for heats.

The method of producing Acme gas is by forcing air under pressure through a series of generators containing crude distillate of petroleum. The oil which is stored in an underground tank is admitted into the generators by means of a pump which delivers the oil as fast as it is being used. The air supply is furnished by either a rotary positive blower or an air compressor. Thus this gas consists entirely of a combination of air and oil; the two being so admixed as to form a fixed gas, of great heating power, in character very similar to natural gas. The crude distillate of petroleum from which the gas is made, having been run through a still, all impurities are removed from it, as well as the heavier portion of the petroleum, so that the gas contains no sulphur or other substances which have a destructive effect upon metals. Because of its purity Acme gas forms less scale in heating iron and steel than other fuels. This fact, together with the intensity of the heat and its peculiar soaking quality, makes the gas particularly adapted to perfect welding.

The method of application used in connection with the Acme furnaces makes it possible to obtain either a long, yellow flame or a short blue, intense Bunsen flame, as an air blast under the same pressure as the gas, is piped to each furnace, and the air and gas pipes are brought together at the burner with a valve on each. The character of the gas is such that no special burners are required, it being usually burned from an open pipe. The Acme gas producing plants are so simple in their operation as to require very little attention. In order to start the plant producing gas, it is only necessary to start the blower and oil pump. After that only casual attention is required, until night, when the blower and pump are stopped and the oil drained back from the generators into the storage tank.

BOOKS AND PAMPHLETS.

Machine Design. Part I. Fastenings. By William Ledyard Cathcart, Adjunct Professor of Mechanical Engineering, Columbia University; Member American Society Mechanical Engineers, American Society Naval Engineers and of Society of Naval Architects and Marine Engineers. 290 8vo pages. Illustrated. Published by D. Van Nostrand Company, 23 Murray Street, New York. Price, $3.00.

This work is of particular interest as being a most comprehensive treatise on the subject of machine design, covering the ground so thoroughly as to be comparable with the famous English work by Unwin. This new book by Prof. Cathcart should receive most favorable notice and, although not a pioneer in its field, is none the less interesting, and is of great value, since it is only the beginning of what will eventually be a most extended and complete treatment of the subject. The thoroughness with which Prof. Cathcart has gone into the matter is evident from the fact that this whole volume is devoted entirely to machine fastenings. The first chapter presents a most careful and satsifactory treatment of shrinkage and pressure joints. The treatment is theoretical, and many tables are given. Following this come screw fastenings, riveted joints, keyed and pin joints. Throughout the work there are theoretical mathematical discussions and tabulated sizes, for convenient reference. The book abounds in tables, not only of dimensions, but of strength of materials, the properties of matter, etc. Considerable attention is given to U. S. Government specifications for screws, riveted joints, etc. To illustrate what is done in the way of theory, may be mentioned the stresses in screws, torsion due to thread friction, stresses in nuts, efficiency of the screw. Altogether the volume is to be recommended as an advanced and practical reference work on such parts of machine design as its pages treat. The printing and illustrations in the work are excellent. The later volumes of this very promising series will be anxiously awaited.

Locomotive Breakdowns. Emergencies and Their Remedies. By George L. Fowler, M. E. Published by Norman W. Henley Publishing Company, 132 Nassau Street, New York. 1903.

This is a catechism treating of accidents and breakdowns of locomotives on the road and gives instructions for emergency repairs. It is the most complete work devoted to this subject and is a book which will be valuable to those who have to deal with the operation of locomotives. It is evidently intended for locomotive engineers and firemen and is admirably adapted to their needs.

The Gas Engine. A treatise on the Internal-Combustion Engine. By F. R. Hutton, Professor of Mechanical Engineering, Columbia University. 483 8vo pages. Illustrated, 243 figures. Published by John Wiley & Sons, New York. Price, $5.00.

Up to the time of the appearance of this volume there has been no comprehensive American treatise on the gas engine, such as have appeared being either of a popular nature or else dealing specifically with gas engine design. The present volume is intended to be a comprehensive American treatment, unsparing in its theoretical deductions, with due consideration of the application of theory to practice—it is of such character as to place the reader in touch with the wonderful gas engine development in this country in the past few years. The most exhaustive chapter, and one which will be appreciated by the investigator, is one on the theoretical analysis of the gas engine. This chapter discusses the different gas engine cycles more complete than any previous work. The volume presents what is latest in connection with the blast furnace and producer gas apparatus. The first three chapters are introductory, reviewing the physical properties of hydrocarbon for power purposes, touching upon the various gases available, for use in an internal combustion engine. Following this is a discussion of a heat engine cycle; chapters on gas, gasoline, kerosene, and alcohol engines; carbureters; methods of ignition; governing, etc. There is a chapter on experiments with explosive mixtures, one on the performance of gas engines by tests, and one on the manipulation of gas engines which considers the ills that such machines are heir to. While many of the chapters are easily read and free from mathematics, the work on the whole is an advanced treatise and one to interest the mechanical engineer or designer.

American Railways, By Edwin A. Pratt, Reprinted with Additions From "The Times" (London). Published by MacMillan & Co., Limited, 66 Fifth Ave., New York, 1903. Price $1.25.

The author of this book spent four months in a study of American Railways, as a special correspondent of *The Times* and presented his observations in a series of thirteen articles in that newspaper. These have been elaborated and extended for permanent record in this book. The author is a close observer and an interesting and impartial writer. While he writes from the standpoint of an experienced traveler, rather than a railroad man, his ideas of the business questions involved in American railways are remarkably clear. His conclusions, like those of others who have studied both English and American railway methods, are that each system is specially well adapted to the conditions under which it developed and that there is little to be gained by introducing the methods of one into the other. This is rather a non-committal statement and it may be challenged. There must be much in each system, which may be profitably considered in the other, else such a book as this would be valueless. One thing which stands out prominently is the author's astonishment at the cheapness with which human life is held in this country. He stands aghast at the way our main lines of well known and prominently advertised railways run through streets of populous cities and he has something to say as to our accident reports. The author is a competent critic, who is evidently very fond of English methods. He does not tear our methods to pieces, but simply says that they will not answer in England. His views may be read with interest by American travelers, and with profit by American railroad officers.

Coal-Washing Machinery.—The Jeffrey Manufacturing Company, Columbus, Ohio, have recently issued an interesting and very comprehensive catalogue in the interests of their improved coal-washing machinery. Many of the prominent plants installed by them for coal-washing are carefully illustrated and described. Plants of their build are to be found in all parts of the country, and they are operating with absolute success. Much interesting data upon this subject is also presented in this book. It should be in the hands of all who are interested.

Dixon's Graphite Suggestions.—This is the title of a 24-page illustrated pamphlet devoted to the interests of the Dixon graphite products. It is an excellent piece of catalogue work and gives the impression that graphite is indispensable in many lines of the mechanical arts, particularly for lubrication. Copies may be had from the Joseph Dixon Crucible Company, Jersey City, N. J.

EQUIPMENT AND MANUFACTURING NOTES.

The Crocker-Wheeler Company, Ampere, N. J., has established headquarters at 425 Empire Building, Atlanta, Ga., for the Southern representative of its Washington office, Mr. S. M. Conant.

The Houston, Texas, office of the Walter A. Zelnicker Supply Company of St. Louis, manufacturers and dealers in railway, mill and factory supplies, has been removed to No. 603 Binz Building. Mr. H. E. Miller, who for many years has been in charge of this office, will continue as manager.

We are pleased to learn that the Homestead Valve Manufacturing Company of Pittsburg, Pa., have installed a complete iron foundry, which was started December 7, in conjunction with their well equipped brass foundry. Both brass and iron castings are produced through the use of the improved converting furnaces, in which a heavy blast is used, the process resulting in purer and better metal in every way than crucible or cupola furnaces produce; this enables them to make the superior semi-steel for the valves for which they are so favorably known.

The Diamond Machine Company, Providence, R. I., announce that they have purchased the disc grinder business, good-will, patents, etc., of the George Gorton Machine Company, Racine, Wis., and are now manufacturing the machines at their works in Providence. The Gorton machines have enjoyed, in every respect, the highest reputation. They will be furnished with grooved or flat discs; in all there are 23 varieties of the machines, including those which are electrically driven. A new catalogue is being prepared and the Diamond Company will be pleased to send a copy to anyone desiring one.

Continued activity in trade and recent large orders are reported by the A. Leschen & Sons Rope Company, 920-932 North First street, St. Louis, Mo., for their wire rope and supplies, the aerial wire-rope tramways which they manufacture and erect, and likewise their underground and surface haulage plants. "We Pull for Leschens" is what reads on the large leather collars of the horses attached to the wagons of the A. Leschen & Sons Rope Company in St. Louis, New York, Chicago and Denver. These are the wagons in which they deliver their reels and coils of Hercules and patent flattened strand and all other kinds of wire rope.

The American Steam Gauge and Valve Manufacturing Company have again been compelled to seek new quarters, owing to the increase of their business, and are at present removing their entire plant and offices from Bismarck street, Roxbury district, to the large buildings, 208-220 Camden street, Boston, Mass. The buildings have floor space of 85,000 sq. ft. The Mowry & Phillips foundry department will also be removed from South Boston and every branch of the business consolidated at the Camden street factory. The new plant will afford them more than double the present capacity, and will be employed in producing their valves, gauges and indicators; also special metals and foundry work in the Mowry & Phillips department.

The Michigan Lubricator Company, Detroit, Mich., have recently brought out an important improvement in their well known locomotive sight-feed lubricators, in the form of an automatic safety device over the sight-feed glasses, which has been thoroughly tried and tested, and has been found absolutely effective. This improvement prevents injury to engineers and firemen in charge of locomotives, from the escape of steam and oil caused by the blowing out of sight-feed glasses. Check balls are used in the top sight-feed arms, and in the water tube, and by the use of a valve and check ball in the top arm, any broken sight-feed glass can be renewed without shutting off the other sight-feeds, or other connections, or the throttle, and this may be done while the balance of the sight-feeds are in operation. The check ball in the water tube also prevents the syphoning of oil or water out of the reservoir of the lubricator at all times.

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL

FEBRUARY, 1904.

RAILWAY SHOPS.

BY R. H. SOULE.

X.

THE STOREHOUSE.

(INCLUDING THE OIL HOUSE.)

The storehouse is a vital part of the shop establishment, and closely identified with its current operations; it is not only a warehouse for keeping material in, but is the agency through which all receipts and shipments are handled, whether for storehouse account or not.

Its operating force is sometimes under the direction of the master mechanic and the motive power department; sometimes under the general storekeeper and supply department, and in a few cases directly under the general manager or other executive officer having jurisdiction over all operating departments. The materials under storehouse control are seldom confined to the building itself, or to its immediate vicinity; but almost invariably include bar iron supplies for and at the smith shop, plates and sheets for and at the boiler shop, lumber for and near the planing mill, and often pig iron for the foundry. The foremen of these departments are virtually deputy storekeepers for these supplies, and their laboring gangs ordinarily load and unload them; therefore, although the storehouse control is, under some systems, vested in departments other than the motive power, its operations never can be isolated from current shop operations and must always be closely identified with them. Unless shop officers have a considerable voice in deciding what kinds and quantities of materials shall be carried in stock, good output results are not to be expected.

The oil house is always under storehouse control, and the stationery stock is usually so. The storehouse is sometimes purely local, sometimes serves a district, and sometimes a whole road or system. The department idea is seldom observed, and but few roads maintain separate establishments for motive power, maintenance of way, and transportation supplies. It is therefore evident that as regards size and floor space the storehouse is not likely to bear any very definite relation to the other buildings in a shop group, but its proportions will have to depend on local conditions for each road.

As it must be served by at least one track it will be long and relatively narrow, and may be of any number of floors and with or without a basement; it may have balconies or galleries; may have tracks on one side or both sides or on the inside; and should be fire proof or of slow burning construction.

The location should theoretically be as nearly central as possible, but practically this is determined largely by track connections, surrounding storage space, fire risk, etc. Storehouse tracks are apt to be blocked with cars at times and thus impede transit across them—this should be studied and avoided in the layout. The stationery storehouse is usually embodied in the general storehouse, but as its shipments are almost invariably in small packages and by passenger train, the passenger station would be an ideal location for it.

The interior of the storehouse should be arranged on certain general principles: Alleyways between racks to run at right angles to main gangways and to length of building; racks to be adjustable, so that spaces between shelves can be varied; space near track side and wagon platform to be fitted up for packing and shipping; main floor arranged for supplies currently handled and other floors for surplus stock; office to be preferably near shipping end or side.

TABLE 17.

STOREHOUSES, ARRANGED IN ORDER OF GROUND AREA.

INCLUDING STOREKEEPER'S OFFICES, BUT EXCLUDING PLATFORMS AND MASTER MECHANIC'S OFFICES.

Location.	Railroad.	Ground Area (approximate). Sq. ft.	No. of Floors.	Total Floor Area (approximate). Sq. ft.	Isolated?	Main Floor Level.	Track Arrangements.
Oelwein, Ia.	C. G. W.	2,820	4 & basement	10,080	No	High*	One side only.
Concord, N. H.	B. & M.	4,000	2	6,400	Yes	High	Both sides.
Reading, Pa.	P. & R.	7,000	1 & balcony	12,080	No	High	Center only.
Dubois, Pa.	B., R. & P.	7,200	2	13,200	Yes	High	Both sides.
Chicago, Ill.	Armour	7,500	1 & balcony	9,180	Yes	Low	One side only.
McKees Rocks, Pa.	P. & L. E.	7,500	2	15,000	Yes	Low	Both sides.
Baring Cross, Ark.	M. P.	7,500	2 & basement	18,750	Yes	High	One side only
Roanoke, Va.	N. & W.	11,550	2	14,700	Yes	High	One side only
Omaha, Neb.	U. P.	14,400	2 & balcony	31,616	Yes	High	Both sides.
Elizabethport, N. J.	C. R. R. of N. J.	15,000	1	15,000	Yes	High	Both sides.
Depew, N. Y.	N. Y. C.	15,216	2	20,520	Yes	High	One side only.
Topeka, Kan.	A., T. & St. F.	17,000	2 & basement	51,000	Yes	High	Both sides.
Collinwood, O.	L. S. & M. S.	18,000	3	54,000	Yes	High	Both sides.
Oak Grove, Pa.	N. Y. C.	18,900	1 & balcony	17,875	Yes	High	One side only.
Burnside, Ill.	I. C.	21,000	2 & basement	61,600	Yes	High	Both sides.
Readville, Mass.	N. Y., N. H. & H.	22,500	1	22,500	Yes	High	Both sides.
Sayre, Pa.	L. V.	37,400	1	37,400	Yes	High	Both sides and center.
Moline, Ill	C., R. I. & P.	50,000	2	100,000	Yes	High	Both sides.

*High = 4 ft. elevation (box car floor level); low = on ground level.

Table 17 gives the ground areas and total floor areas for eighteen storehouses, sixteen of which have been built within the last five years; in this, the following points may be noted:

The Oelwein storehouse is the only one having four stories and basement. This storehouse is not isolated, but is in one end of the main shop building. It is also peculiar in that the main floor of the storehouse is on the same level as the gallery floor of the shop, and the main floor of the shop is on the same level as the basement floor of the storehouse; this is due to the difference in level between shop yard and transportation yard. What seems like an inconvenient working arrangement here is redeemed by good crane service between the "pulpit" (extension of the storehouse main floor) and the main floor of the shop below, and by good electric derrick service between the storehouse platform and the shop yard and transfer table below.

The Concord storehouse is small for the size of the shop, and has been supplemented by a castings shed placed some distance away from it, but adjacent to the machine and erecting shop.

The Reading storehouse is not isolated but is introduced

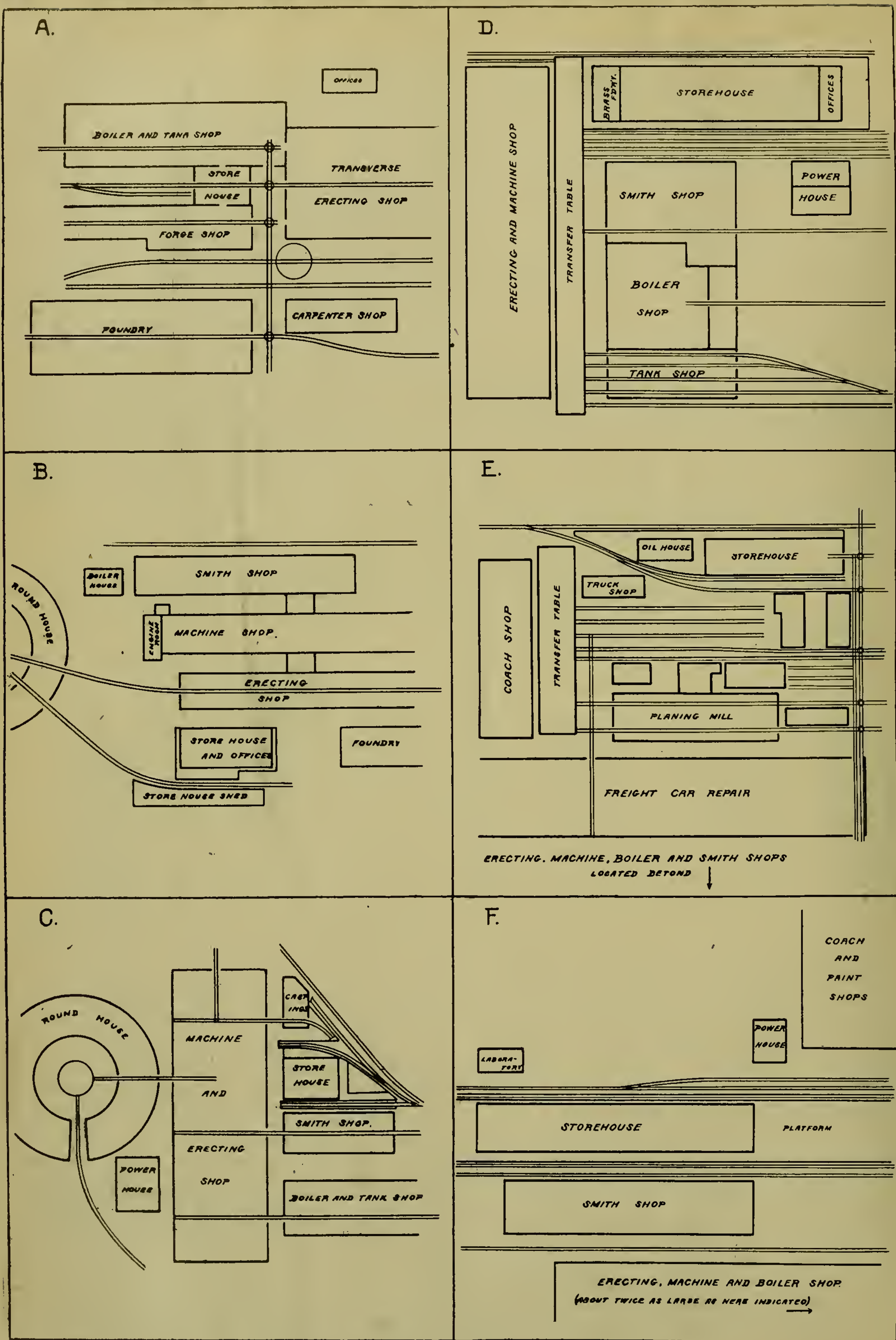


FIG. 5.—TYPICAL STOREHOUSE TRACK ARRANGEMENTS.

A, B AND C = EASY OF ACCESS; D, E AND F = DIFFICULT OF ACCESS.

between the boiler shop and the smith shop having common walls with both; this makes it impossible to have track approaches on either side of the building, and one is brought directly through the center. The floor level being high compared with the track level, the track way forms a pit in the floor which presumably has to be spanned by plank bridges for working purposes.

The Armour storehouse, at Chicago, though not a regular railway storehouse, is mentioned as illustrating the possibility of placing the building on the ground level with a depressed track alongside; it is also notable because it has easy access on three sides, without obstructions (tracks, platforms, etc.). The McKees Rocks storehouse is similarly located on the ground level, but has two depressed tracks, one on either side, and is the only railroad storehouse, here listed, which is so arranged; it is therefore worthy of careful consideration. The end of the storehouse building is quite close to the face of the main shop building, and all of the conditions are favorable to a free interchange between the two.

The Baring Cross, Topeka, Collinwood and Burnside storehouses form a group by themselves, as each has three working floors. Collinwood has three floors above the ground level, the others having two above the ground level with basements below.

The Omaha storehouse has two working floors and an intermediate balcony, and in this respect stands alone. Those at Baring Cross, Roanoke, Depew and Oak Grove have a track on one side only, and when the track is on the side of the storehouse building away from the other adjacent shop buildings, it makes a good working arrangement.

The Elizabethport, Readville and Sayre storehouses are all one story structures, Elizabethport and Readville having two tracks, one on either side, and Sayre having three, the additional one running through the center of the building (as at Reading), and thus giving four working platforms. The Moline storehouse leads all in both ground area and floor area, and, being 100 ft. wide with tracks at the sides only, much trucking will be required in its operation. The Sayre storehouse is also 100 ft. wide, but has three tracks, as above stated.

It will be noted that the storehouses of largest total floor area are generally in the west, a fact largely due to their several locations being remote from the base of manufactured supplies; but this is also influenced to a considerable extent by the system of handling supplies which prevails on the individual roads. Collinwood appears to have an exceptionally large storehouse for an eastern road, but it embodies the general stationery storehouse of the system.

With electric power generally available it is probable that the traveling crane will be regarded as an essential adjunct to every large storehouse of the future. This is foreshadowed at Moline, where a rectangle of 80 ft. by 400 ft. on the storehouse platform is covered by a 5-ton electric traveling crane, and similar installations, though on a smaller scale, are creeping in elsewhere.

Accessibility to the storehouse by track connections is sometimes favored to such an extent in the original layout that accessibility by foot and by hand truck are sacrificed. Fig. 5, illustrating several storehouse track arrangements, is introduced in this connection; it gives six examples from actual practice, three (A, B, C,) are presented to illustrate arrangements providing facility of access, and the other three (D, E. F,) to illustrate difficulty of access (from other shop buildings).

Sometimes the storehouse is not centrally located, but oftener there are physical obstructions, such as transfer pits or tracks to be crossed. Transfer pits are absolutely prohibitive of easy interchange and tracks are apt to be blocked with cars—even when not so blocked they can be crossed with a hand truck or barrow only where planked over. It will always contribute to good results if the side of the storehouse nearest to the principal shop buildings has no track alongside of it. An ideal arrangement (not yet found in actual practice) would be to have the storehouse building on ground level with its track on one side only, its opposite broad side being open to access from the adjacent principal shop buildings; this is usually difficult to accomplish, however, on account of the connections to the depressed track, and would generally require that the storehouse track be along one edge of the property.

Iron racks for the storage of bar iron for smith shop use are susceptible of a great variety of design. The essentials are a firm foundation to sustain the heavy load, and that the horizontal members, at least, should be made of round bars or pipe to facilitate the handling of the contents. Boiler plates are stored most compactly and handled most easily if stood on edge, except when a lifting magnet is used, which requires that the plates be laid horizontal, but the use of the magnet has not yet extended largely to railway shops. At Elizabethport, and in a few other shops, the boiler plates are stored inside the shop, so as to come under the travelling crane. At the Juniata (Altoona) shops of the Pennsylvania R. R. the plates are stored in the yard to the westward of the boiler shop building, the traveling crane serving both shop and yard by passing through an opening in the gable end of the building.

The oil house is almost invariably a separate establishment from the storehouse, although under the same control. Its location is determined by such a variety of influences that no uniformity results; if the shop plant includes a large roundhouse the oil house is usually near it, to facilitate the delivery of oil, in cans, to locomotives, while if there is no roundhouse the location will ordinarily be conveniently close to the storehouse, with only enough intervening distance to minimize the fire risk. Any variation from this practice is usually due to purely local conditions, such as available track connections, etc. At the shop points listed in Table 17 the distances from storehouse to oil house range from a minimum of 25 ft., at Topeka, to about 1,125 ft. at Elizabethport, the oil house location in the latter case being determined by that of the roundhouse. In a very few instances, paint stores are kept in the oil house, and the location of the paint shop then has an influence in determining the oil house location.

As to the type of building for oil house purposes, three varieties prevail: The gravity type, with three different levels for supply, storage, and service; the gravity and lift type, with a minimum of two levels, one for supply and one for storage, the service level being either one of these or possibly a third; and the lift and gravity type, with two levels, one for storage and one for service. The lifting process may be accomplished by pumping or by compressed air, but it has been found by experience that compressed air under average shop conditions is apt to infuse suspended water into the oils with which it comes in contact, and therefore the illuminating oils are now seldom handled by this means but rather by pumps. The lubricating oils continue to be successfully handled by air, however. At outlying and isolated points where land is plenty, and compressed air not to be had, a gravity system is usually preferred, and by using horizontal tanks the necessary three levels can be obtained without going below ground level; at central points where conditions are different, operations conducted on a large scale, and the expense is justified, vertical tanks will be found preferable, as a given storage capacity can thus be concentrated into a smaller ground area. Heating coils should be under or alongside of tanks rather than in them, as repairs of internal coils would be burdensome and the leakage disastrous.

The oils for which separate storage is usually provided in the average railway oil house are: engine oil, cylinder oil, carbon oil of low fire test, carbon oil of high fire test, car oil, fuel oil, etc. Where power is available mixing tanks can easily be arranged and with proper pipe connections can easily be operated and the staple mixed oils produced at low cost.

The service taps in a large oil house should all be piped to a common point with oil cocks ranged over a drip pan, and in a lift system the lifting agency, whether compressed air or pump, may be controlled from the same point. The most conspicuous examples of the lift gravity system are the recent installations at Omaha (Union Pacific) and Pocatello (Oregon Short Line); these being practically duplicate plants. Their underlying principle is that the oil, received from the manufacturer (whether in tank cars or barrels), is pumped (by steam pumps in this case) into the storage tanks, and the oil used for service is drawn by gravity; under this system the storage tanks may be kept above ground and have to be elevated from floor level only enough to give the necessary head room for filling barrels, cans, etc. But where conditions permit making the necessary excavation it is believed that the gravity-lift system is superior to the lift-gravity system, as in the former, tank cars can be more quickly emptied and released, while the process of lifting can be done in detail installments to suit the requirements of service.

At Houston, Tex., on the Houston, East and West Texas Railway, there is an oil house fitted with vertical storage tanks, each of which has a false bottom forming a steam drum below for heating purposes. It is evident, of course, that either this steam drum must be strongly braced or else the steam fed to it must be passed through a reducing valve and brought down to a low pressure, unless, possibly, exhaust steam is used.

The Baltimore & Ohio have a standard arrangement of oil house for outlying roundhouse points, where the storage tanks are below ground level and under a steel and concrete platform which is about 30 ft. by 50 ft. At one end is the serving house of two floors. The lower one (depressed below ground level) being the place where supplies are drawn, and the upper one being for waste storage; these oil houses are operated on the gravity system throughout.

The Galena-Signal Oil Company issue a book of diagrams showing five alternative oil house plans, the estimated costs of which range from $1,000 up to $18,000.

(To be Continued.)

ERRATA:—We regret an unfortunate omission in the preceding article of this series. In the first column of the article, on page 1 (January issue), the 9th line from the bottom should read as follows: "capacity to evaporate 30-lbs. of water *per hour* into steam."

AN IMPORTANT NEW TERMINAL-YARD LIGHTING AND POWER PLANT.

WEEHAWKEN, N. J.

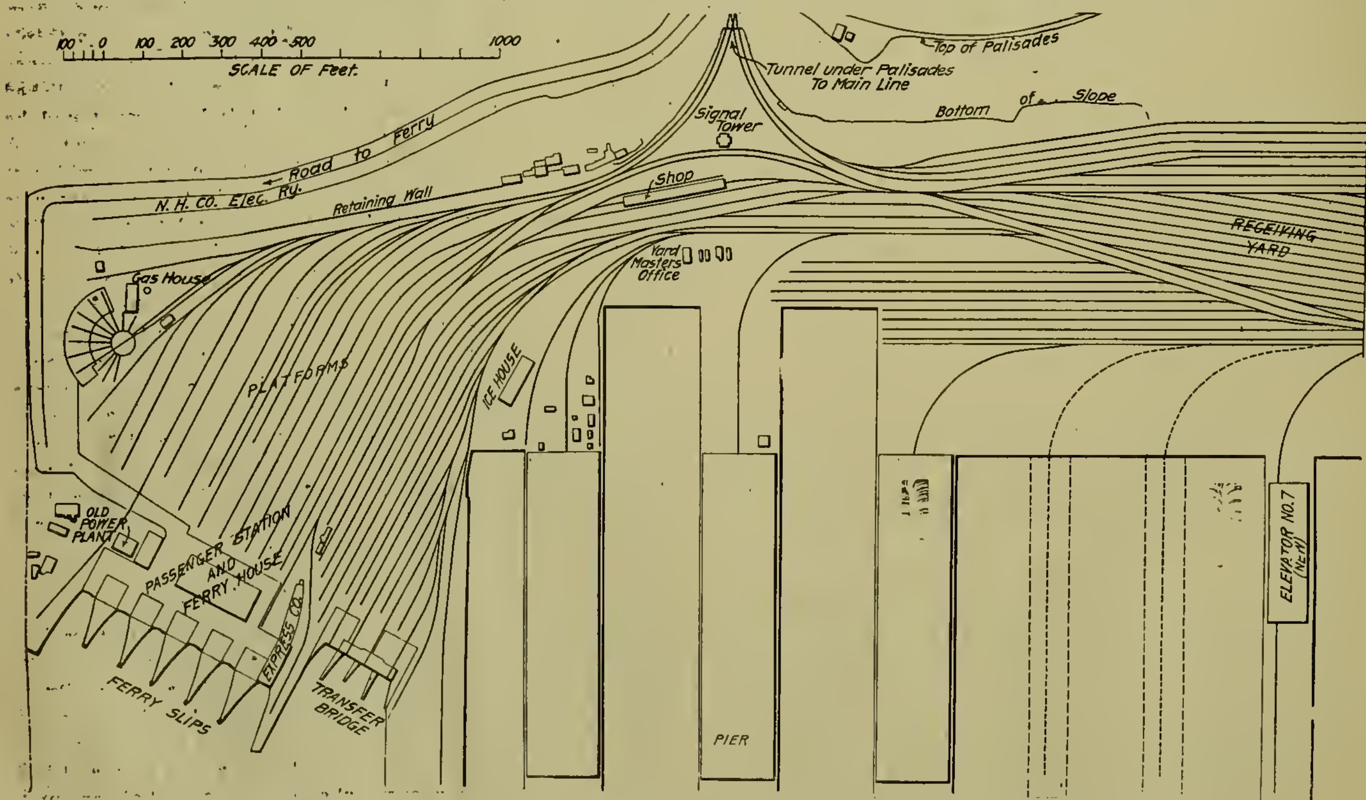
WEST SHORE RAILROAD.

I.

The installation of the large new power plant which is now in process of construction at the Weehawken, N. J. terminal of the West Shore Railroad, is a remarkable example of the applicability of electricity to the auxiliary service of a large steam railroad. There are many uses for power in a large tide-water terminal of this nature, where besides the usual division repair-shop, yard and station lighting, etc., there are large export grain elevators and transfer bridges for the car floats, which require large amounts of power. It becomes a difficult and involved problem to supply the amount of power required under the old conditions of individual steam power plants, with the large amount of attendance required, as well as the ensuing uneconomical operation. Also the lighting of a yard of this size, with the older methods, is a problem of considerable magnitude, and one that became very expensive and complicated, if carried out to any degree of completeness.

With the introduction of the private central power station for the lighting of large railroad properties of this nature, however, comes naturally the suggestion of relief, in carrying the design of the plant to a further degree and embracing in its scope the generation of all the power required for electrical distribution to the various points of consumption. This is, in fact, the direction in which progress is tending; electric illumination for outdoor, as well as inside lighting, is by far the most practicable and satisfactory, and is practically the only lighting system that is given serious consideration for large installations of this character. With the initial expenditure for a lighting plant and its attendant expense of maintenance approved of, it is only a small step and one of comparatively little additional expense to add the necessary equipment for generating large quantities of power for electrical distribution.

The problem that was presented in the equipment of the West Shore terminal at Weehawken was that of lighting the



PLAN OF THE TIDE-WATER TERMINAL AND YARD OF THE WEST SHORE RAILROAD AT WEEHAWKEN, N. J.

FRONT AND NORTH END ELEVATIONS OF THE POWER HOUSE, SHOWING CHARACTER OF CONSTRUCTION AND ARCHITECTURAL DETAIL.

NEW TERMINAL YARD LIGHTING AND POWER PLANT.—WEST SHORE RAILROAD.

large car storage and classification yard, and also the large number of depot and shop buildings, as well as the grain elevators and dock buildings and facilities; also power was used in quantities at a large grain elevator and a much larger elevator was to be built and, in addition to this, power was required at a small repair shop, at the roundhouse, at the marine equipment repair shop, at the transfer bridge where car floats are loaded, and elsewhere. When the problem of providing a power plant for the large new elevator was taken up, it was seen to be only a step further, and moreover—one in the direction of progress, to erect a central power plant which should not only supply the power for the new and the old elevators, but also for the other power service and also for the entire lighting of the yards and all the buildings.

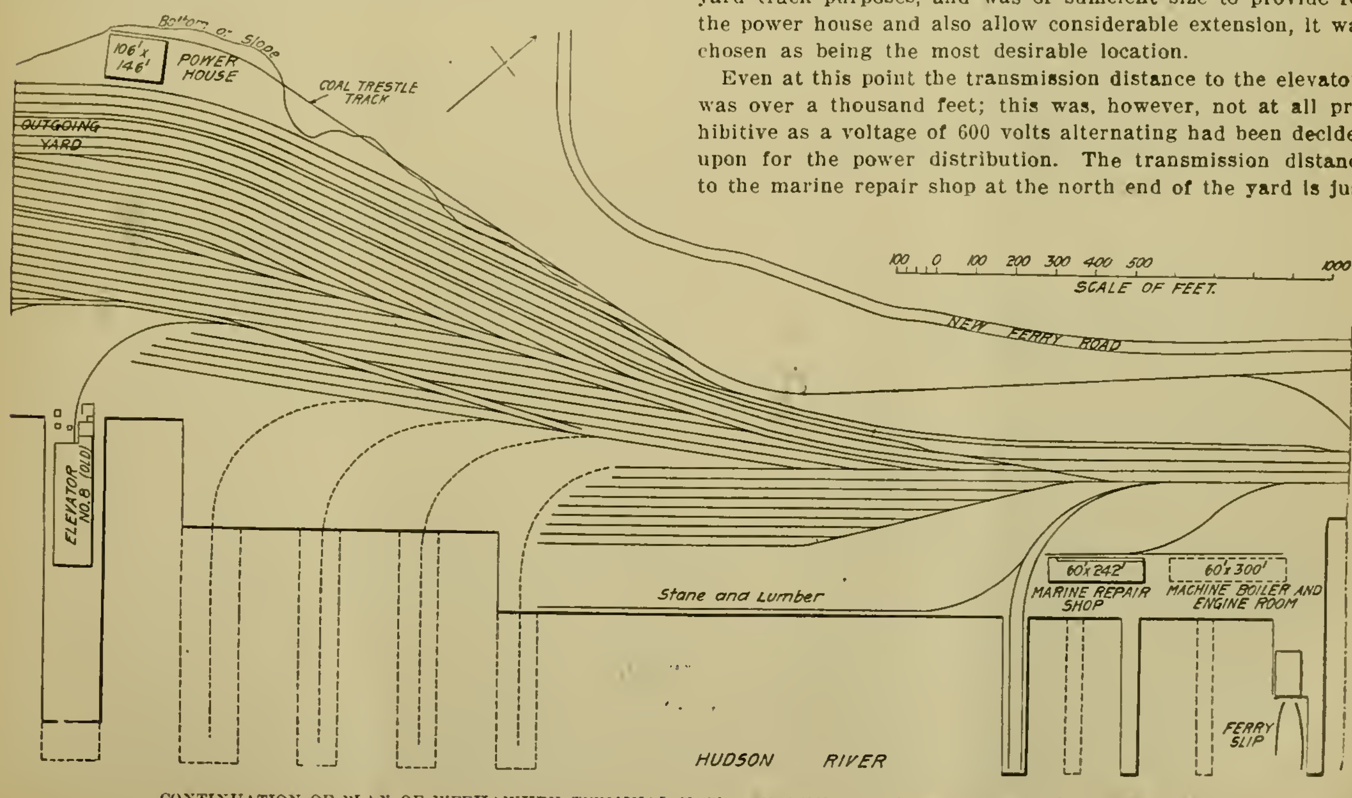
The result of careful consideration of the question from all points of view led to the decision in favor of the central power plant, and in consequence a magnificent plant is being erected, with a total generating capacity of over 3,000 rated horsepower. Many radical improvements are embodied in its design, which will render it particularly interesting as exemplifying the application of the latest principles to the designs of a power plant for mixed power and lighting service. Also interest is added on account of the severe limiting conditions imposed which governed the location and which materially affected the design.

LAYOUT OF THE YARD.

As may be seen from the accompanying engraving, showing the yard layout at Weehawken, the power is to be used at widely scattered points, the depot buildings and roundhouse being at one extreme end of the yard, the marine shops at the other end and the elevators at the middle. The total length of the yard is 6,700 ft., so that it at once became evident that the distribution problems would have to be carefully considered.

In this connection the location of the power plant was of the greatest importance. A central location was, of course, preferred, and in this instance, it became a necessity for the reason that the points of greatest power consumption were found to be at the elevators, which are located almost exactly at the middle of the yard. It was thought inadvisable to place the power plant close to the elevators on account of the poor foundation facilities near the dock, and yet on the other side of the yard the steep ascent of solid rock, known as the "Palisades," limited very much extension in that direction. A sort of recess in the foot of the Palisades, at a point opposite the elevator on Pier No. 8, however, seemed to lend itself naturally to the accommodation of the power plant building and presented the most desirable features for its location that could be found. Inasmuch as this site was inaccessible for yard track purposes, and was of sufficient size to provide for the power house and also allow considerable extension, it was chosen as being the most desirable location.

Even at this point the transmission distance to the elevators was over a thousand feet; this was, however, not at all prohibitive as a voltage of 600 volts alternating had been decided upon for the power distribution. The transmission distance to the marine repair shop at the north end of the yard is just



CONTINUATION OF PLAN OF WEEHAWKEN TERMINAL YARD, SHOWING LOCATION OF CENTRAL POWER PLANT.

one-half mile, while that to the old power plant in the depot at the south end of the yard, is over 3,500 ft. This old power station in the depot is the source of power for the present depot and yard lighting equipment, but will later be charged to serve as a substation, operated from the new power plant, for the local distribution of power and lighting at that point, and will supply power to the roundhouse and also to the motors for operating the aprons of the transfer bridges.

The export grain elevators will require the largest amounts of power. The new elevator, No. 7, will be equipped for motor driving in the latest and most up-to-date manner, and will have 3,300 horsepower in total motor capacity installed. The old elevator, No. 8, which is now driven by an old steam power plant nearby, will be driven by motors on the group system. The power feeders leading to the elevators will be carried through an underground conduit, while the other power transmission and lighting circuit wires will be carried on overhead pole lines.

POWER PLANT BUILDING.

The power house is a well designed building of steel and brick construction, with a particularly substantial steel frame. It is 146 ft. 4 ins. long and 105 ft. 8 ins. wide, outside, and is divided by a division wall into two sections, one—the engine room—located on the east side (toward the river) and the other—the boiler room—at the rear, or west side. The engine room is 143 ft. by 52 ft. inside the walls and has a free height of 28 ft. under the roof trusses; the boiler room is 143 ft. by 49 ft. 4 ins. inside and has a free height of 32 ft. beneath roof trusses, the boiler room floor being located 4 ft. lower than the engine room floor. Under the engine room there is a 12 ft. basement for steam piping, auxiliary equipment, etc., and under the operating floor of the boiler room there is a 10 ft. basement for access to the ash conveyor system.

The exterior appearance of the building is presented in the accompanying engraving. The architectural result is very pleasing and the design symmetrical. While no extraordinary efforts have been directed toward the exterior appearance, still the result indicates that care was taken to harmonize the details, and without sacrifice of the usefulness of any part. Ample daylight lighting is provided in both boiler and engine rooms, the window arrangement being of a most pleasing design. Both sections of the building have monitors in the roof which provide both lighting and ventilation.

Concrete construction entered largely into the construction of this building, the wall and engine foundations and the floors being of concrete. The composition of the concrete used in the footings of walls, foundations, etc., was one part of Portland cement to two of clean sharp sand and four of broken stone. The floors are laid with a first course of concrete composed of one part Portland cement to three parts of sand and six of broken stone, and this is covered with a top course, 1 in. thick of a stiff mortar consisting of equal parts of Portland cement and sand. The steel work will be referred to in a later article.

The entire main roof and roof of monitors is to be constructed of 3 in. concrete slabs, made of the first mentioned stone concrete, with No. 16 gauge galvanized iron wire. The upper surface of the roof slabs is made smooth with a course of mortar of equal parts of Portland cement and sand, laid during construction. The outside of this is covered with pitch and a coating of slag, graduated and bolted, for sizes ¼ to ⅝ in. The monitors are covered on sides and ends with 16 oz. sheet copper, crimped and moulded to conform to the details of construction, and extended within the window construction for weatherproofing. Inside roof drainage is provided to prevent freezing.

Other interesting details of the building will be presented in our next issue, in connection with sectional detail views of the building showing its equipment. We are greatly indebted for this information to Mr. Edwin B. Katte, the designer of the plant and electrical engineer of the New York Central and Hudson River Railroad Company.

(To be continued.)

A NEW 50-TON BOX CAR.

WITH STRUCTURAL STEEL UNDERFRAME.

MIDDLETOWN CAR WORKS.

The accompanying engravings illustrate a new box car that has been designed by and of which five were built by the Middletown Car Works to meet special requirements of the Illinois River Packet Company (the Turner-Hudnut Company, Pekin, Ill.) for handling grain shipments in their home territory, and also to seaboard cities. Features of particular interest have been introduced into the design of this car; the underlying idea has been:

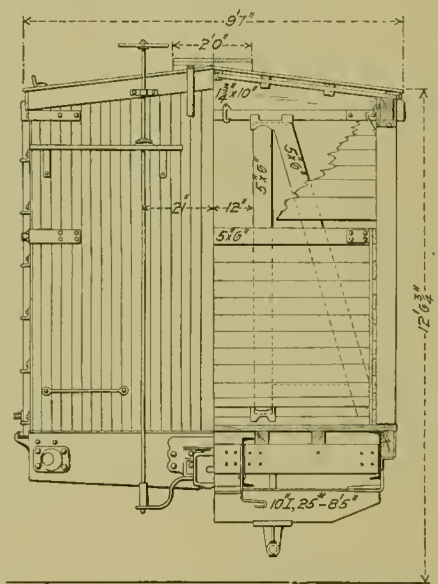
First—To secure sufficient cubical contents for 50 tons of grain;

Second—To use a structural steel underframe of simple type, that would facilitate repairs;

Third—To have ample strength in the underframe and superstructure to support the load and withstand service shocks;

Fourth—To follow the general lines for a standard box car as proposed by the M. C. B. Committee at the last Saratoga Convention.

With respect to cubical contents, it was thought desirable to base this on a length inside of 40 ft., for the reason that to



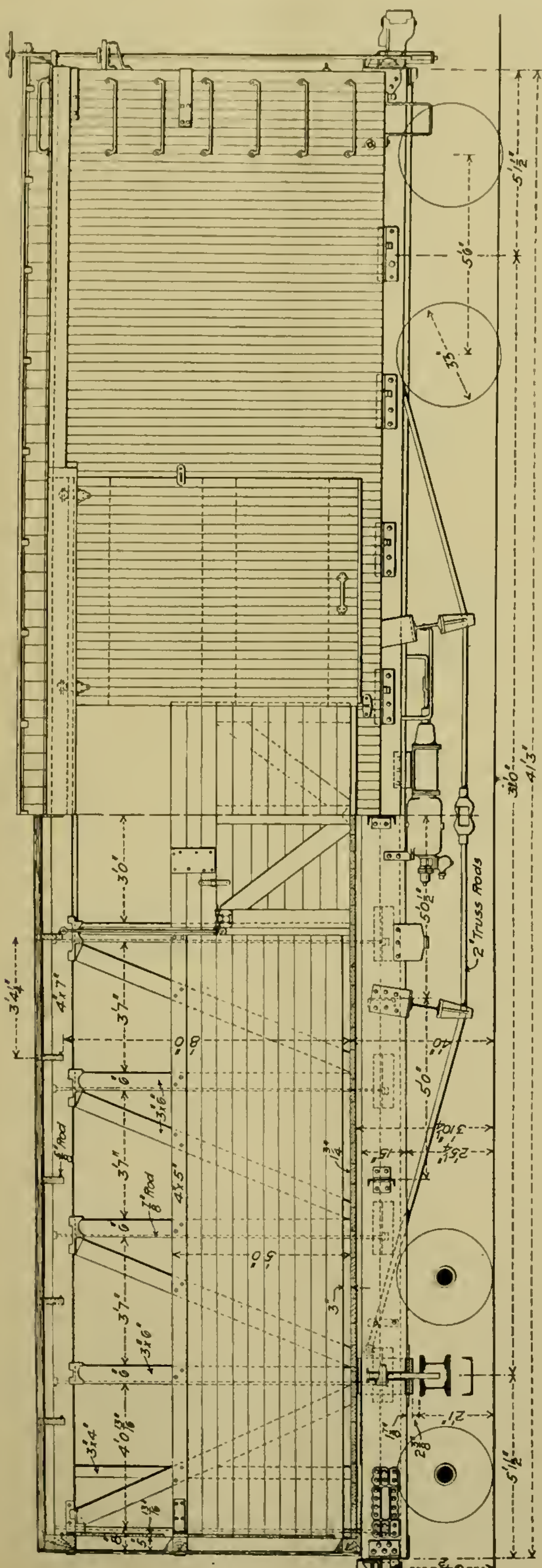
HALF END ELEVATION AND CROSS SECTION OF THE STEEL UNDERFRAME BOX CAR.

load 50 tons of wheat into a 36-ft. car is a difficult matter at most elevators. A car 40 ft. long gives considerably more head room when loaded, and from this point of view seems more desirable than the American Railway Association standard length. The inside clear width is 8 ft. 6 ins.; height from floor to underside of carlins 8 ft. 0 in., and cubic contents to these dimensions 2,720 cu. ft., or 54.5 cu. ft., per ton of rated capacity.

In selecting the type of underframe, the designer, Mr. George I. King, has worked out a design which, in many respects, follows the general lines of wooden car construction, at least to the extent of employing sills of a uniform depth throughout, which are assisted in carrying the load by the use of truss rods.

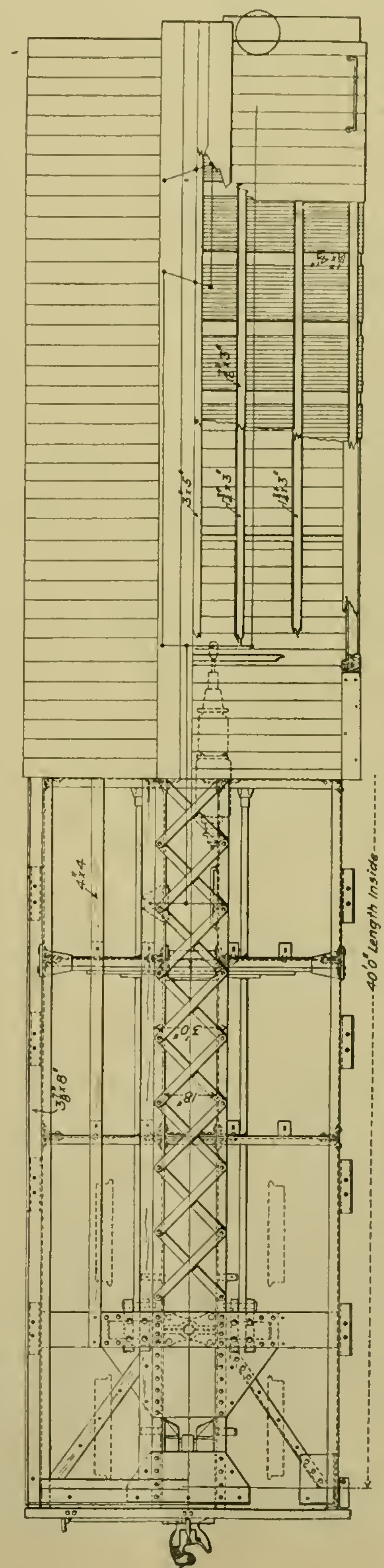
There are four steel sills extending from end sill to end sill, each longitudinal member being a 15-in. channel, 33 lbs. per foot. These sills are supported at each bolster by a bent plate construction consisting of a top bolster bar 12 ins. x ¾ in., and a bottom bolster bar 12 ins. x 1 in., the latter reinforced by 3 x 2½ x ¼-in. angles to prevent buckling. Each side sill is secured to the ends of the body bolster by four 1-in. rivets at each joint. Suitable malleable iron fillers are used between the center sills at the body bolsters to resist the upward thrust due to the load at the center plates; to serve the double purpose of stiffening the center sills and to firmly fasten the top bolster member to these sills, a gusset plate 36 x 5-16 x 60 ins. is interposed between the top surface of the center sills and the under surface of the upper bolster member. Each side bearing is a malleable casting riveted to the lower bolster member, and to prevent distortion of the bolster by side bearing shocks, a 6 x ¾-in. brace has one end riveted to the bolster over the side bearing and the other end secured to the top flange of the center sill.

The two truss rods which extend from bolster to bolster, with turnbuckles at the center of car, are 2 ins. in diameter, with ends upset to 2½ ins., and at the bolsters each rod is pinned between two heavy forged straps. These straps are anchored up at their outer ends, the anchors passing through slots in the large gusset plates above mentioned and fitting tightly against the outer edges of the top bolster bars. Since the horizontal component of the stress in the truss rods is transmitted largely to the top flanges of the center sills, they are latticed together by a double system of 2½ x ½-in. lattice



PART LONGITUDINAL SECTION AND PART ELEVATION OF THE STEEL UNDERFRAME CAR.

Showing Arrangement of Cross Ties for Truss Rod Struts, and Supporting Brackets Below Sills.



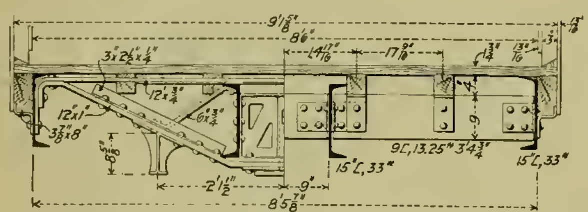
PART SECTION AND PART PLAN OF THE STEEL UNDERFRAME BOX CAR FOR THE ILLINOIS RIVER PACKET COMPANY.

Showing Latticed Construction to Stiffen the Top Flanges of the Center Sills.

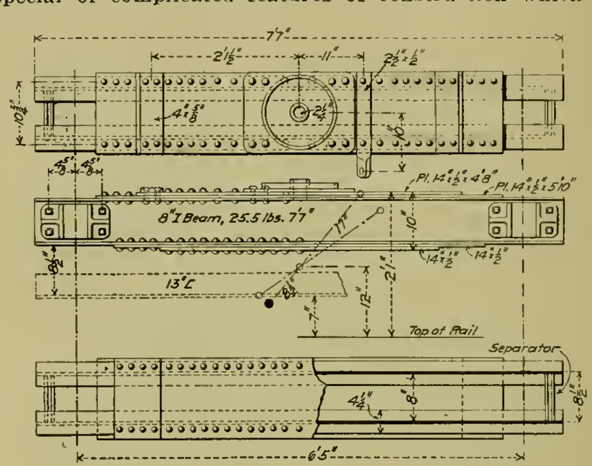
George I. King, *Designer.* Middletown Car Works, *Builders.*

bars, thus forming a very stiff column. Truss rod struts of cast iron bear against two 10-in. I-beam cross ties, as shown; to avoid punching holes in the bottom flanges of the center and side sills, these cross ties are secured to the center sills by 9 x ½-in. steel plate brackets, the ends of which are bent up and riveted to the webs of the center sills; similar brackets ¾ in. thick are secured to the webs of the side sills and support the ends of the cross ties.

The end sill arrangement has been designed to leave this feature of the car as free as possible from connection with parts that would be difficult to remove in case of damage. It will be noted that each end sill is made of ¼-in. plate, bent to a Z shape, the top flange projecting outwardly from the car, and the bottom flange extending inwardly. Neither end sill has any connection with any frame members of the car except the side and center sills, and there is a space of ⅞ in. between the back of each end sill and the outer face of the end sheathing—this to permit moisture to drain away and prevent rotting of the end of the wooden superstructure. Each end sill is faced by a heavy cast-steel striking bracket, to the underside of which is bolted a 4 x 1-in. carry-iron for the drawbar. As the center sills are spaced 18 ins. apart with a view to using double connection angles at their ends, where they are riveted to the end sills, a twin spring draft gear was determined upon. This is of the usual type and employs the M. C. B. standard tail strap. There are four malleable-iron draft castings per car, each secured to center sills by 20 ¾-in. rivets. This underframe cannot be excelled for simplicity, durability and ease of repairs.



HALF CROSS SECTIONS AT DIFFERENT POINTS IN FLOOR OF THE CAR. SHOWING BENT PLATE CONSTRUCTION AT BOLSTER TO SUPPORT THE SIDE SILLS.



DETAILS OF THE TRUCK BOLSTERS, SHOWING SIMPLE AND STRONG CONSTRUCTION.

STEEL UNDERFRAME BOX CARS.—ILLINOIS RIVER PACKET COMPANY.

Particular attention should be given to the method of securing the wooden side sills to the steel underframe. Instead of using angles projecting outwardly from the steel sills, upon which to place the wooden sills, as is frequently done, Mr. King has used a series of bent plate Z bars, one flange of each of which is riveted to the channel side sills. The web forms a support for the wooden sill, and the other flange turns up and practically encloses it, securely locking it in position and preventing displacement sidewise even in case of failure of the frame rods, which also pass through this series of Z bar plates.

Each wooden side sill is 3⅞ x 8 ins. Between the side and each center sill are two 4 x 4-in. yellow-pine nailing strips, extending from bolster to bolster, and supported at intermediate points by a series of floor beams, consisting of 9-in. channels, 13.25-lbs. per foot, the ends of which are securely riveted to the side and center sills. It will here be observed that the center sills have been dropped 2 ins. lower than the side sills—this was done to avoid any cutting of the under surface of the floor to clear rivet heads.

The superstructure of this car is unusually heavy. The side posts and braces are 3 x 6 ins. throughout; the door posts are 6 x 6 ins.; the corner posts 5 x 8 ins.; the end posts as well as the end braces are 5 x 6 ins., while the sub-sills are 6 x 8 ins., rabbeted out to form a bearing for the floor. All post and brace pockets are provided with lips to bear against the side sills and side plates, as well as the end sub-sills and end plates. The end plates are 5 x 13 in. oak. This construction would seem to preclude any possibility of bulging at the sides, even if the car is loaded to the roof.

It will be noticed in this design that Mr. King has found it possible to use 15-in. channel center-sills extending from end to end sill, with the top of floor 4 ft. above the rail, while the outside dimensions of the car conform with the height of 12 ft. 6¾ ins. from rail and width of 9 ft. 7 ins. at eaves, recommended by the last M. C. B. Committee. This arrangement has brought the center of the draft gear almost at the neutral axis of the center sills, which is highly desirable. In order to accomplish this result a low truck is essential; the arch bar type of truck has been used, the top and bottom bars being 5 x 1¼ ins., with 5 x ⅝-in. tie bars. The wheel base is 5 ft. 6 ins. The spring plank is 13-in. channel, 35 lbs. per foot.

The truck bolster, which is shown in detail in one of the engravings, is notable for its simplicity of design, which is obtained without sacrifice of strength. As shown, it is built up of two 8-in. I-beams, 25.5 lbs. per foot, with two top covers and two bottom covers, each 14 x ½ in., riveted as closely as possible to the flanges of the beams. Malleable-iron center-plates are used and the brakes are hung to projecting arms on the truck columns. The springs used are P. R. R. standard Class H-59. One of the strongest claims for this truck, as well as for the interesting new design of underframe, is the absence of special or complicated features of construction which are costly to repair; we see no reason why this car cannot be repaired throughout by any ordinary repair shop.

Concerning the light weight of this car, which is 48,000 lbs., it should be noted that this compares favorably with the light weight of the Pennsylvania Railroad standard pressed steel underframe cars, 36 ft. long inside, as these Pennsylvania cars weigh 45,000 lbs. light. It is not believed that a thoroughly substantial steel-underframe car of 50-ton capacity, 40 ft. long, can be constructed with much less material than has been used in this design. It is a question whether a car of this size and weight would pay for general traffic where the average load might not exceed the light weight of the car.

We are greatly indebted for this information to the designer, Mr. George I. King, vice-president and general manager of the Middletown Car Works, to whom patents have been granted covering the design of the novel underframe construction.

Overloading of engines has been carried to an extreme on some roads. Recently the writer saw a heavy train hauled over a long division by one engine which was not powerful enough to make a speed of over eight miles an hour. This train was immediately followed by a light engine which kept in sight of the heavily loaded one but did not help. This road keeps a record only of loaded trains and the superintendent has the record of his road for heavy tonnage per train. The light engine did not appear on the reports as a train. If this superintendent could have charge of a roundhouse for a short time he would know what such methods mean to the owners of the road. Officers who can not see beyond the limits of their own departments have no legitimate place in modern railroad operation. One of the best preventives of this sort of practice is a regular conference of the heads of all departments.

EDITORIAL CORRESPONDENCE.

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

(*Continued from Page 7.*)

Labor, particularly unskilled, is cheap in England. In going north of London on one of the leading railroads the writer saw a rail about 75 lbs. per yard, which was being carried at a speed of about one-eighth of a mile per hour on the shoulders of as many men as could crowd together under it. There were probably 16 men under its 30 ft. of length and they walked lockstep, being so close together. It was carried in this way perhaps 200 feet along the track. The camera was not out in time or the picture would be recorded for the benefit of the reader. Imagine the adjectives which an American manager would select to express his views of such economy as this, if he should see it from the observation window of his car while on an inspection trip! Perhaps the same sort of thing will be found on the continent, but that remains to be seen.

It is not at all unusual to find a large number of men—20 or 30—handling coal at a locomotive coaling station whereas with our best appliances two men would do it all. In the hand work about the fine finish of locomotives, much labor is uneffectively employed. The locomotive supplies no legitimate opportunity for the art of draw filing, but lots of it is done here nevertheless.

Labor questions here are as important as they are at home, and this is one of the subjects most worthy of attention. Labor unions are strong and they have exerted a powerful leveling influence, which is an exceedingly important factor to be dealt with. I am told not by one but by many—and am absolutely sure of the correctness of the statement—that the lack of leadership talent here is due to the attitude of the men themselves, who do everything they can to discourage unusual efforts on the part of their fellows and prevent the discovery of those who are capable of advancement to positions of responsibility. A good man and a "duffer" works side by side and for the same wages. There is no inducement for the good man to forge ahead and get more than a "duffer's" wages. The influence is toward a very dead level and this level is that of the lazy workman. The effect is everywhere apparent in passing through the shops. This general statement is warranted, because it is confirmed by conversations with the workmen themselves. Several, with whom the writer talked openly admitted it. The least tendency toward any effort which makes a man favorably conspicuous before his superiors is frowned upon by his fellows, in the name of labor unionism. This is a grave mistake on the part of the men. A work's manager in charge of five thousand men, told the writer of cases in which good men had been disciplined in one way and another for doing more than their mates wished them to do. This condition seems to be general and not at all confined to a single road or any particular section of the country. In this respect labor unionism is a positive detriment to the advancement of the best interests of the workingmen, and it works them an injury. It does more than that—it hurts the business of Great Britain and greatly increases the cost of work, thus reflecting directly upon the best interests of the men.

With this condition combined with very high freight rates, the English railroad stockholder is in a bad way. I am told that it costs more to send certain commodities from London to Manchester, than from New York to London—3,200 miles in one case as against 180 in the other. The economical operation of locomotives here does not result in cheap freight transportation. There are other factors in the cost of transportation which must be attended to here without delay. The locomotive superintendent cannot do it all.

But with regard to the labor situation it should be said that one can see his own faults very easily when exhibited by others. It is just possible that we also are drifting very far toward the "dead level" referred to above. Workingmen cannot afford to cut off their own chances for promotion and their employers, whether in England or America, cannot afford to have them do so, as it has certainly been done here. It is exceedingly difficult to find good foremen over here and this is one reason why the railroads are so earnestly trying to improve their apprentices.

Improved methods with respect to apprenticeships constitute a subject upon which it is easy to get English motive power men to talk. They are far ahead of us in this, for they have not merely talked for a number of years about what should be done, they have really done something, and it is very interesting to find that the appreciation of this question is universal. There is not the slightest difficulty here in securing apprentices, either the so-called "workmen apprentices," "premium apprentices," or "pupils." Premium apprentices are usually sons of men outside the railroad circle, who desire shop experience and are able to pay for the privilege. They are more or less independent and are in a sense privileged characters about the shop. "Pupils" are usually college graduates who also pay premiums for the opportunity to work in the shops. They must necessarily have considerable means in order to do this. These two classes of young men have supplied some very successful railroad officers, but it may be said, speaking generally, that these forms of apprenticeship have not met the need for able managers of departments better than special apprenticeship has done on our side of the ocean. Special attention is now being given on several English railways to the workman apprentices who are sons of employees of the shops. An effort is being made to improve all of this class of apprentices by means of technical education and to develop every apprentice so that he will reveal his capabilities and enable his employers to discover the direction in which his individual ability will be most satisfactorily developed.

Mr. D. Drummond, locomotive superintendent of the London & South Western Railway, is a leader in this movement. He does not consider our special apprenticeship at all satisfactory as a means for recruiting the service with leaders of men, and while he does not disapprove of giving college men an opportunity in the shops, he considers it necessary to provide a system which will give the poor man's son an equal chance with the rich man's. He believes that the thorough shop training given the ordinary apprentice, combined with as much technical education as he can take, will supply many good men from the ranks. Considering the fact that many of the successful leaders of the past and present have come from the ranks, he has put into effect a plan whereby the apprentices attend a technical school at regular periods during working hours and at the expense of the railroad company. Last March Mr. Drummond issued the following bulletin:

LONDON & SOUTH WESTERN RAILWAY.

Locomotive Engineer's Office, Nine Elms Works,
London, S. W., March, 1903.

NOTICE TO APPRENTICES.

I am anxious that the apprentices in the L. & S. W. Ry. Works at Nine Elms should have every possible opportunity afforded them of having a scientific education, arranged to go hand in hand with their practical every-day work, and so enable them to prepare, at the end of three years, to take up the higher scientific training to be obtained at the technical colleges during the last two years of their apprenticeship. The course will commence in October and end in February.

This has been arranged to enable you to have proper time for study in the evenings, and to compare the scientific teaching you receive at the classes with the practical work going on in the workshops, so as to cultivate the habit of thinking independently for yourselves.

I have arranged for a competent teacher to give one hour, from 8 A. M. to 9 A. M., on three mornings of the week for juniors, and one hour two mornings of the week for seniors, which will form part of the day's work.

You will be expected to pass a preliminary examination in proportion, fractions, cubic and square root and mensuration, before being allowed to join the classes.

At the end of three months in each term an examination will take place to enable me to ascertain what progress has been made; the final examination to take place at the end of each term.

Those who pass the final examination will enter the higher class for the second year, and so on to the third.

Those who fail to pass the first examination, but receive from their teacher a recommendation, will have the privilege of continuing in the same class another year to give them the opportunity of passing into the higher classes.

Those who do not receive a certificate from the teacher, or who fail at the second opportunity of passing, will have to retire from the classes.

I will arrange for those who fail not to work overtime during the winter months so as to enable them to attend evening classes if they so desire.

The apprentices who pass all their examinations satisfactorily will be allowed to attend the engineering colleges during the winter months to secure a higher education, and the time so occupied will be counted as part of their apprenticeship, and those who successfully pass the college examinations will have the privilege of entering the drawing office or the chemical laboratory during the summer months.

This privilege will continue for the last two years of their apprenticeship.

Those whose conduct is satisfactory and who have shown ability both in workshops and in technical work shall have the first call for promotion. I therefore hope that every apprentice will do his utmost to improve his knowledge and so become eligible for promotion.

Any lad whose parents have not had the means to keep him sufficiently long at school to give him an education such as would qualify him to pass the preliminary examination will call upon me, and I shall endeavor to make such arrangements as will enable him to acquire the necessary knowledge to do so.

The three subjects for the session will be "applied mechanics," "heat," and "electricity." Only one subject will be dealt with until the class is thoroughly capable of understanding it before the next is entered upon.

The directors have kindly agreed to pay the teacher's fees for the first three years. D. Drummond.

It will be impossible to discuss all of the principles involved in this plan, but the most important ones may be touched upou. This is so nearly the idea which has developed in the minds of the editor of this journal as to give him great pleasure in presenting it to those who will read these paragraphs.

Mr. Drummond wishes first to offer the boys an educational opportunity which they need; second to afford means for thoroughly sifting and sorting their capabilities in the shop and in the school; third, to encourage them to become thinkers and independent personal units in the works; fourth, to develop all as far as they can be developed, some to be merely better workmen, others to be organizers and foremen, others to go into the engineering work of the department and every one to be something that he would not be under the prevailing methods with respect to apprenticeship. He has at Nine Elms about 300 regular apprentices and 1,500 workmen in the locomotive shops. About 100 of the boys have taken advantage of his generous offer. The boys are not expected to educate themselves, after working hours, but to go when fresh from a good night's rest into the class rooms for a short time at the beginning of the day. He believes in education in direct connection with their work and he outlines the class room work to suit their needs. The instruction is given at Battersen Polytechnic School, near the works, and is under the direction of Professor Wells. Mr. Drummond watches the whole movement personally, and gives it a great deal of attention. He also considers it important that clerical positions should be filled by young men who fully understand the work of the department and expects to recruit the clerical force from apprentices. In this way he hopes to make the office more valuable in watching and checking costs and expenditures, thus rendering the office more important as a means for cheapening the cost of work. He has had years of experience with apprentices and has reached the conclusion that this plan is the very best which can be evolved.

Putting ones judgment against that of Mr. Drummond does not seem exactly modest, but nevertheless, the writer wishes to say that he hopes to see a railroad undertake this work somewhat differently. Mr. Drummond is unquestionably correct, except as to sending the boys out of the works to a school which is not specially and specifically devoted to the instruction of railroad shop apprentices. The school work is so vitally important and the apprentice is in himself such a specialty as to render it positively necessary to build up a school to fit his needs. But Mr. Drummond is actually putting his plan into effect.

Other railroads in England are occupied with this problem and further mention will be made of it in these letters.

G. M. B.

Glasgow, December 12, 1903.

It is decidedly shortsighted to dismiss foreign railroad practice with the remark that we have nothing to learn from it. In every department there is something to be learned and a proper study of British, German and French methods would require at least a month in each country, in addition to time spent in sight-seeing. The sight-seeing itself is good for an American, because here may be seen many works of art and many relics of by-gone ages which indicate that human nature is ever the same. The people of 3,000 B. C. had very much the same troubles that we have, and, when visiting museums and ruins and old buildings which are now in use, the questions naturally arise—Are we nowadays constructing, as a whole, anything nearly as permanent as these works of 600 to 1,000 years ago? Are our efforts of to-day as worthy of preservation in stone and steel as are these which we cross the ocean to see? Many of these remarkable works were built when wages were "a penny a day" and when engineering methods were not understood. Men in those days must have loved their work, they were so thorough. Do we love ours as well? Do we work as honestly?

These questions are strictly appropriate to a study of British railroad methods, because here people work steadily and faithfully, with but little prospect of advancement and comparatively small wages. The working people on these railroads have scarcely enough to live on, yet their faithfulness and precision of service is worthy of wide notice. In the train service this is specially apparent. These men must love their work. We could not get people to do as well as they do for any such wages, if we could get it done at all.

Competition in every direction has given Great Britain a railroad service which has no parallel elsewhere. The railroads serve the people with passenger and "goods" trains which are not equaled. No other country attempts to provide so many fast trains running long distances without intermediate stops and none provides freight service which should be classed with secondary passenger service as to celerity and certainty. Between Manchester and Liverpool, 34 miles, the Lancashire & Yorkshire runs a practically hourly passenger service with trains making the run in 40 minutes. These trains are not held out anywhere by freights and are punctual. How these people manage to do this in the midst of a congested freight district is difficult to understand until one sees the book of train schedules, which is as large, for this one small road, as our "Official Guide." Every freight is scheduled and every one is expected to run on time. The Lancashire & Yorkshire has 571 miles of line and to operate it in this way, over 800 signal towers are required. This little road runs across Great Britain and is not a trunk line. Its efficiency is remarkable. It hauls two and a half times as many passengers and nearly five times as much freight tonnage as the 3,027 miles of railroads in Ireland. Last year the Lancashire & Yorkshire handled 22,200,000 tons of freight and the Irish roads handled 5,100,000 tons. The gross earnings of this 571 miles of road last year were $45,000 per mile.

English roads were very expensively built because of the permanent character of their original construction. These comparative figures, as far as the United States is concerned, cannot be verified at the time of writing, but the comparison is something like this: The total capital of American roads is about $60,000 per mile of single track, as against $140,000 per mile in England. The comparison of expense per mile of road for permanent way is about $1,800 per mile in the United States and $2,080 per mile in England.

Passenger business in England yields a proportion of revenue receipts in some cases nearly as great as freight. On the Lancashire & Yorkshire, in the half year ending June 30 last, the total passenger service receipts were 1,082,889 pounds sterling and the freight receipts were 1,508,647 pounds. Passenger train mileage on eleven of the most important British railroads, last year, averaged 60 per cent. of the total mileage.

English railroad efficiency is very great. The small and poorly paid staff of a large station is a source of wonder in the work done and the quiet way in which it is accomplished. Existing facilities seem to be worked to their ultimate capacity before changes are made. Because of this, extensive changes are sometimes delayed, perhaps too long.

The railroads are operated for the convenience of the people and service which we would consider extravagant is expected as a matter of course, because, through competition, the people have come to rely upon it in their business. For example, quick freight methods enables London manufacturers to compete in point of time of delivery with those of Liverpool and Manchester in goods, machinery, etc., which are to be used in Liverpool and Manchester. The goods traffic manager of one of the largest roads told the writer that between these points and London competition had compelled the establishment of a freight service which would permit a shipper in London to have goods called for at his warehouse at 6 P. M. to be delivered by the railroad delivery wagons in Manchester or Liverpool at 10 A. M. on the next day. This is an ordinary "goods" service between these and points of similar importance and at equivalent distances. No extra charge is made for such rapid deliveries and the London merchant now depends upon the railroads to put him in position to put his goods down in any part of Great Britain as quickly as they can be obtained from the nearest storehouse stock. While very convenient for the people, this is a serious problem for the railroads, and it explains many things which are not generally understood in English practice. As long as this sort of thing continues, good trains cannot be heavily loaded; they must always be fast and, to keep out of the way, they must even be accelerated above present speeds of from 30 to 40 miles per hour. It seems impossible for English railroads to delay very long in adopting electric power for everything.

In efficiency, as a whole, British railroads stand out prominently. These people get most surprising results from their inadequate facilities, but they have a difficult future to face.

The way the English people as a whole interest themselves in railroad achievements is a source of encouragement and help to those who are working out the problems. Every new locomotive design is talked about by the traveling public, and the men who produce them are looked up to. In fact, railroad officials in Europe have a high social position because of their interest. It means a lot to be a railroad officer, and it should be so.

Mention has already been made of the high standing of the motive power superintendents over here. Almost invariably in speaking of those whom they serve they mentioned the directors and not the general manager. One only referred to the manager, and, in that case, that officer is recognized generally as the ablest railroad man in Great Britain. One of our greatest needs in American railroads is a revision of the opinion in which the superintendent of motive power is held. It will come in time, but the uplifting of the American motive power official needs to be accelerated. He needs to be recognized as the most important of the subordinates of the president. He needs to be given standing and authority which will place him in position to establish a policy for his department in everything pertaining to it, and then he should be held responsible for the results. It may take some years for the necessity for this change to force itself upon our railroad stockholders, but it will come. It must come. The necessity for this is a striking result of my study abroad. Not that we have everything to learn from foreign methods, but it is perfectly apparent that the motive power departments over here are to furnish most of the advances in economy in the future. Furthermore, these motive power officers are in position to carry out all the economies which their abilities place them in position to produce. Under such circumstances a man may make a record and have all the assistance he needs to make it, and with no hindrances such as always follow placing the superintendent of motive power directly under an operating official who knows nothing about motive power matters and is not sufficiently broad-minded to let the motive power superintendent have full swing in handling his work. American railroads positively require the emancipation of the motive power departments after the manner which is general in England. We need such treatment of the heads of these departments as will make it pay the best mechanical men to enter and remain in the service. I wish it were possible for me to state this in terms as clear and positive as is my conviction on the subject.

If American superintendents of motive power had the authority of their English brothers they would save millions of dollars to their employers every year.

The writer did not pass over any road in Great Britain having as good track as that of the Lake Shore and other good American lines. The purpose of the trip was not to study track and the itinerary did not cover all of Great Britain, but it covered enough to show that we are not backward in this matter. On the leading British lines the track is usually uniformly good, but on some lines it is worse than I ever rode upon before. The spring suspension of the light English cars is very good and the track is usually in excellent surface. Whatever the shortcomings may be as to surface the spring hanging may be good enough to conceal them, but inequalities in alignment cannot be concealed by springs, and the alignment is not as good as it has been said to be. There is no hesitation whatever in making the statement that English track does not "ride" as well as the best American track, but the general average in England is better than ours. What this track would do if respectable wheel weights were used is only a matter for conjecture, and it was found that English officials in charge of track are quite willing to keep down the weights in order to maintain the track. An examination of this matter in a casual way leads to great admiration for American maintenance of way departments for what they accomplish in the face of heavy locomotives and heavy cars. It is astonishing that with the steel-tired wheels in freight equipment, as is universal practice here, the wheel loads of "wagons" should be so low. An American manager would find some way in which to increase the efficiency of these toy cars.

The only way to give water purification a fair trial is to equip an entire division, so that certain engines may always use the treated water and not mix the good with the bad. Four roads are now preparing to do this and it is important that the necessity of this should be appreciated. Attention was directed to a case of a switch engine which with bad water required retubing every six months. This engine is now using only treated water which has been reduced from 72 to 6 grains of incrusting solids per gallon; it has been operated this way long enough to warrant the expectation of more than doubling the life of the flues. This is an excellent test but the best comparison can only be made when entire divisions are equipped. This is expensive, but it will, unquestionably, pay.

After certain tests of abrasive wheels made at Sibley College, the metal removed was micro-photographed. The photographs, it is said, show that the metal removed by emery wheels is in the form of minute globules; that from carborundum wheels is in the shape of chips or shavings. This seems to show that an emery wheel "grinds" or wears the metal off while the carborundum wheel cuts it off in a manner much the same as a milling cutter. This is an important distinction. It not only indicates that the carborundum wheel should be the most efficient in metal removed for the same power, but that heating should be much less since it is cut off instead of being abraded by friction. The wheel that heats the least, other things being equal, should give the most accurate work.—*Machinery.*

INDICATOR TESTS OF A LARGE TANDEM COMPOUND

ATCHISON, TOPEKA & SANTA FE RAILWAY.

Records from actual service showing the net tractive effort of large locomotives are rare, and, because these are shown and the distribution of effort from both high and low-pressure cylinders of a tandem compound, as well as the tractive effort when operating with live steam in the low-pressure cylinders, the accompanying indicator cards and data are worth preserving. These results were obtained from one of the tandem consolidation engines of the Santa Fe, built by the American Locomotive Company, and illustrated on page 179 of our June number, 1902. In order to ascertain the actual capacity of these engines, one of them was indicated on the Albuquerque division in February last, and from the cards taken four are selected for reproduction.

By applying the usual formulae, a tractive effort of 41,024 lbs. would be expected. By actual test, allowing 8 per cent. for internal friction, the tractive effort, operating as a compound, averages 41,000 lbs. At 11 miles per hour—card No. 10—the effort was 31,315 lbs. In the work done by the high and low-pressure cylinders there is a rather large difference, but with the tandem arrangement this should not cause any difficulty. The figures show the proportion of work done in each cylinder and the additional effort made possible by simple working. For convenience a diagram of the engine and some of the principal dimensions are presented. We are indebted to Mr. R. S. Wickersham, assistant engineer of tests, and Mr. G. R. Joughins, mechanical superintendent, of the Santa Fe Coast Lines, for this interesting record.

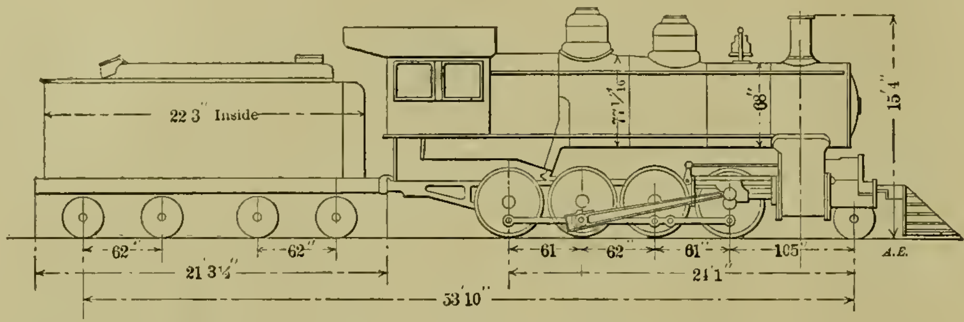


DIAGRAM OF THE TANDEM-COMPOUND LOCOMOTIVE.—ATCHISON, TOPEKA & SANTA FE RAILWAY.

TANDEM COMPOUND LOCOMOTIVE.

2-8-0 Type Atchison, Topeka & Santa Fe Railway.

Cylinders	16 and 28 x 32 ins.
Driving wheels, diameter	57 ins.
Boiler pressure	210 lbs.
Weight on drivers	176,000 lbs.
Weight, total	201,000 lbs.
Heating surface	2,965 sq. ft.
Grate area	50 sq. ft.

(For other dimensions see AMERICAN ENGINEER, June, 1902, page 179.)

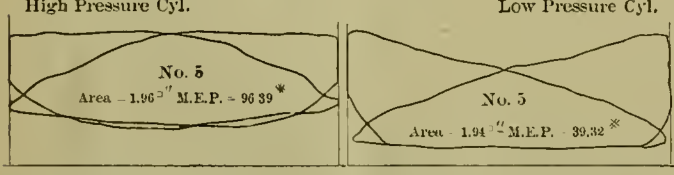
The summary of results and data for the indicator cards are given in the accompanying tables.

TANDEM COMPOUND CONSOLIDATION ENGINE NO. 861.—February 28, 1903.—Tonnage = 1,020.

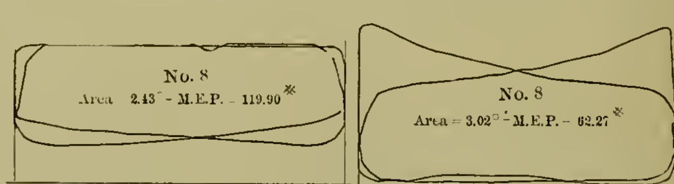
No. of Card.	Engine Conditions. Speed in M.P.H.	Engine Conditions. Boiler Pressure in Lbs. Per Sq. In.	M.E.P. High Pressure Cylinder. Lbs.	M.E.P. Low Pressure Cylinder. Lbs.	Tractive Force. Power Developed on One Side. High Pressure Cylinder.	Power Developed on One Side. Low Pressure Cylinder.	Power Developed on One Side. Total.	Grand Total.	Net. T. F. at rim of wheel, allowing 8 per cent. reduction for internal friction, etc. Engine Working. Compound.	Engine Working. Simple.	Remarks.
1	4	200	8.669	71.92	6,229	15,827	22,056	44,112	......	40,583	
2	6	200	120.00	56.96	8,623	12,535	21,158	42,316	38,931	......	
3	10	205	87.95	67.50	6,320	14,855	21,176	42,350	......	38,962	
4	12	205	125.00	59.80	8,983	13,160	22,143	44,286	40,743	......	
5	18	205	96.39	39.32	6,927	8,653	15.580	31,160	28,667	......	Second notch below one-half stroke
6	5	198	125.41	60.20	9,012	13,248	22,260	44,520	40,958	......	
7	6	198	77.21	94.73	5,548	20,847	26,395	52,790	......	48,567	
8	5	195	119.90	62.27	8,606	13,704	22,310	44,620	41,050	......	
10	11	205	103.13	43.66	7,411	9,608	17,019	34,038	31,315	......	Fifth notch below one-half stroke
11	4	205	89.21	94.95	6,411	20,896	27.307	54,614	......	50,225	
12	6	200	120.70	64.44	8,674	14,181	22,855	45,710	42,053	......	
13	3	205	74.75	102.70	5,336	22,601	27,937	55,874	......	51,404	
14	4	200	123.00	67.07	8,839	14,760	23,599	47,198	43,422	......	
15	6	200	83.72	96.30	6,016	21,193	27,209	54,418	......	50,065	
16	4	203	121.91	66.91	8,760	14,725	23,485	46,970	43,212	......	

All cards taken with full throttle and reverse lever in corner, except four, which were half throttle, with cut-off as shown under "Remarks."

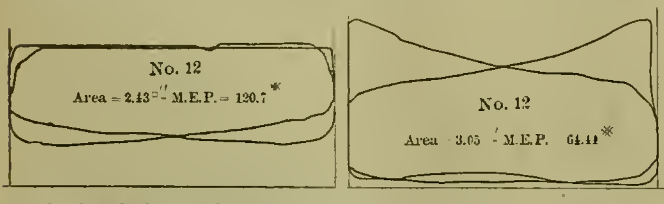
High Pressure Cyl. Low Pressure Cyl.



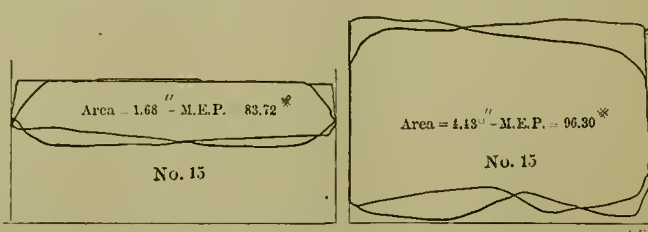
No. 5—Speed, 18 m. p. h.; throttle, half open; cut-off, second notch below half stroke; boiler pressure, 205 lbs.; engine working compound.



No. 8—Speed, 5 m. p. h.; throttle, full; cut-off, full; boiler pressure, 195 lbs. Engine working compound



No. 12—Speed, 6 m. p. h.; throttle, full; cut-off, full; boiler pressure, 200 lbs. Engine working compound.



No. 15—Speed, 6 m. p. h.; throttle, full; cut-off, full; boiler pressure, 200 lbs. Engine working simple.

TRACTIVE FORCE SUMMARY.

Approximate Average Tractive Force Developed. Engine 861.

	High Pressure Cylinder.	Low Pressure Cylinder.	Net Total.
Engine working Simple	5,828	21,384	50,070
Engine working Compound	8,870	13,688	41,507

Percentage of Total Tractive Force Developed in Each Cylinder.

	High Pressure Cylinder.	Low Pressure Cylinder.
Engine working Simple	21.4%	78.6%
Engine working Compound	39.3%	60.7%

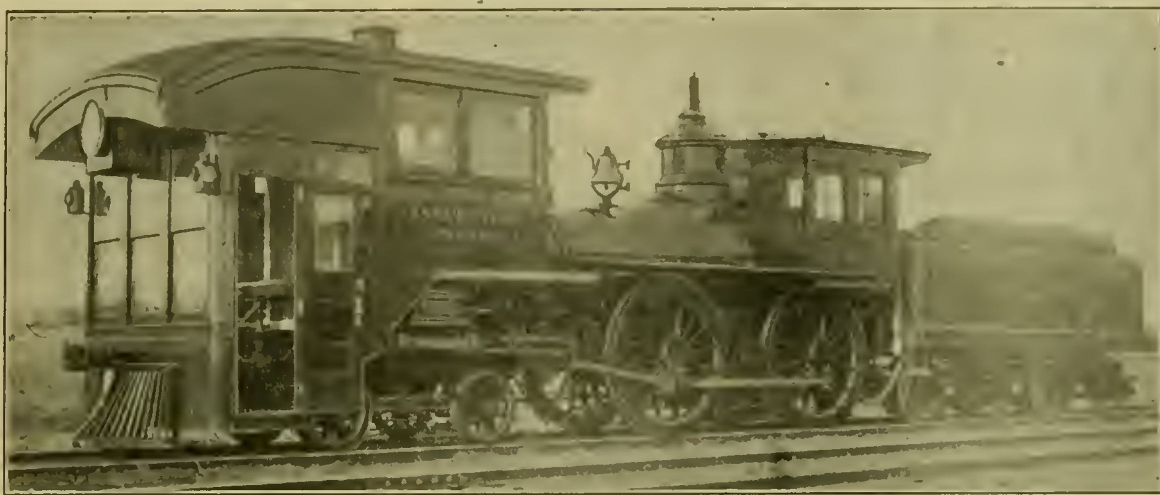
Comparison of Tractive Force Developed in High and Low Pressure Cylinders Using High Pressure Cylinder as a Basis.

	High Pressure Cylinder.	Low Pressure Cylinder.
Engine working Simple	100%	366.9%
Engine working Compound	100%	154.3%

frames of the engine. To these the woodwork and framing are secured.

By bringing the front of the cab low with respect to the track the inspecting officer is enabled to closely observe the condition of the track when running slowly. Seating capacity for seven is provided in the observation space in front, while five more are comfortably accommodated in the upper part, through which the stack passes. By lagging the entire front end and stack with magnesia and leaving air space for insulation, the entire observation space is made quite comfortable for summer use; in the winter it is heated by means of steam coils.

Longitudinal seats are provided in the upper room and also a folding seat for the conductor, for use when necessary. In the observation room the seats are very conveniently and advantageously arranged in two tiers.



VIEW OF THE NEW DESIGN OF INSPECTION LOCOMOTIVE.—BURLINGTON & MISSOURI RIVER RAILROAD.

NEW INSPECTION LOCOMOTIVE.

BURLINGTON & MISSOURI RIVER RAILROAD.

A photograph of this unique inspection locomotive is reproduced by the courtesy of Mr. R. D. Smith, superintendent of motive power of this road. The locomotive is an old one of the 4-4-0 type with the observation cab built over the front end and extending back of the stack sufficiently to secure good anchorage and satisfactory balance. The observation cab is built upon steel plates which are securely fastened to the front frames of the engine.

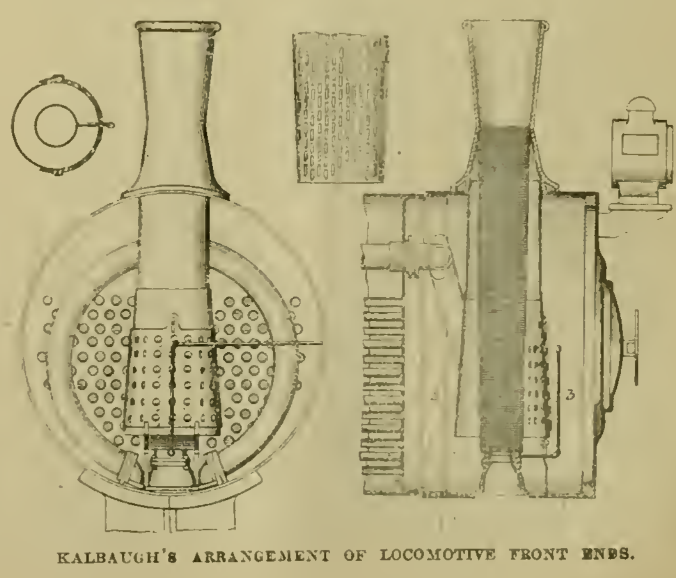
This locomotive is controlled, except as to the reverse lever, by the person sitting in the front seat. He has the throttle, air brake valve, whistle and bell at his command, so that the inspecting officer may himself run the engine. The fireman tends the reverse lever, the fire and water. The engine has an electric headlight and incandescent lamps in the cabs. The observation cab is provided with hot and cold water in overhead tanks and a folding wash basin as well as a clothes cupboard.

Mr. Smith reports the engine to be very satisfactory. The details are very nicely worked out.

KALBAUGH'S ARRANGEMENT OF LOCOMOTIVE FRONT ENDS.

Through the courtesy of Mr. I. N. Kalbaugh, superintendent of motive power of the West Virginia Central & Pittsburgh Railway, the drawing of a new front end arrangement, devised and patented by him, has been received. While some of the elements of this construction have been used before, the combination is new, and it has given excellent results in service. The stack is tapered and the spark netting is in the form of a very long truncated cone reaching from the nozzle tip to the choke of the stack. Instead of the usual diaphragm plate a conical hood is employed, which surrounds the netting and the draft effect is adjusted by means of the sliding plate in front of this hood.

The perforations in the cone are 3-16 by 1½ in. The engines fitted with this device emit quite a number of small sparks, but because of their small size they are not objectionable and a smaller opening in the netting does not seem to be necessary. This locomotive has 22 by 28 in. cylinders and a 5 in. exhaust nozzle. With very poor, small vein coal the locomotives steam freely, and this is very difficult with the usual construction of front ends with this fuel. Mr. Kalbaugh has found a marked saving in fuel as a result of the application of this arrangement in the smoke box, and is applying it to a number of locomotives.



KALBAUGH'S ARRANGEMENT OF LOCOMOTIVE FRONT ENDS.

THE APPLICATION OF INDIVIDUAL MOTOR DRIVES TO OLD MACHINE TOOLS.

McKees Rocks Shops.—Pittsburgh & Lake Erie Railroad.

BY R. V. WRIGHT, MECHANICAL ENGINEER.

VII.

RADIAL DRILL PRESS.

Figures 32, 33, and 34 illustrate an interesting motor application to an old Niles radial drill, with a 6-ft. arm which had been in service at the old locomotive shops of this system at McKees Rocks. Its condition seemed to warrant the change in its equipment for individual driving, which was carried out as here indicated.

In order to more fully understand this application, and to get some idea of the comparatively small amount of work and material which were required in this case to change over from the belt drive, reference may be made to Fig. 35, which is a diagram showing how the tool was driven originally with the belt drive.

This drill is of the usual style with the arm, which carries the drill spindle, arranged to swing about the column, and on the opposite side of this column from the arm, and bolted to the arm casting where it embraces the column, is a bracket which previously carried the two speed cones and the gears as designated on the diagram. Gears 4 and 5 and the spline shaft, (see Fig. 35), were arranged to swing with the arm, and as gear 3, which is carried on top of the column, is concentric with the column, gear 4 keeps in mesh with it as the arm is revolved. As the arm is raised or lowered, gear 5, slides on the spline shaft and keeps in mesh with gear 6. A separate shaft which operates the mechanism for moving the arm up or down on the column has at its upper end a gear, not shown on the diagram, which can be thrown in mesh with a gear keyed to the same shaft as gear, 3, at will.

The bracket which carried the two speed cones was not suitable for supporting the motor. However, in order to use a single motor for driving the tool and for raising and lowering the arm, and, in order to use two runs of gearing and thus allow the use of a comparatively small motor, a new bracket to replace the old one would have had to be of a rather intricate design. Since there was only one tool of this design to be changed, it was thought best to attach the motor to the bracket by means of wrought iron braces and to strengthen the bracket with a wrought iron strap, in the manner indicated in the accompanying drawings.

Referring now to Figs. 34 and 35, and comparing them, it will be seen that in order to apply the motor the lower speed cone, 8, was removed and replaced by a double clutch and gears A and D. Gear A, is cast solid on a sleeve which projects through the bearing in the bracket and far enough beyond it to carry the large sprocket, F, which is connected to the pinion on the motor by means of a 1¼-in. Morse silent chain. A cast iron gear sleeve, C, was placed on the back shaft to which the gear, B, is keyed, this sleeve being rotated by gear, B, meshing with driving gear A. The two runs of gearing for the spindle drive are here provided, one by throwing clutch, K, directly in clutch with A, and the other by clutching with gear D, D being driven from A through the large speed reduction. The clutch, K, is splined on the lower shaft which extends out on the arm and drives the spindle. The drawing of details, Fig. 36, shows the details of the above-mentioned sleeve carrying gear, A, and to which sprocket, F, is keyed, and also the gear sleeve, C, which rotates on the back shaft. The details of the lever and latch plate for use in operating clutch, K, are also made clear in this view.

On the back shaft sleeve, C, the silent chain sprocket, G, is also keyed. The upper speed cone, 7, was replaced by the

FIG. 32.—GENERAL VIEW OF THE NILES RADIAL DRILL AS EQUIPPED WITH THE INDIVIDUAL MOTOR DRIVE. CROCKER-WHEELER MOTOR AND CONTROLLER. MCKEES ROCKS SHOPS.—PITTSBURGH & LAKE ERIE.

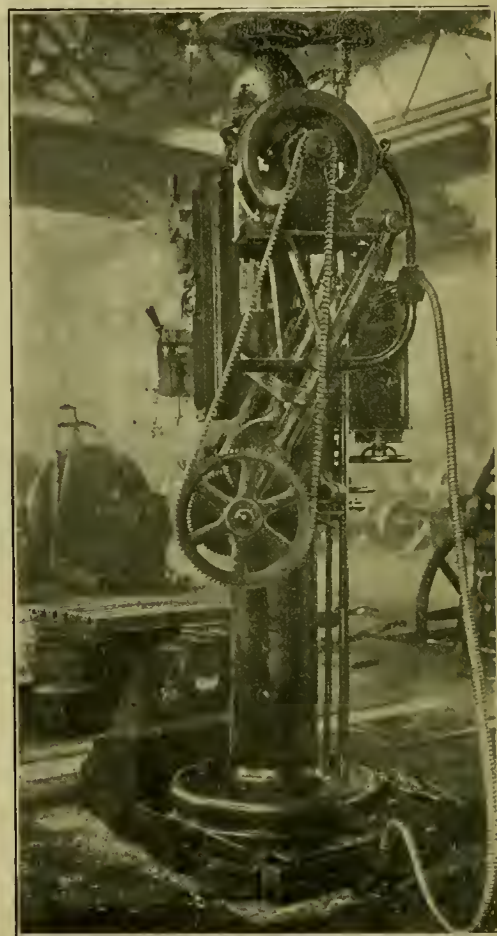


FIG. 33.—REAR VIEW OF THE DRILL, SHOWING METHOD OF MOUNTING THE MOTOR UPON THE BRACKET.

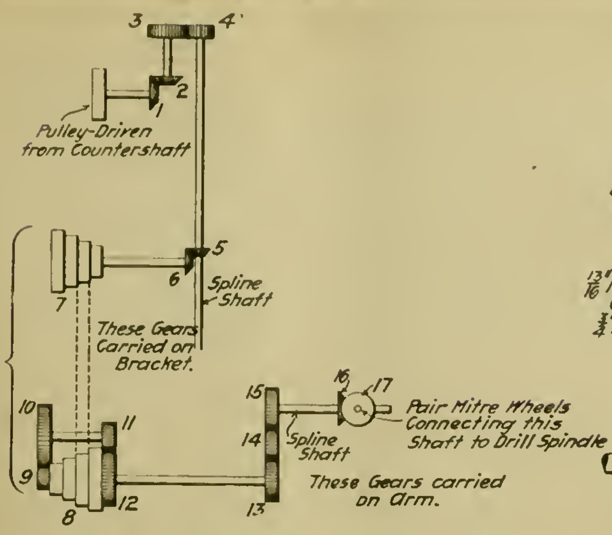


Fig. 34.—Diagram of the Original Arrangement of the Drive with the Cone Pulleys Carried on the Bracket at the Rear of the Arm.

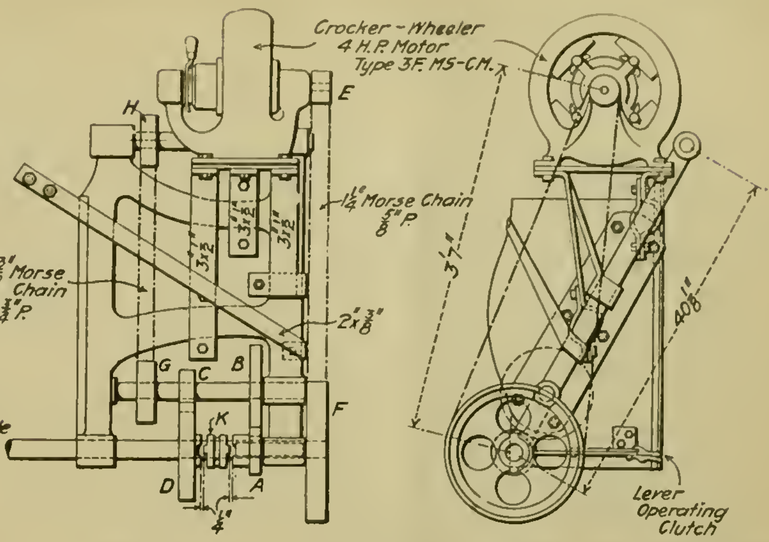


Fig. 35.—Details of the Application of the Motor Drive, Showing Method of Mounting the Motor upon the Bracket by Means of the Wrought-Iron Plate and Straps.

sprocket, H, which is keyed to the upper shaft, and is driven from the sprocket, G, by a 13-16-in. Morse silent chain and which in turn drives gears 6, 5, 4, 3 and the gears which control the mechanism for raising and lowering the arm. By running the motor at a high speed the arm can, in this way, be moved up or down at fair rate.

This tool has been running with this arrangement of motor driving for some time and except when the drill is rotating at a very high speed and cutting, there is practically no vibration of the motor and bracket, and even then the vibration is hardly noticeable.

As will be seen by referring to Fig. 32, the controller is attached to the arm casting at the column within easy reach of the operator, and as it revolves with the arm, it is always in the same relative position as regards the work. The panel which carries the switches, circuit breaker, etc., is attached to the motor braces at the rear, and while out of the way, is easily accessible. The wires are carried from the wire box underneath the floor by means of flexible tubing conduit as shown in the views. This tool is equipped with a type M. F.-21 multiple-voltage system controller and the type 3 F., M S., C. M. variable speed motor, to develop 4 horsepower at 240 volts, built by the Crocker-Wheeler Company.

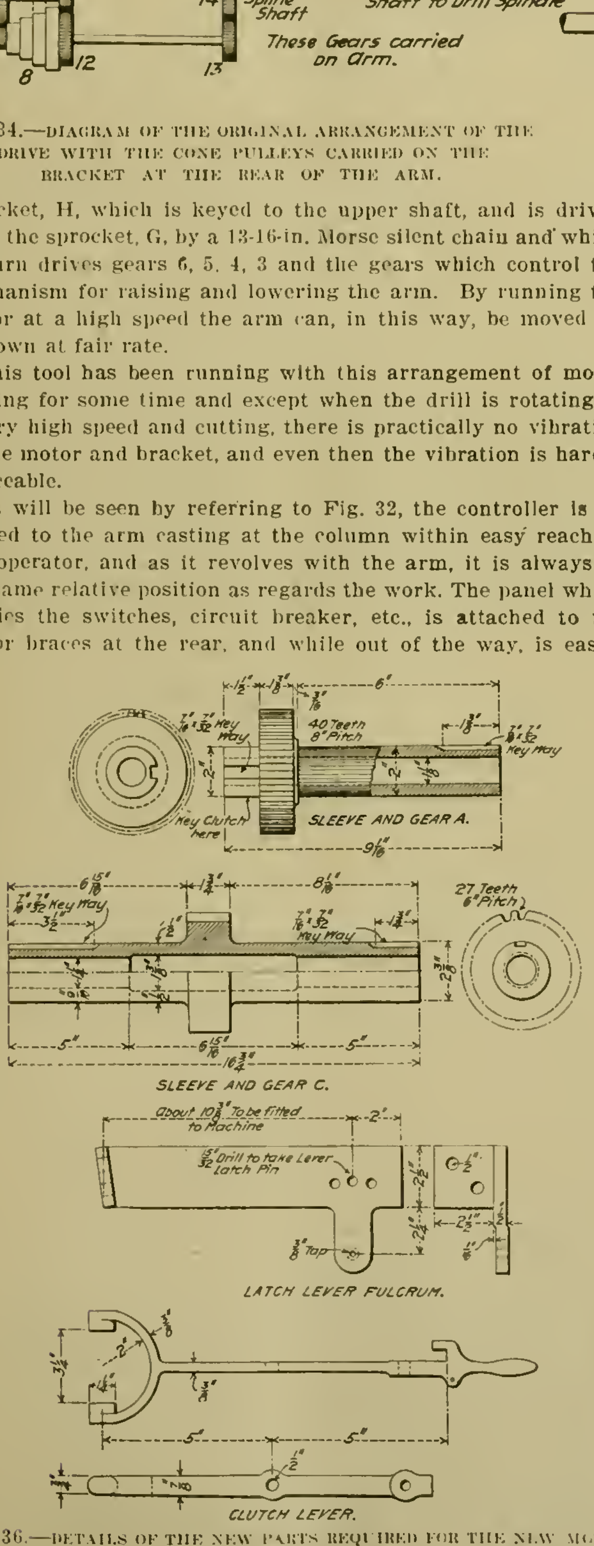


Fig. 36.—Details of the New Parts Required for the New Motor Drive, to Furnish Two Changes of Speed by Gearing.

The range of spindle speeds and the power provided throughout are the same as for the vertical drill presses described in the fifth article of this series (see pages 441-2, December, 1903, issue), and the diagram shown on Fig. 25 of that issue shows the variations of power at the various speeds. Because of the large number of speed steps provided and because of the ease with which speed can be changed, the efficiency of this tool has been considerably increased by the application of the variable speed motor.

NOTE.—Inadvertantly the last sentence of the preceding article of this series (see page 15, January, 1904, issue) was made to read somewhat indefinite. The concluding statement: "although the latter type furnishes a somewhat greater speed range than is necessary for these tools," would tend to indicate that the type M. F.-21 controller of the Crocker-Wheeler Company was more elaborate than was necessary in this case. The fact, is, however, that the drive for this machine had been designed for a M. A.-12 controller (the type using armature resistance for the intermediate speeds) and all the materials, sprockets, chain, etc., ordered before it was decided to use the M. F.-21 type of controller. Since the M. F.-21 allows a higher motor speed than the M. A.-12, it was found necessary to cut out the three highest steps so as not to run the ram of the slotter too fast. If it had been decided to use the M. F.-21 controller in the first place, a greater speed reduction from the motor to the tool would have been made, and by being able to use the highest points on the M. F.-21 controller, a higher average power would have been available throughout the working speed range of the tool, than with the M. A.-12, or, in other words, a higher voltage could be used to obtain the same speed with the M. F.-21 than with the M. A.-12 type of controller.

Mr. T. S. Reilly, associate editor of the Railway and Engineering Review, has been appointed superintendent of the railway division of the department of Transportation Exhibits at the Louisiana Purchase Exposition, and has assumed the duties of the position. Mr. Reilly learned the machinist's trade before going to college, where he graduated in civil engineering, after which he spent some time on various railways as machinist, fireman and draughtsman. Recently he has been mechanical editor of the Railway Review; in charge of dynamometer car tests W. A. B. Co.; master mechanic C. C. C. Co.; road foreman of equipment and then master mechanic of the Frisco system.

RAILROAD SHOP MANAGEMENT.

BY WILLIAM S. COZAD, NORFOLK & WESTERN RAILWAY.

III.

It is the purpose of this article to present, in detail, a systematic method of time keeping and accounting for railway repair shops in which a part of the labor performed is paid for on the basis of piece rates.

In every piece-work shop, no matter how extensively the system may be introduced, there is a certain portion of the labor that must be performed on a shop time basis and any system of time keeping introduced into such a shop must be sufficiently broad to properly account for both classes of time. It should also be emphasized here that methods of accounting for labor performed should be applied with special reference to the way in which the work is carried on in the shop, instead of requiring shop methods to conform to any system of time-keeping.

The system described in this paper is handled entirely, with the single exception of the time book, by the use of cards made of a very cheap grade of thin cardboard, and in point of first cost of stationery will be found much less expensive than many of the methods now in use. The size of these cards is 4½ by 9 ins. and with slight modifications, they can be applied equally as well to shops run entirely on a day work basis as in shops where part of the labor is performed on piece-work.

Fig. 1 represents what is termed the Employee's Daily Check card, and is intended to form a record of the time when each workman enters the shop, both in the morning and after the

A. B. C. RAILWAY COMPANY.

EMPLOYEE'S DAILY CHECK CARD.

..............................Shop. Date........ *11/4*............

	Charge.		Hours.		Commenced work.	
Number.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.
350	*310*	*310*	*5*	*5*	*7*	*6*
400					*7*	*6*

(This form to contain 20 blank lines.)

Correct..., Shop Foreman.

FIG. 1.

noon hour. On entering the shop in the morning each workman is required to pass the shop office or some other convenient place, which may be arranged by the general foreman, and call a number which has previously been assigned to him, and which must agree with his number on the card case (which will be described hereafter, Fig. 9). His number will be recorded in the column headed "number"; in the column headed "commenced work" should be recorded the time at which each employee enters the shop, all workmen entering before the whistle blows being registered at the hour adopted by the shop to begin work, but any entering after this time being required to see the time keeper, who will register his number and the time he enters the shop in red ink on the record card. Any employee failing to call his number, or failing to have his number and time registered when entering late, should be liable to loss of all time for that half day, subject to the discretion of the foreman.

The two columns headed *"charge"* and *"hours"* are to be used only by those who work on shop time and whose time is chargeable to specific items, such as engines, cars or special accounts. When calling their number upon entering the shop at 1:00 P. M., workmen may report the charge for the work done during the preceding half day, which should be entered in proper columns along with the hours worked. Before work closes in the evening, the clerk having charge of the daily check cards, should go out through the shop, ascertain from each workman who is paid by the hour what his time should be charged to for that half day and make proper record on the card. This card should then be carefully checked by the gang foreman and foreman, and turned in to the time keeper to be recorded on the Daily Shop Time Service card.

Fig. 2 represents the next card in order which is the Daily Shop Time Service card and covers shop time only. These cards should be printed with thirty-one spaces representing

A. B. C. RAILWAY COMPANY.

DAILY SHOP TIME SERVICE.

OF *Wm. Jones.* NO *350.*

Machine SHOP. *November,* 1903.

Date.	Charge.	Commenced work.	Finished work.	Hours.
11/4	*E 310*	*7 A. M.*	*6 P. M.*	*10*

(This card to contain 31 blank lines.)

	Total hours..	....	....	*10*

Total hours *10.* Rate, *$1.25.* Amount, *$1.25.*

Correct, *J. A. Jensen,* Shop Foreman.

FIG. 2.

thirty-one days. For all laborers and men whose time each day is chargeable to the same account one card will answer for the entire month. When the time of any workman is chargeable to a number of different jobs, these Daily Time Service cards, when full, must be totaled and entered in the time book and new ones started, which, when full, will be again entered in the time book, and so on to the end of the month. Fig. 3 is the opposite side of the card shown in Fig. 2, and is designed to record all overtime made by the regular day workman whose name appears on the other side.

A. B. C. RAILWAY COMPANY.

RECORD OF OVERTIME SERVICE OF PERSONS NAMED ON OTHER SIDE OF THIS CARD.

Date.	Charge.	Commenced work.	Finished work.	Hours.
11/4	*E 310*	*7 P. M.*	*9 P. M.*	*3*

(This card to contain 31 blank lines.)

		Total hours..	....	*3*

Total hours, *3.* Rate, *$1.25.* Amount, *0.37.*

J. A. Jensen, Shop Foreman.

FIG. 3.

Figs. 4 and 5 represent opposite sides of another card, which is used by piece-workers only and is handled exclusively by the piece-work inspector and approved by the foreman. On the front side of this card (Fig. 4) is shown the name and number of the workman, or the leader of gang, if two or more men are working on the same job. This card is so arranged as to furnish a means of recording, in a very condensed form, the information contained in the piece-work schedule, and in order to use it to best advantage, the piece-work schedules should be made in duplicate on a mimeograph and copies placed at different points in the shop where the employees may have ready access to them. The piece-work schedule for each shop (see Fig. 8) should be designated by some letter of the alphabet so

Card No. *1.*

A. B. C. RAILWAY COMPANY.

PIECE-WORK RECORD CARD.

OF *Frank Carper.* NO. *400.*

Charge.	Schedule number.	No. of pieces.	Price per piece.	Amount.
E 310	*M 500*	*1*	*$ .75*	*$ .75*
E 310	*501*	*4*	*.30*	*1.20*
E 310	*502*	*2*	*1.75*	*3.50*
E 850	*502*	*3*	*1.75*	*5.25*
E 75	*500*	*4*	*.75*	*3.00*
	501	*4*	*.30*	*1.20*
				$14.90

Rates and Calculations Checked by

Work authorized and done, *J. H. Pattison*, Foreman.

FIG. 4.

DAILY TIME CERTIFICATE.

Number.	Names of Workmen.	Date. 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	30	31	Total hours.	Rate.	Amount.
		Hours.																																	
400	*F. Carper.*				*10*	*10*	*10*																										*30*	*30c*	*$14.90*
																																		Total........	*$14.90*

Fig. 5—(Opposite Side of Card Shown in Fig. 4).

that cards from the different departments can be readily distinguished, and each operation in the schedule should be preceded by a number and the schedule letter.

In making a record of the time, the piece-work inspector will take from the filing case the cards he may wish to use, and after carefully inspecting the work, will enter on the card the charge, schedule number, number of pieces, price per piece and total amount. This should always be done in the presence of the workmen, so that any mistake may be avoided, and also so that the workmen may, if he desires to do so, make the same record in his memorandum book which he may provide for the purpose.

When the face of this card (Fig. 4) is full the column headed "amount" should be totaled and carried forward to the top of the same column on the card shown in Figure 6. This card (Fig. 6) is printed on one side only and may be added to the side of card shown as Fig. 4, one after another until the end of the month; or when two or more men are working together and it becomes necessary to separate the gang, then the cards must be closed, proper division of the money made, and the

A. B. C. RAILWAY COMPANY.

TIME BOOK.

Name, *Frank Carper.* Occupation, *Machinist.*					Name, *Wm. Jones.* Occupation, *Laborer.*				
Date.	Card number.	Hours.	Rate.	Amount	Date.	Card number.	Hours.	Rate.	Amount.
PIECE-WORK.					PIECE-WORK.				
11/6	*1*	*30*	*$3.00*	*$14.90*					
	Total		.....	*$14.90*		Total			
SHOP TIME.					SHOP TIME.				
					11/5	*350*	*13*	*$1.25*	*$1.63*
	Total	....	....	......		Total	....	....	*$1.63*

FIG. 7.

Charge.	Schedule number.	No. of pieces.	Price per piece.	Amount.

(This card to contain 30 blank lines.)

		Total.....	.....	.....

FIG. 6.

hours worked and money earned by each man entered in the time book (Fig. 7). Fig. 5 is the opposite side of the card shown in Fig. 4, and is desiged to keep the time of the men whose names appear thereon while working on piece-work only.

If a workman is changed from piece-work to shop time at any time within the day, the time at which the change is made must be authorized by the foreman or piece-work inspector, and the inspector will then make a note of the number of hours worked shop time and insert the proper charge on the Daily Shop Time Service card (Fig. 2), and send that card to the foreman's desk, who will note and, if correct, place the same in the case.

Fig. 7 represents a sample page of the time book and is plain enough to require but little explanation. It should be understood, however, that all piece-work cards bear a local number at the upper right hand corner (see Fig. 4), which has no relation whatever to the number of the workman, but serves to designate the card after it is placed in the case in one of the pockets marked 100, 200, etc. When piece-work cards are entered in the time book they should be entered under their card number and with no reference to the number of the workman, and where two or more men are working together and are shown on the same card, each should be entered under the same card number. Then if it becomes necessary to refer back to the card, it can be easily located.

At the end of the month all cards should be closed, the time entered in the timebook, after which they should go to the distribution clerk; after the distribution has been made, the cards should be returned to the time-keeper's office. When payment has been made for the time covered by the cards for any one month and the errors, if any, corrected, they can then be placed in permanent file in the card record case.

Fig. 8 is a sample leaf of the Machine Shop Piece-Work Schedule, and is submitted so that the illustrations of the cards will be complete.

A. B. C. RAILWAY COMPANY.

PIECE-WORK SCHEDULE, MACHINE SHOP.

EFFECTIVE, DECEMBER 1, 1903.

Schedule number.	Operation.	Price.
M500	Driving axle centered, faced on ends and rough cut, all work, job complete, each.	$ .75
M501	Driving wheel tire, 60-in., bored to fit wheel center, each..................	.30
M502	Driving wheels, old, put in lathe and tires turned complete, includes all work from start to finish, per pair.............	1.75

FIG. 8.

(To be continued.)

A SHOP SCHEDULE FOR LOCOMOTIVE REPAIRS.

CHICAGO & NORTHWESTERN RAILWAY.

Through the courtesy of Mr. Robert Quayle, the schedule for locomotive repairs at the Chicago shops of the Chicago & Northwestern is presented. This plan was developed by Mr. G. R. Henderson when assistant superintendent of motive power of that road, assisted by Mr. O. Otto, general foreman at Chicago. It is part of a plan which has been found very beneficial, and has introduced an element of commercial spirit into the work which is not too often seen in railroad shops.

In order to provide repair material without delay, each division master mechanic keeps a card record for each engine, with a statement of the kind of service and mileage made since the previous shopping. Ninety days before an engine is to go to the Chicago shops (where all heavy repairs are made) its card is sent to Chicago and the repair material is ordered. The engine is ordered to the shop at the expiration of this period, and this occurs usually after having made from 150,000 to 200,000 miles. These cards contain a concise record of each engine and its location and service after leaving the shops.

Nearly all repair work, except on wrecked engines, may be covered by three classes: 1. General repairs, including a new firebox or half side sheets, combined with a back flue sheet or a new crown sheet. This requires 24 shop days. 2. General repairs, with half side sheets, requiring 21 days; and 3. Light repairs, involving easy boiler work, and requiring but 8 days.

The 21 and 8-day schedules are presented here to indicate the business-like way of handling the work in the various departments. Each line of the schedule has a date, and the entries under each department heading indicate the dates upon which each part of the work must be ready for the work of the next department. For example, the boiler goes to the erecting shop on the fourteenth day. At that time the brakes, valves, frames, driving wheels, driving boxes, springs, etc., are all ready for the erecting shop. The other parts are brought in, the tender completed, and a day is allowed for finishing up after the valves are set. The work on the 21 pits is handled by 4 gangs.

Each foreman has these schedules mounted in permanent form, and a slip is provided for each engine in the shop. These slips are dated and held upon the schedule by a spring clip. They are ruled in columns, for the different grades of repairs. In this way each foreman knows exactly when each part of each engine must be ready.

The weekly record contains the information required by the general foreman, giving at a glance all of the work in the shop and the engines turned out during the current month. Thus the report for the last week of the month gives the output for the entire month. A part of the plan is to hold a meeting of the foremen every week to discuss the subject of the work in hand and the reasons for such delays as may occur. In such a scheme as this, wrecked engines present a difficulty which cannot be provided for by any schedule. Smooth working of schedules is also upset by discovering defects which are not revealed until an engine is stripped. These cases, however,

ENGINES IN SHOP.

WEEK COMMENCING..............................190..

GANG I.					GANG II.					GANG III.					GANG IV.				
Engine No.	Div.	Date in	Repairs	Date out	Engine No.	Div.	Date in	Repairs	Date out	Engine No.	Div.	Date in	Repairs	Date out	Engine No.	Div.	Date in	Repairs	Date out

OUTPUT MONTH OF...

NOTE.—Under this heading is placed a record of the locomotives turned out each week.

SCHEDULE OF WORK FOR ENGINE NO —— GENERAL REPAIRS AND HALF SIDE SHEETS OR FIREBOX.

Date.	Erecting Shop.	Boiler Shop.	Machine Shop.	Smith Shop.	Tank Shop.	Carpenter Shop.	Paint Shop.
	Engine taken in.						
	Stripped and to boiler shop.	Boiler in shop.					
				Valve yokes.			
				Brake work, frames.			
	Cylinders bored.			Tender springs.	Trucks completed.		
			Brakes, valves and yokes.	Rods and straps.	Frame completed.	Cab repaired.	
					Tank repaired.	Tender work.	
	Steam chests and valves up.			Guides and yokes.	Tender completed.		
			Frames finished.				
		Firebox repaired.	Driving boxes fitted driving wheels ready, shoes and wedges.	Spring rigging.			
	Boiler returned.	Boiler to erecting shop.	Eccentric straps and rods.	Truck springs.			Cab painted.
	Frames up, steam pipes in.		Cross heads and guides.	Driving springs.		Back running boards up.	Wheels painted.
	Truck ready, cab up.	Flues reset.	Links.				
	Wheels under, spring rigging up.	Boiler tested.	Pistons and rods.			Pilot repaired.	
	Boiler lagged, boiler jacketed.		Main rods.		Smokebox work.	Front running boards up.	
	Piping up, valves set.		Side rods.		Ash pan up.		Tender painted.
	Completed and painted.						Engine completed.

THE 21-DAY SCHEDULE.

SCHEDULE FOR ENGINE NO. —— LIGHT REPAIRS.

Date.	Erecting Shop.	Boiler Shop.	Machine Shop.	Smith Shop.	Tank Shop.	Carpenter Shop.	Paint Shop.
	Engine taken in and stripped.						
				Valve yokes, rods and straps.	Trucks completed.		
	Cylinders bored.		Valves and yokes.	Frames, brake work.	Frame completed.	Tender work.	
	Steam chests and valves up.		Eccentric and straps, brake rigging, driving boxes & wheels.	Spring rigging and springs.	Tank repaired.	Cab repaired, running boards up.	
	Wheels under, eccentrics and straps.	Firebox work.	Rods, pistons and rods.		Smokebox work. tender completed	Pilot repaired.	
	Valves set, rods up. completed.				Ash pan up.		New work painted

THE 8-DAY SCHEDULE.

constitute less than 10 per cent. of the total number of engines repaired. The schedules were prepared by consultation of the foremen, and it has not been found necessary to revise them. One of the benefits derived is a natural pride in keeping to the schedule, especially because the operating department is told when to expect the engines. When the date of delivery of an engine is made definite, the whole department is informed, and each shop must necessarily do its work systematically and in the order of its importance.

It is stated that since this schedule went into use the output of these 21 pits has been increased from 30 to 40 locomotives per month. Some of the improvement is due to improved shop equipment, but unquestionably most of it is due to the effect of the schedule in systematizing the work in the shops.

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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CONTENTS.

This journal is pleased to announce that it has secured the services of Mr. Willard C. Tyler, who assumes charge of its Eastern Business Department on the first of this month. During the last four or five years Mr. Tyler has made several trips to Japan, China, and the Far East in the interests of certain locomotive and railway material manufacturers, with the result of a considerable increase in the use of the American locomotive in that part of the world. Mr. Tyler is well and favorably known to the railway supply and machinery trades through his long connection with the Railway and Engineering Review, and also Engineering of London.

BETTER INSTRUCTION OF APPRENTICES.

From time to time for many years apprentice systems have been started under auspices which appeared to be favorable, and for one reason or another they have been dropped, sometimes gradually and sometimes suddenly. Just now a revival of interest in the subject appears in several directions, due undoubtedly to an awakening to the fact of a dearth of the right sort of material for filling subordinate positions, such as those of foremen. The cause of the lack of this material is in itself an interesting subject of speculation and an important one. It is sufficient for a discussion of its own.

The treatment of apprentices is revived periodically, plans and apprentice courses are lined out, each time upon "firm" bases, almost as regularly as "New Year's resolutions." Better instruction of apprentices is now spoken of, however in a way which warrants the conclusion that an earnest effort will soon be made to put this matter in better shape than it has ever taken. The whole apprentice question will be taken up again and more earnestly because it is necessary that it should be done.

If a motive power officer desires to raise the right sort of boys through his apprentice courses, how shall he go about it? He naturally wishes to induce study and encourage improvement among the boys with a view of leading them to improve themselves. It is difficult to accomplish this. Shall he establish a shop school, maintained by the company, and invite attendance from all apprentices, or shall such attendance be a requirement of apprenticeship? Granting that education is necessary, who shall be responsible for the schools and how shall they be organized and maintained? These questions are now being asked.

At the outset it is safe to say that improvements based upon the prevailing treatment of apprentices will fail in the future as they have in the past for very simple reasons. Busy officers find it easy to forget apprentices and their obligations to them. They are promised a training, systematic and thorough. Do they get it? Never—unless it is someone's business to see that the terms of the contract are fulfilled, and usually no one is held responsible for this. A boy in opening his apprenticeship is at the most impressionable stage of his life. If he is kept for a year at the bolt cutter—and this is by no means a rare occurrence—he should not be blamed for lack of enthusiasm. Such treatment naturally kills ambition so that a miracle will not resurrect it. The boy is defrauded and numbed. After this treatment can he be expected to jump at the chance to improve himself at hard study? Is it cause for wonder that it is so difficult to find responsive apprentice boys?

It is time to take up the school question when the boys are ready for it. After being defrauded as they are, almost universally, only those who are bound to rise regardless of difficulties will be ready for it. But fix the apprenticeship and the school will present an easy problem because the boys will want it. Fulfill the apprentice obligation and the best sort of a school is already practically established—but after that something more is needed.

Apprenticeship must necessarily be a farce unless the foremen understand and appreciate it and co-operate earnestly. No man is fit for foremanship who does not do this when encouraged to do so. Foremen must be interested in the boys. It would be well to include in the apprentice course a certain number of talks every year by the foremen upon subjects connected with the shop work, and perhaps an annual talk from the head of the department to all the boys. An occasional stereopticon talk on carefully selected subjects would awaken dormant interest. The officer preparing such a talk to good live boys will himself receive not the least benefit from the operation.

After going thus far a school will be demanded, or the writer is mistaken in his conceptions of human nature. Then comes the question of how to provide the school. In these days of the Y. M. C. A. the means are usually at hand. A bit of encouragement from the local officers of the railroad will probably meet a ready response from the local secretary of the association, or perhaps the local public school provides night instruction. If not, the railroad should provide for the deficiency, and for instructors the drafting room force is always available, and the work should be well paid for. The officers should not fail to see that the instruction for the shop boys meets their special needs. For example, arithmetic should be presented in such a way as to include the problems found in the shop and in the laying out of work.

With a good apprentice system faithfully fulfilled and the school establishment within or outside of the railroad, it will be easy to select the earnest boys. A very proper and profitable step after this would be to offer as a prize for earnest effort a few special two years' courses at the best technical school, with all expenses paid by the company.

Has anyone thought of establishing a "question box" for apprentice boys—or for men in the shop—to be discussed and answered by the foremen? This whole subject is a fascinating one and is full of interesting possibilities, and it will pay to think of it seriously. Some definite and practical commonsense plan that will interest and encourage self-improvement will in a short time surely develop enough material and to spare for recruiting all the offices of the department.

This journal wishes to enter a vigorous protest against further neglect of regular apprenticeship. Many of the ablest motive power officers of the present time have risen from this starting point. The door has been allowed to almost close. It must be opened again.

Operating officers are becoming alarmed by the increasing frequency of break-in-twos, because of failures of couplers through wear and breakage. On several large railroad systems it has been decided to be necessary to stretch all trains on arrival at division terminals in order to inspect the couplers properly by gauges indicating the amount of wear of the coupler and knuckles. This requires considerable delay, but these officers are glad to provide time for the purpose of reducing the number of break-in-two accidents. The matter is becoming so serious as to warrant general adoption of this method of inspection.

COMMUNICATIONS.

THE RECORD-BREAKING TIRE-BORING OPERATION.

To the Editor:

Having read Mr. Pattison's letter on the tire-boring operation in the January issue of your paper, page 21, I take the liberty of differing with him as to the relative costs of boring tires at West Albany and at Roanoke. He has charged up the time of four helpers at West Albany and for but one at Roanoke. I think he has forgotten to charge the time of the two men which he states are required to roll tires for him, which should be accounted for.

He also says this work is done on a boring-mill which has been in use for 20 years. We did the work at West Albany on a mill, which has been in use for an equal length of time, before getting the new mill a year ago, which we now use. Since sending you the article, published in your November issue, we have done very much better, but do not think it necessary to publish it.

All that I wish to do is to prove to Mr. Pattison that he does not bore tires cheaper than is done at the N. Y. C. & H. R. shops at West Albany. Taking the same figures which Mr. Pattison has used, we have the following results; proving that Mr. Pattison has made a slight mistake and showing conclusively that we bore tires at a considerably less cost than is done at Roanoke.

Charging him with three helpers, as should be done, we have the following:

Roanoke Shops.—Norfolk & Western Railway.

Time of One Mechanic, 4 2-3 hrs. at 50 cts. per hr.......	\$2.33
Time of Three Helpers, 4 2-3 hrs. at $12\frac{1}{2}$ cts. per hour	1.74
Total cost for boring 10 tires.......................	\$4.07
Average cost for boring 1 tire.......................	.41

West Albany Shops. New York Central.

Time of One Mechanic, 4 2-3 hrs at 50 cts. per hr......	\$2.33
Time of Four Helpers, 4 2-3 hrs. at $12\frac{1}{2}$ cts. per hr......	2.32
Total cost of boring 11 tires.......................	\$4.65
Average cost of boring 1 tire.......................	.33

This shows that, with more help than Mr. Pattison used, we bore tires 8 cents cheaper than he does.

ALBERT H. REESE.
19 N. Lexington Ave., Albany, N. Y.

MAXIMUM PRESSURE ON CROSS-HEAD PINS OF COMPOUND LOCOMOTIVES.

To the Editor:

The interesting article entitled "Limits of Wear of Crosshead Pins," which appears on page 462 of the December, 1903, issue of the AMERICAN ENGINEER, contains the unqualified statement that for compound locomotives, the maximum normal load on the main crank-pins is obtained "by multiplying the low-pressure piston area by the boiler pressure and dividing this product by the cylinder ratio plus 1." Since this rule is totally unsuitable for determining the limits of pin wear of both Vauclain and tandem compound engines, and would probably result in very serious consequences if employed for this purpose, I beg to present the following explanation of the derivation of this rule, together with the modification necessary to render it applicable to the above mentioned types of locomotives.

The foregoing rule is based on the assumption that the engine is correctly designed, so that a practically equal division of total work is obtained between the high and low-pressure cylinders. Thus, if we consider a two-cylinder compound locomotive having a cylinder ratio of, say 1 to 3 ($r=3$), it is evident that it will require three times as great an effective initial pressure in the high-pressure as in the low-pressure cylinder in order to equalize the work between them. With a boiler pressure, $P=220$ lbs. per sq. in., we would, neglecting low-pressure, back-pressure and other losses, require 55 lbs. per sq. in. initial pressure in the low-pressure cylinder, and 220 lbs. per sq. in. initial pressure in the high-pressure cylinder, because this latter pressure is opposed by the 55 lbs. back-pressure offered by the receiver pressure (which is also the low-pressure initial pressure), thus leaving 220-55=165 lbs. per sq. in. *effective* initial pressure in the high-pressure cylinder, or three times the low-pressure initial-pressure. Consequently, the proper theoretical maximum low-pressure, initial-pressure is

$$\frac{220}{4} = \frac{220}{3+1} \text{ or } \frac{P}{r+1};$$

and letting A = the area in sq. ins. of the low-pressure piston, it follows that for any correctly designed two-cylinder compound locomotive, the maximum normal load (neglecting friction) on the cross-head pins, and on the main crank-pins $= \frac{P\ A}{r+1}$.

In the case of Vauclain and tandem compound engines, since both the high and low-pressure pistons act upon the same cross-head, the total effective initial pressure on the high-pressure pistons must be added to that on the low-pressure piston in order to obtain the maximum thrust on the cross-head pin. If we assume, as before, an equality in the work performed by each cylinder, it is obviously necessary to multiply the preceding expression by 2; and therefore, for Vauclain and tandem compound locomotives, the maximum normal pressure on the cross-head pins and main crank-pins $= \frac{2\ P\ A}{r+1}$.

It is evident that neither of these formulæ take account of the enormous loads to which the main and cross-head pins are occasionally subjected, due to the presence of considerable quantities of water in the cylinders, since these augmented pressures result from abnormal conditions, and are consequently impossible to estimate.

EDWARD L. COSTER,
Assoc. Am. Soc. M. E.
25 Broad Street, New York, December 9, 1903.

AN EXTENSIVE WATER-SOFTENING INSTALLATION.

Total Capacity, 348,000 Gallons per Hour.

PITTSBURG & LAKE ERIE RAILROAD.

IV.

(*Continued from page* 19.)

In the preceding article of this series a general description of the large and interesting Kennicott water softener, which is in use at the McKees Rocks locomotive water-supply station, was presented. The details of the automatic regulating apparatue for controlling the supplies of chemicals to the water to be treated were referred to only in a cursory manner on account of lack of room; the importance of these factors of the system are so great that they will be referred to in this article in considerable detail.

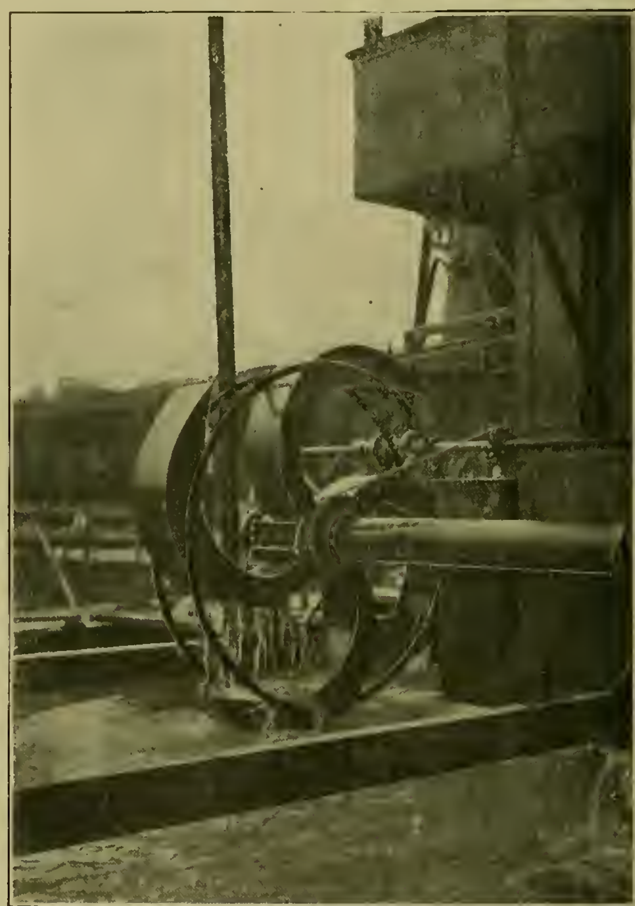
In the first place, attention should be called to the method of graduating the supplies of water to the chemical tanks, including soft water for the lime saturator and soda solution for the mixing chamber. As stated in the previous article, the amount of raw water flowing into the softener governs the rate of flow of the chemical solutions for chemical action; the method of accomplishing this is by an interesting system of a float and head-varying devices in each of the solution tanks. The float, Y, is located in the raw water tank, B, and chains passing over pulleys from this float regulate the positions of these head-varying devices in tanks, T and N.

This arrangement is very nicely shown diagrammatically in the first view below. The float is shown within a guiding cylinder in the raw water tank, above the water wheel, and the chain runs from it, over two pulleys, and down to a swinging pipe in the tank below. The principle upon which the slotted orifice is made to work is as follows: This orifice is smaller in cross-sectional area than the pipe into which it admits the water, and, therefore, the flow through it is dependent upon the hydraulic head acting upon it, which, in turn, depends upon its distance below the surface of the water. Thus, when it is desired to have the flow through the pipe the greatest, it is only necessary to drop this orifice to its lowest position, and for the least flow, to raise the orifice as high as possible.

DIAGRAMMATIC VIEW OF THE FLOAT MECHANISM FOR VARYING THE HEIGHT OF THE ORIFICE IN THE TANK OUTLET PIPE, AS USED TO CONTROL THE RATE OF FLOW OF THE CHEMICAL SOLUTIONS.

It is evident that the flow of the chemical solution from the tank through the orifice should be in proportion to the amount of raw water entering the softener. Inasmuch as the raw water enters the machine through the slot in the lower side of tank B, which directs it upon the water wheel, C, the amount of flow of this raw water depends upon the hydraulic head in the tank, B, or the height of the water in that tank; as the water rises in tank, B, the flow into the softener increases, and vice versa. In this way may be seen the principle which is made use of in the float operating the slotted pipe: As the head in tank, B, increases, the flow of the solution from the lower tank is also increased by the rising of the float and the resultant dropping of the slotted pipe and increase of flow through it.

This principle is made use of both for controlling the supply of soft water from box, N, into the lime saturator and of the soda solution from tank, T, into the mixing chamber (see diagrammatic view of the softener on page 17 of the preceding January, 1904, issue). It works admirably, and can be adjusted to a refinement of exactness. If it is desired to change the rate of flow of either of the liquids in relation to the amount of raw water, it is only necessary to lift the slotted pipe out of the water and move the threaded sleeve forward or back, so as to cover or uncover the slot; in this way the effectual size of the orifice may be adjusted at will.



VIEW OF THE LIFTING WHEEL, DRIVEN BY THE WATER WHEEL, USED TO LIFT SOFT WATER INTO TANK, N, FOR DELIVERY INTO THE LIME SATURATOR.

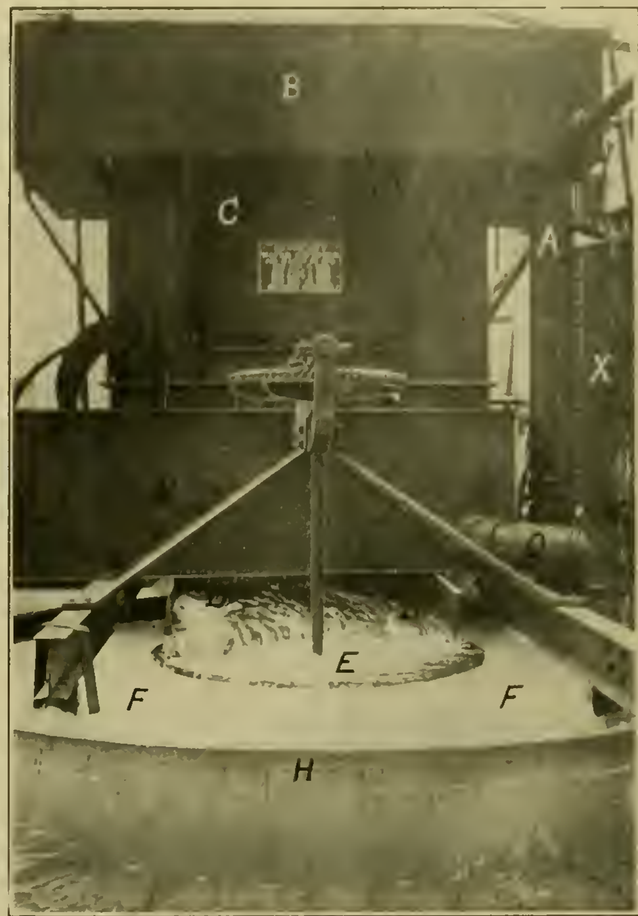
In this connection it may be of interest to state why it is that soft water is used for making the lime solution in the lime-saturator. This is done to prevent the precipitation of the scale-forming impurities in the lime-saturator tank in the quantities which would occur if raw water were used for this purpose. The proportion of impurities brought down by the lime solution is much the greater of the two solutions, and this, taken in connection with the large amount of lime solution used, makes it advisable to use soft water for this purpose, whereas in the case of the soda solution, so little of the same is used in comparison to the total amount of solution treated that the effect caused by any precipitation from the raw water in the soda tanks is not troublesome.

The method of lifting the soft water up into the tank, N, is interesting. It is accomplished by means of the wheel, L, having hollow curved arms, open at the ends, which dip into the water and lift it up; the water flows through its arms into the large hollow shaft, M, and thence into tank, N. This wheel is revolved by means of a chain-drive connection from the shaft of water wheel, C. The passage of the entering raw water over water wheel, C, which is of the over-shot type, generates sufficient power to easily operate this lifting wheel for this and other service. An excellent idea of this wheel may be obtained from the accompanying view of the same, which is from an instantaneous photograph of the wheel when in operation; the closed portions of the curved arms are easily recognized and the dripping of water from the arms was realistically caught by the camera. The important feature of this method of raising the soft water into the supply tank, N, is that it eliminates the necessity of providing a mechanically operated pump at the top of the softener; the water is thus lifted entirely by the action of the raw water passing over water wheel, C, in entering the softener. This feature of the mechanism requires practically no attention.

The soda solution is prepared in the two tanks, R-R, each of which contains a wire basket at one side for holding the soda. This greatly facilitates the dissolving of the soda into the water, as it drops down from the basket into the water gradually as it dissolves away. These tanks are constructed of sheet steel, square in shape, and are elevated upon a structural stand, bringing their bases 30 ins. above the top of the softener. They are each 3½ ft. high and of sufficient size each to supply soda solution to the softener for a 12 hour run.

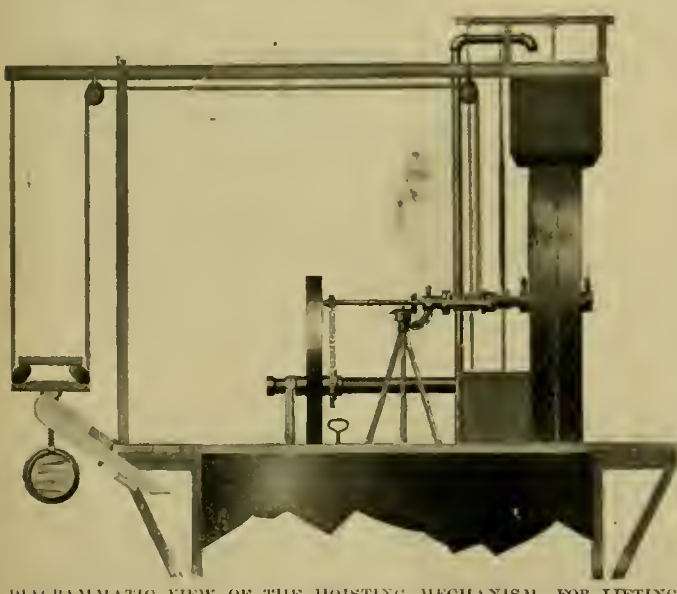
They are supplied with water directly from tank, B, as before stated. These tanks are used alternately, the solution in one being prepared while that in the other is being used. They are filled through the pipe, Z, and deliver through pipe, S, to the soda solution tank, T. A constant level is maintained in tank, T, by means of ball cocks and floats, as indicated in the plan drawing of the top of the softener, page 64. From tank, T, the soda solution is delivered into trough, D, to enter the mixing chamber, E, by means of the slotted pipe arrangement of orifice, as above described.

On account of the great size and capacity of the McKees Rocks softener, relatively large proportions of soda are required, which must be dissolved as quickly and with as little labor as possible. In this connection an important and unique feature has been introduced to accomplish the rapid solution of the soda ash in the tanks. A small air compressor was installed to be driven from the shaft of water wheel, C, which drives the lifting wheel, and its discharge was piped to a perforated delivery pipe, extending around the sides of the soda tanks at the bottom. The passage of the numerous streams of air through the solution thoroughly agitates the water in these tanks and entirely eliminates the possibility of caking of the soda. The effect of this agitation process is to cause the water to circulate in the tanks violently and has been found to greatly facilitate the solution of the soda ash.



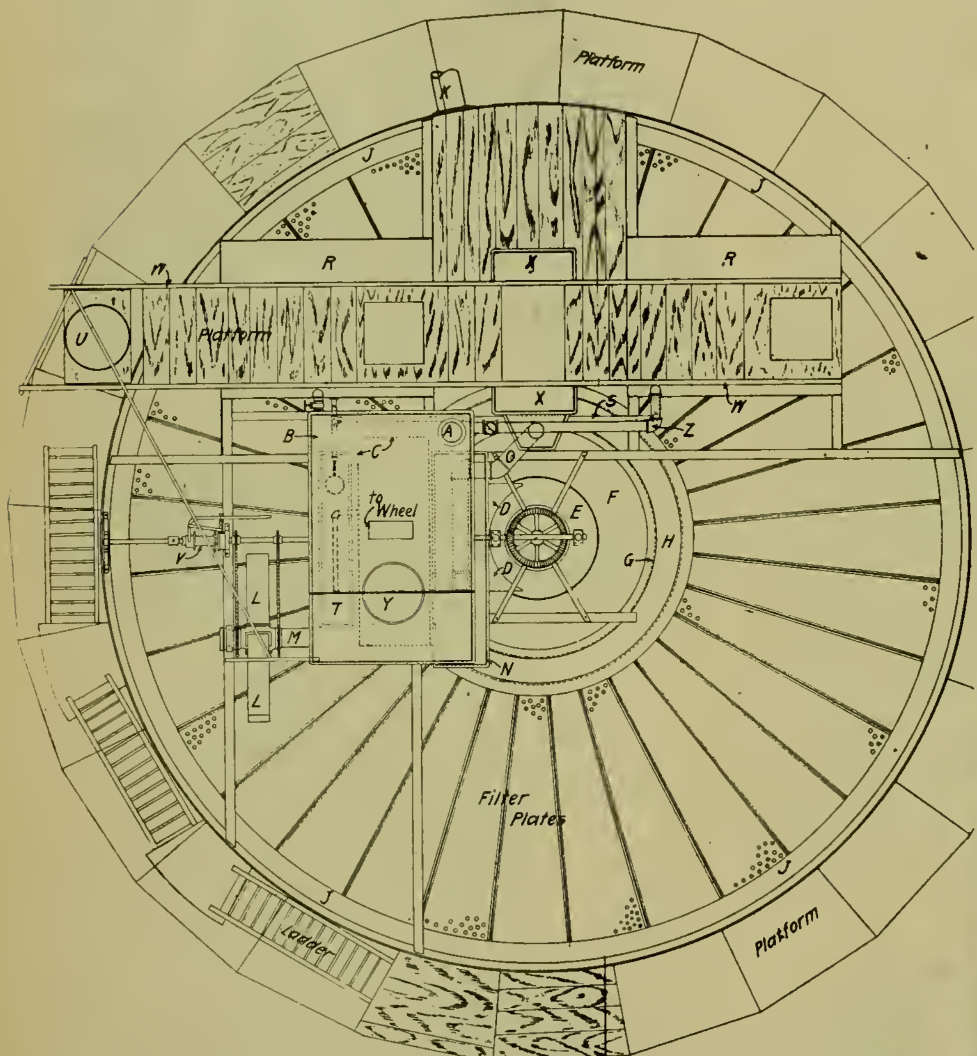
VIEW OF THE TOP OF THE McKEES ROCKS SOFTENER WHILE IN OPERATION. RAW WATER ENTERING MIXING CHAMBER AT E; CLEAR SOFT WATER ABOVE FILTER PLATES IN IMMEDIATE FOREGROUND.

On this page is presented another very interesting view upon the top of the McKees Rocks softener. This view is taken from a point on the platform opposite the stairway side of the softener and looking directly at soft water tank, N, and into trough, D. In the upper part of the view is shown raw water tank, B, which rests upon the top of the case surrounding water wheel, C. Beneath tank, N, the raw water appears entering the mixing chamber, E, from trough, D. Also entering mixing chamber, E, may be seen the vertical shaft, which is driven through bevel gearing from the water wheel shaft; this is the shaft which drives the mechanical agitators at the bottom of the lime-saturator. In front of the mixing chamber, E, may be seen the water rising, milk-white, from the revolving deflector plate chamber, F, and flowing over the edge of tank, G, into the space within the settling cone, H; this is very clearly shown. In the extreme foreground the soft water is clearly shown between cone, H, and the edge of the softener, where it has just risen up through the filter. This view presents an excellent idea of the operation of the softener.


DIAGRAMMATIC VIEW OF THE HOISTING MECHANISM, FOR LIFTING WEIGHTS, BARRELS OF CHEMICALS, ETC., TO THE TOP OF THE SOFTENER (AS USED UPON THE SMALLER SIZES OF THE KENNICOTT WATER SOFTENER.).

The hoisting device which forms a part of the mechanism of the Kennicott softener is an interesting and economical feature of its operation. The accompanying view of one of these hoists explains clearly its mode of operation. The hoisting drum, V, consists of a loose sliding sleeve upon the water wheel shaft, which may be slid over into clutch with a collar revolving with the shaft, or released, by means of the handle shown in the plan drawing. When thrown into clutch it takes power from the water wheel shaft and winds up the rope over the pulleys and lifts the barrel of chemicals, or the can, U, as desired. On the McKees Rocks softener there is an elevated track, W, extending across the softener and running under the hoist; as the barrel is lifted to the top of the hoist, the little car is run under the same, after which it may be run across to either side of the tank. For lowering a weight to the ground there is provided a friction brake at the end of the drum, V, opposite from the clutch; by moving the drum over against this brake shoulder, weights can be dropped to the ground as slowly as desired.

The view of the hoist mechanism on page 63 shows the tilting platform method of receiving the weight after it has reached the top of the tank. After it has been lifted above this swinging platform, the platform drops back into place and acts as a floor to receive the weight. This is the construc-

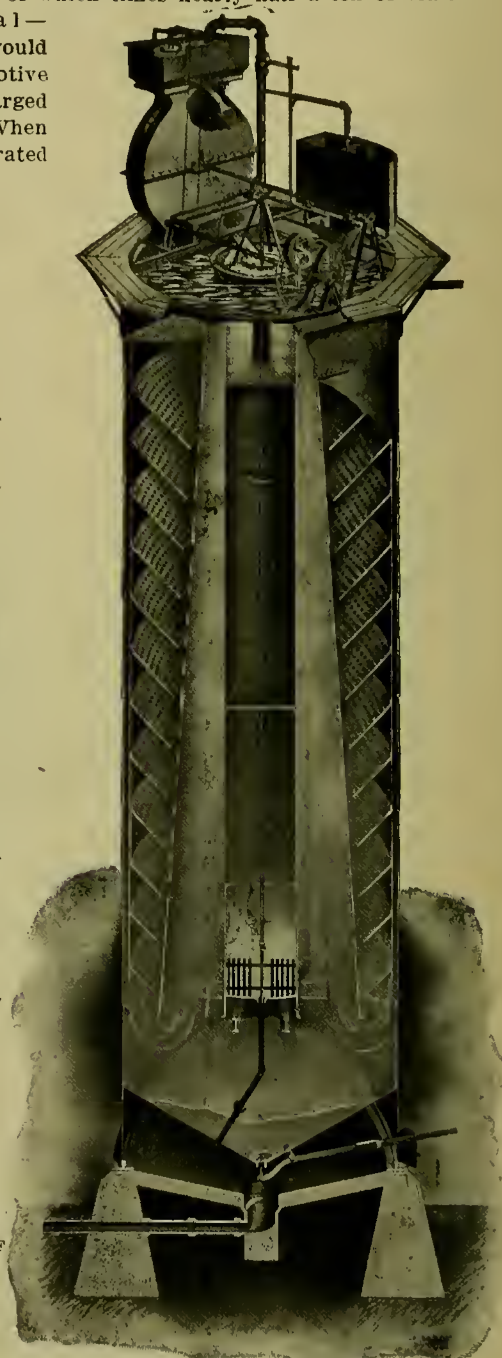


PLAN OF THE TOP OF THE McKEES ROCKS WATER SOFTENER TO SHOW THE ARRANGEMENT OF THE APPARATUS.

tion used on the smaller sizes of softeners; upon the larger sizes of softeners, of capacities of 40,000 gals. per hour and over, the elevated track and larry-car method of receiving the weight is used, as shown upon the top of the McKees Rocks softener. Another important feature of this lift is the spacer for separating the ropes used for hoisting; by thus separating these two ropes the inconvenient swinging of the weight is eliminated and no time is lost in this way.

At the right, on this page, there is an interesting view, which presents a sectional diagramatic view of one of the Kennicott softeners to illustrate the method of operation. The construction shown in this view is that used in the smaller softeners of the installation on the Pittsburg & Lake Erie, although it does not differ in principle from the large softener at McKees Rocks. The arrangement of the baffle plates outside of the settling cone and of the lime-saturator tank within, as well as the other important characteristic details of the Kennicott water softener are comprehensively shown in this view.

Some of the features of the operation of the large softener at McKees Rocks may be of interest: This softener is run to its full capacity for 12 hours per day. The only attention required is at starting up time and at noon, at each of which times 3½ bbls. of lime and 750 lbs. of soda are added to the lime-saturator and to the soda tanks respectively. The main sludge valve at the bottom of the settling cone is opened twice a day also, at each of which times nearly half a ton of scale-forming material—which, otherwise, would go into the locomotive boilers—is discharged into the sewer. When this softener is operated 10 hours per day with the present mode of treatment, 1,974 lbs. of solid matter are precipitated.



SECTIONAL VIEW OF A TYPICAL KENNICOTT WATER SOFTENER, SHOWING CLEARLY ITS INTERNAL CONSTRUCTION.

Water is supplied to this softener from a well 45 ft. deep by two direct-connected motor-driven centrifugal pumps, which are operated at speeds of from 840 to 1,200 rev. per min. Each pump has a capacity of 1,000 gals. per min., one pump only being worked at one time. They lift the water about 85 ft. at a cost of about $0.006 (6-10 cent) per 1,000 gals.—for power and labor. At the present time the amount of scale-forming impurities in the water is reduced from the raw water condition of about 24 grains per gallon to less than 5 grains per gallon after treatment.

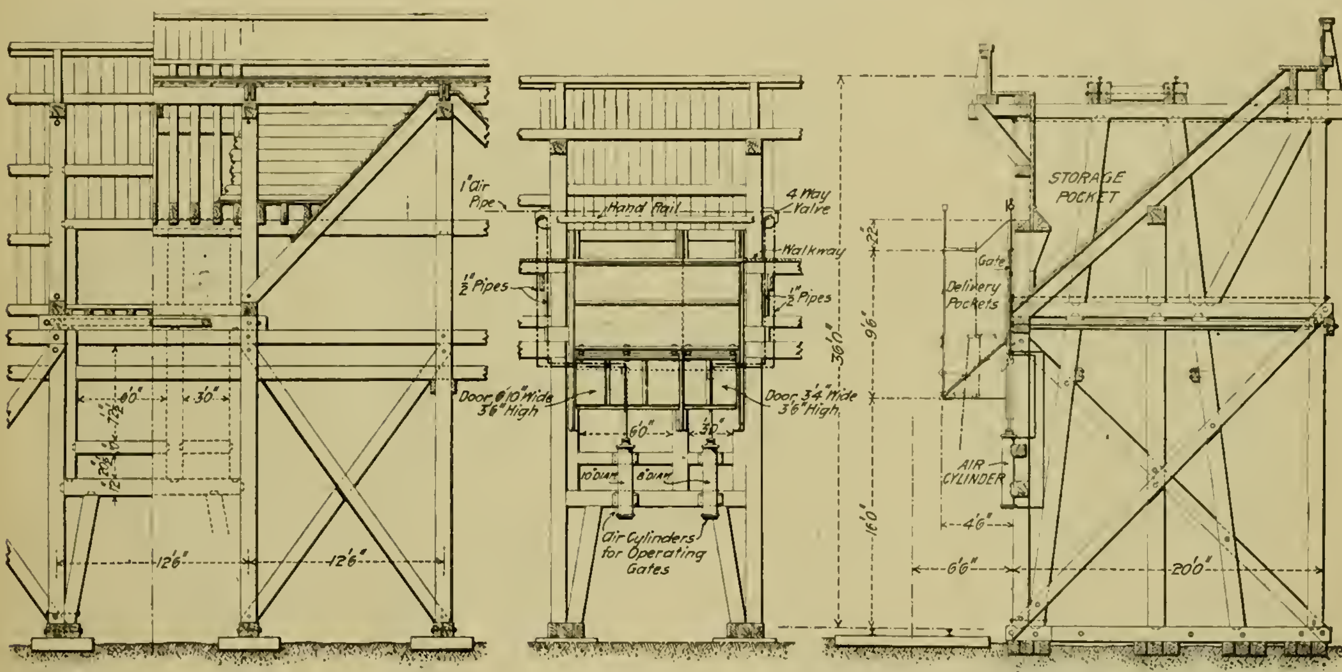
COAL CHUTES FOR LOCOMOTIVES.

A New Idea In Measuring Coal.

BALTIMORE & OHIO RAILROAD.

Railroad officers having charge of coaling stations for locomotives have in many cases of late, indicated their unfavorable opinion of weighing devices by omitting them entirely and going back to the old method of dumping coal on tenders with no attempt at obtaining an even approximate record of the amount delivered to each engine. They have been building chutes which have no provision for measuring coal given to each engine.

In such cases the coal record standing of the engine crews must necessarily be given up and efforts to save coal must be confined to those which are put forth by the traveling engineers and firemen. This appears to be a serious mistake which can not be considered as an advance step, or as one leading to the best use of fuel. This journal holds the opinion that coal must be weighed or accurately measured in order to form the basis for its economical use.



HALF FRONT VIEW. HALF LONGITUDINAL SECTION. CROSS SECTION.

DETAILS OF THE APPLICATION OF THE MEASURING DELIVERY POCKETS TO STORAGE TRESTLES AT COALING STATIONS.—BALTIMORE & OHIO RAILROAD.

The Baltimore & Ohio chutes at Brunswick, Md., at Keyser and Fairmont, W. Va., and at Newcastle Junction, Pa., are interesting in this connection. They provide delivery pockets in pairs, each pair containing 4 and 2 tons of coal, which are made to measure the coal as accurately as it can be measured by volume. These pockets project over the track as indicated in the accompanying engravings, which show clearly the details of construction.

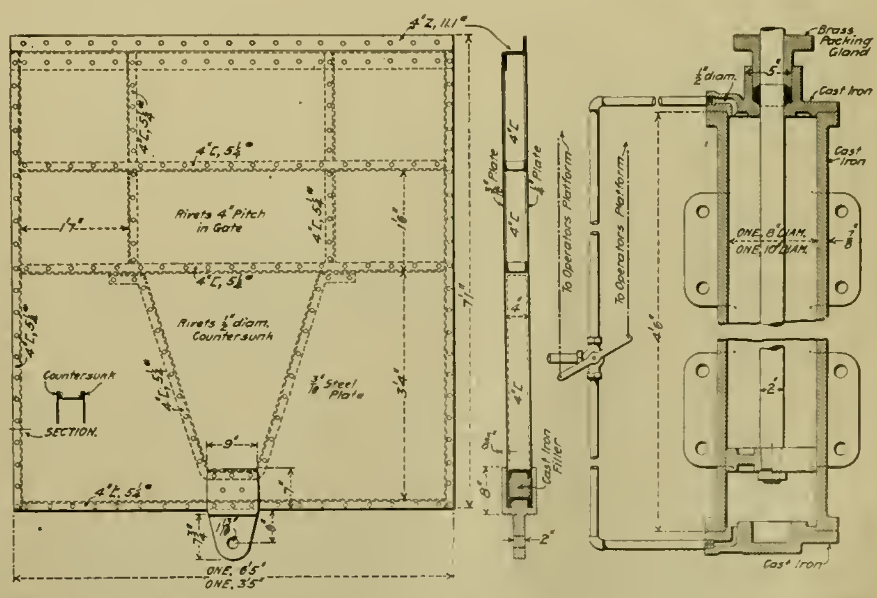
Two sizes are provided, in order to adjust the amount delivered without gauging or partially emptying a pocket. When 4 tons are wanted the large pocket is emptied. Both pockets used together give six tons, and for 8 tons the 4-ton pocket is used twice. The small pockets are filled from a 60-ton storage pocket overhead.

By using pneumatic, vertically moving gates between the storage and delivery pockets the latter may be emptied and filled in less than one minute. A method of interlocking the shutoff gates with the delivery valves, which is provided, makes it possible to deliver coal to a tender while the main shutoff gates are open. With this arrangement the average delay to locomotives at these chutes is reduced to 2¼ minutes. Coal comes to the chutes in 50-ton cars and is unloaded directly into the storage pockets, each of which takes the full load of a car. There is no manual handling of the coal, and the total cost of the operation of the chute with 10 pockets is the maintenance and the labor of two men.

Thus far the two sizes of delivery pockets have met all requirements. The pneumatic cylinders for operating the gates appear to be entirely satisfactory and the idea of the construction promises to provide a way to retain individual coal records, combined with a very inexpensive method of handling coal. We are indebted to Mr. V. Z. Caracristi for the information and to Mr. J. E. Muhlfeld, general superintendent of motive power for the drawings. These are selected with a view of self explanation.

In regard to the operation of this system, Mr. Muhlfeld states:

"The storage and delivery trestles of this type that we have in use at the above points are giving very good results. We



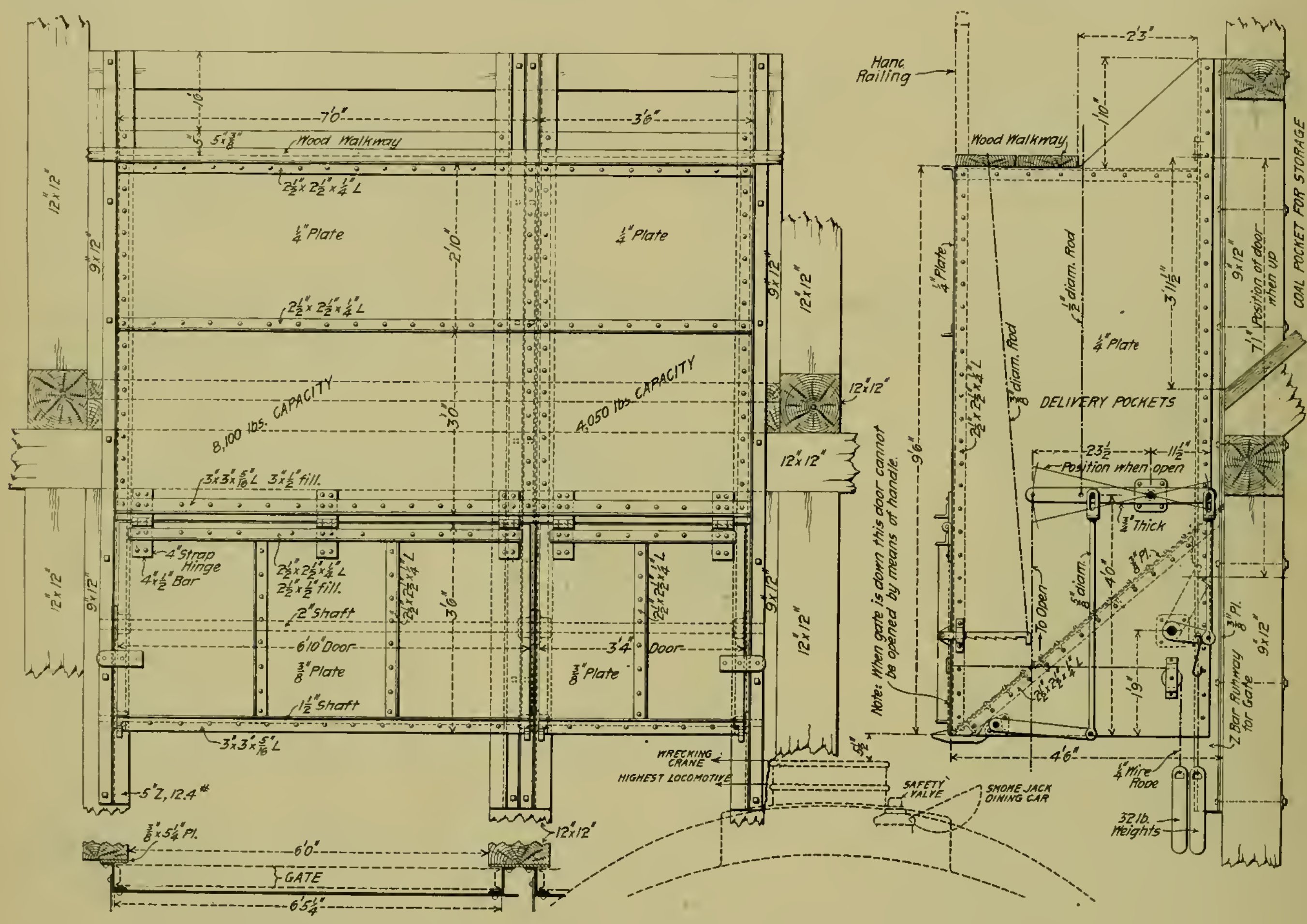
DETAILS OF THE STEEL GATE FOR SEPARATING THE STORAGE AND DELIVERY POCKETS, AND OF THE PNEUMATIC CYLINDER USED IN OPERATING SAME.

find that at the present time, the two-ton unit of coal to be delivered to locomotive tenders is about as small as necessary; in fact, our records show that there is less than one-fifth of the coal that is delivered from the two-ton pockets, the four-ton being used to the greatest extent. The coal supplied to tenders is always in two or four-ton lots, or in multiples thereof.

"With the fifty-ton storage pockets filled with coal, to each one of which is attached a two and a four-ton measuring pocket, it is possible to dump the coal from both of these pockets, refill them and again dump, supplying in all twelve tons to the tender, in less than one minute. We handle the coal from steel-hopper self-dumping cars to the locomotive tenders from these coaling trestles at a cost ranging between ½ cent and 1 cent per ton, depending on the effect that weather conditions, operates the gate, controlling the flow from the large storage, from the measuring pocket platform; the coal can then be dumped from the measuring pockets to the tenders either from the measuring pocket platform, or from the engine cab. The amount of coal received and disbursed on each coaling trestle is balanced each day, and what slight adjustments may be necessary, can be promptly taken care of.

"There is very little difficulty or expense experienced on account of spilled coal from the tenders having to be picked up from the ground, and we think that the labor expense in connection with handling the coal around the trestle is reduced to the minimum."

It should be stated that the air cylinders were made of such diameters as to insure closing the gates through the streams



FRONT ELEVATION OF THE 2 AND 4-TON MEASURING POCKETS AS APPLIED TO A STORAGE TRESTLE, AND CROSS SECTION SHOWING CLEARANCES OF ROLLING STOCK.

daily delivery from the chutes and other items have in connection with the work. We have one man on duty during the twelve-hour day shift, and one during the twelve-hour night shift, and where in the neighborhood of 500 tons of coal are disbursed during the twenty-four hours, this man has also considerable time to spend in the drying of sand.

"When the storage is practically empty, the practice is to have a switch engine place five cars on the trestle, which are immediately dumped; the empty cars are then taken down, and five additional cars run up and dumped; these latter empty cars are then taken down and another lot of five cars placed on the trestle, and the hopper doors opened. This makes a storage of 750 tons, 500 tons of which will be in the storage pockets in the trestle, and 250 tons in the cars. In addition to this, 60 tons can be stored in the measuring pockets at the same time, making a total storage of 810 tons, which, at the average coaling station, will make it unnecessary to switch the trestle more than once during the twenty-four hour period.

"We find that the measuring out of the coal by this gravity method is close enough for all ordinary purposes. The coal is dumped into the self-measuring pockets by the tipple man who

of coal when using 50 lbs. air pressure. This construction is likely to be used in other locomotive terminals on this road and it now promises to prove to be a turning point in coal chute practice.

GRAB IRONS ON LOCOMOTIVES.

The Interstate Commerce Commission, after full investigation and consideration of the matter involved in the above title, rendered opinion and filed its report, ordering: That the time of common carriers by railroad in the United States to comply with so much of Section 1 of the Act of Congress of March 2, 1903, as requires the application of grab irons to the front ends of locomotives and sides of locomotives near the front ends, be further extended to the first day of March, 1904.

Mr. Charles A. Hino, who for many years has been connected with the mechanical department of the Lake Shore & Lackawanna in Buffalo, has been appointed general foreman in the Delaware, Lackawanna & Western shops at Elmira.

MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

XIII.

BY C. W. OBERT.

For some time a need has been generally felt for a mechanical speed-changing device of small size and simple, which may be used in connection with variable-speed motor drives of limited speed-range (such as those using field control) and in other cases for driving machinery, where a few speed changes are necessary and desirable. The use of a device designed to fulfill these requirements would do much to afford simplicity for methods of motor driving and would make possible the use of individual drives in many places where it would be prohibitive otherwise.

In the accompanying engravings is illustrated a new and interesting form of positive-drive variable-speed mechanism, recently perfected and placed upon the market by the National Machine Tool Company, Cincinnati, O., which fullfils these requirements. This device was designed by Mr. W. L. Schellenbach, President of the company, and is similar in general principle to the larger variable-speed countershaft, built by this company which was described in article VI. of this series (page 229, June, 1903). The new mechanism differs from the former, however, in that it provides a smaller number of steps, although the speed range is fully as large. The most noticeable feature of this new device is its compactness in relation to the capacity.

The principle of operation is essentially that of the Schellenback method of raising loose gears into mesh with the revolving gears of a gear-cone, and clutching them on the splined shaft in the manner that was described in Article VI. of this series. But the arrangement of parts and adaptation of the principle of this device, as well as its form of case, present many changes and improvements that will be of interest.

The main frame, or casing, is built oil tight, making it possible for the gears to be run in an oil bath. It is designed to be separated on a horizontal plane directly between the two shafts; the upper and lower half being doweled and held together by screws. The gear casing has planing pads running its entire length on four sides; these are drilled and tapped, to receive a form of hanger which can be attached to the top for bolting it to the ceiling; to the sides for bolting it to the wall, and to the bottom for mounting it directly upon the floor. The planing pads are also a great convenience in attaching the gear casing directly to the side of a machine tool.

In using the device as a regular countershaft, it is only necessary to have the gear casing and necessary hanger for attaching it. The usual cone-pulley countershaft may be cut off at the cone and attached to shaft "A" of the speed changer by a coupling thus avoiding the extra expense of the pulleys otherwise necessary. The operating handle may be extended up or down to within easy reach of the operator of the machine to be driven.

This device is well illustrated in the engravings, Figs. 56, 57 and 58. Fig. 56 is an interesting and comprehensive view; it illustrates the device with a part of the case cut away to show the interior. Fig. 57 is an end elevation of the exterior and Fig. 58 presents a longitudinal and a cross section of the device.

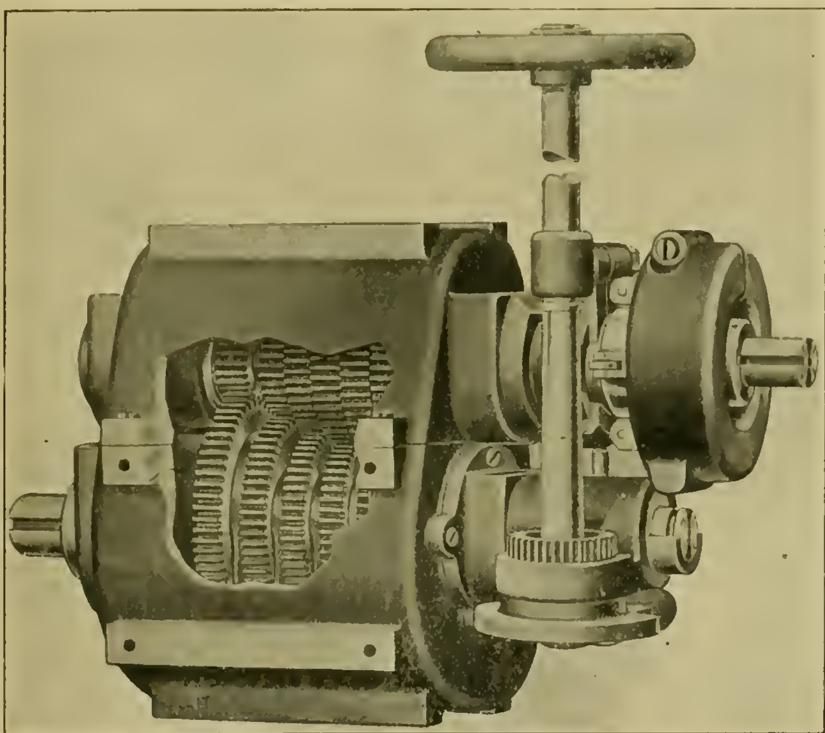


FIG. 56.—GENERAL VIEW OF THE NEW SPEED CHANGER, SHOWING PADS FOR ATTACHING TO HANGER OR MACHINE.

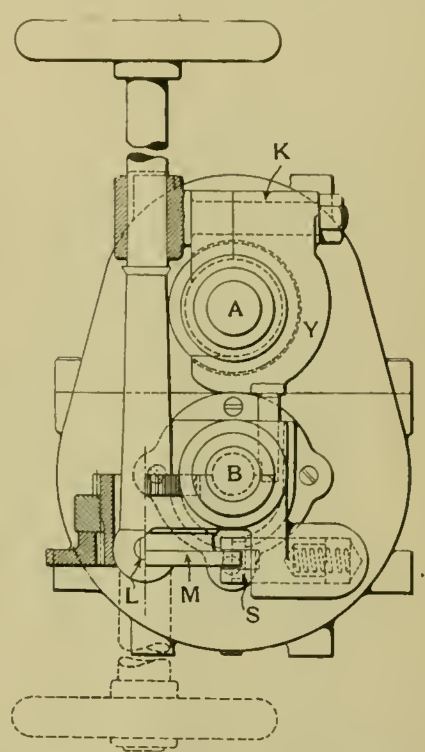


FIG. 57.—END ELEVATION SHOWING OPERATING HANDLE MECHANISM, AND PLUG ATTACHMENT, S.

As may be seen from these the upper shaft, A, is the driving shaft, while the lower shaft, B, delivers to the driven machine. Shaft A, carries the solid cone, C, of five gears, running loosely upon it, and at its left end has a small pinion, G, cut on it to mesh with large gear, H, on the lower shaft.

The important feature of this device is that it is so arranged that while a change of speed is being made the slowest speed of the series is always in action; that is, in changing from one speed to any other of the series the friction clutch, K, on the upper shaft is released and the speed will diminish until the slowest speed is reached, continuing at that speed until the desired speed is selected, which speed will become operative the instant the friction is re-engaged. The changing is performed as follows:

The lower shaft which is of tool steel, is made with an enlargement at about the center, which enlargement is beveled at both edges and is provided with tool-steel spring keys to clutch into the seats cut into the bores of the loose gears. The lateral motion of the enlargement, N, of the lower shaft imparts vertical motion to the gears meshing and unmeshing them from their mates above as it passes through their bores. This lateral motion is imparted to the lower shaft through a rack sleeve cut on it at the right-hand end, and a gear meshing therewith, which receives the ball seated lever, L. This lever carries a hand wheel, which can be arranged either above or below the casings as is shown by the dotted lines.

The gears on the upper shaft, with the exception of the small pinion, G, turned on shaft "A" is controlled by the friction clutch, K, which is operated by lever, L, on shaft, A. The

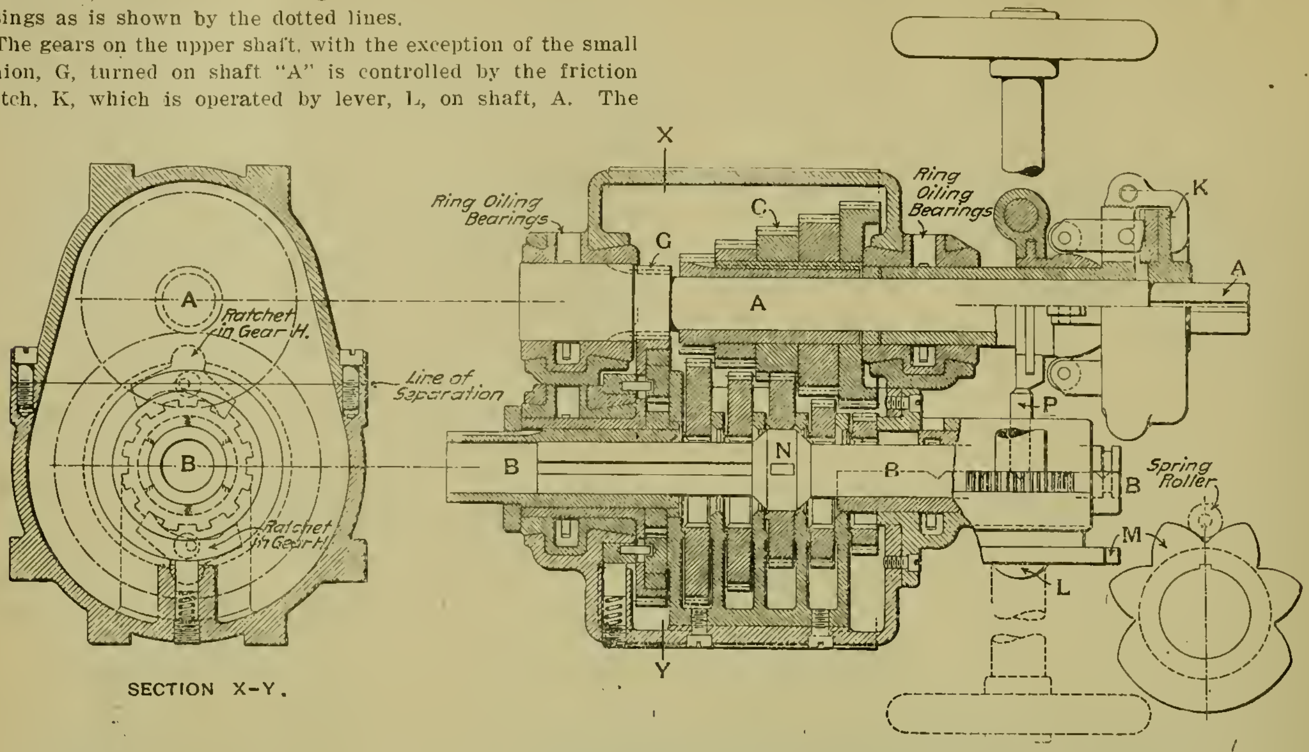


FIG. 58.—CROSS AND LONGITUDINAL SECTIONS OF THE NEW SCHELLENBACH SPEED-CHANGING MECHANISM, SHOWING MODE OF OPERATION, AND DETAIL OF CAM, M.

largest gear of the lower cone is always in mesh with gear, G, and transmits the slowest speed to the lower shaft by a ratchet device, the pawls of which are carried by it. The ratchet, which is really a part of the lower shaft, will always revolve faster than the pawls, when any speed higher than the slowest is used and will thus be running idly at those times, but the moment that friction clutch, K, is released by lever, L, however, the lower shaft will slow down until it reaches a speed equal to that of the pawls. The pawls are automatically reversible so that they will be effective when running in either direction.

When friction, K, is engaged the lower portion of the yoke Y, which operates the cone, rests directly on the top of plug, "P", the lower end of which is beveled to fit into the notches of the sliding rack sleeve which operates the lateral motion of the lower shaft. This makes an effective locking device, which compels the releasing of the friction and thus taking all load off the gears while a change of speed is being made; it also prevents the locking of the friction if the change is only partially completed. A spring seated plug secured to the rack gear and carrying a roller which engages cam M, determines the proper lateral adjustment of the lower shaft.

This device may be connected directly to an electric motor to give mechanical speed changes of ratios arranged in geometrical progression, of from 8 to 1 down to 2 to 1. The ratios and number speeds may be arranged to suit almost any condition, with this construction, and the hand wheel then indexed to correspond with the speeds.

This speed changer is built in six sizes to transmit from one-half to ten horsepower running at 375 revolutions per minute. An idea may be gained of its sizes for the different capacities by reference to the following dimensions:

DIMENSIONS OF THE VARIOUS SIZES OF SPEED CHANGERS.

Horse-power. 375 R.P.M.	Pitch Gears.	Diam. Shafts A. and B.	Length of Bearings.	Length, Case.	Length, Total.	Width, Total.	Height, Total.	Distance between Shafts.
½	14	13-16	1¾	4 11-16	12	5⅝	7¼	2½
1	12	1	2⅜	6¾	16	6⅝	8½	2 11-12
2	10	1 3-16	3	8½	21⅞	8	10½	3½
4	7	1 7-16	3⅝	10¼	25⅜	11	14¾	5
7	6	1 11-16	4¼	12	29½	13½	17½	5 5-6
10	5	1 15-16	5	13¾	35	16	21	7

As will be noted from the above table of sizes, the length over all on a changer of ½ horsepower is but 12 ins., while on the largest size made, 10 horsepower, the length is but 3 . ins. All gears used are made of mild steel forgings.

The principal object of the National Machine Tool Company in bringing out this design of speed changer has been to make it adaptable to the many varied conditions of driving and to also produce a design which can be manufactured as an article of stock and sold in standard sizes suitable to meet the requirements of the trade. With a view to ascertaining the needs of machinery builders and users W. L. Schellenbach, president and general manager, recently made an extended tour of a large number of works in this country and this device is intended to fill a long felt need.

PERSONALS.

Mr. P. P. Wright has resigned as assistant general manager of the Lake Shore & Michigan Southern.

Mr. A. H. Babcock has been appointed electrical superintendent of the Southern Pacific, with headquarters at San Francisco, Cal.

Mr. W. G. Wallace has been appointed superintendent of motive power and cars of the Duluth, Missabe & Northern, with headquarters at Proctor, Minn., to succeed Mr. William Smith, resigned.

Mr. W. K. High, master mechanic of the Cleveland, Cincinnati, Chicago & St. Louis at Mount Carmel, Ill., has been transferred to the Wabash shops of the company to succeed Mr. W. J. Thomas, resigned.

Mr. C. S. Hall has been appointed master mechanic of the Boston & Maine at Springfield, Mass., succeeding Mr. Aiken. Mr. Hall has been with the Boston & Maine for over thirty years, having filled various positions in the operating and motive power departments, including sixteen years as engineer.

The many friends of Mr. O. H. Reynolds, formerly connected with the American Locomotive Company, will be pleased to learn that he has joined the editorial staff of the *Railway and Engineering Review* of Chicago. He will be their editorial representative in the East, with headquarters at 140 Nassau street, New York City.

MOTOR-DRIVEN MACHINE TOOLS.

Planer Driving by Electric Motors.

The conditions under which the metal planing machine is operated are such that the problem of motor driving presents some features quite different from most other machine tools. Anyone who has opportunity to compare the planing machine of to-day with one built twenty years ago, will be struck with the fact that, while it has in some ways been considerably improved, in other ways the rate of advance has not kept pace with some other machine tools. The planing machine has been, and is yet considered, by some, a mechanical absurdity, in that a heavy piece of work must be moved to and fro under a cutting tool, which with its holder is comparatively light. The critics say: Why not move the tool and its holder over the work?

It is often said that the link motion of a locomotive is one of the most imperfect devices ever put upon a machine, but it must be considered that if any device existed that would fulfill

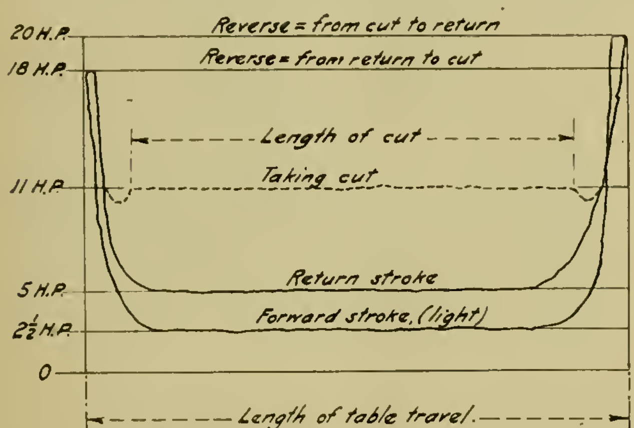


Fig. 1.—Diagram Indicating the Demands for Power Occurring in a Planer Drive During a Cycle of its Operation.

in a better manner all of the requirements of the link motion, it would have been generally adopted long ago. So it is with the planing machine, the faults of which are generally admitted, but until some better method of handling such work is devised it will continue pulling and pushing the work under the tool.

The conditions to be considered when arranging for a planing machine drive are as follows: A heavy platen or table with the work secured to it is first to be moved under the cutting tool; then the forward motion must cease and the direction of motion be reversed; and then the platen and all of its driving parts must be moved in the opposite direction, at as high a rate of speed as possible. The older type of planing machines usually were operated with cutting speeds of anywhere from 16 to 24 ft. per minute, and return speeds of about double the cutting speeds. Within recent years, however, much higher cutting speeds have come into use, until, for cast iron, 30 or 40 ft. for roughing, and from 40 to 60 ft. per minute for finishing cuts are not uncommon. The reverse speed also has in many instances been very much increased. The amount of increased speed and the successful operation of the same varies greatly with the different types and makes of planing machines.

It is the intention at the present time, however, to go into a study of the merits of the various types of driving of this class of machine tools by electric motors. The conditions to be met are, as above stated, a platen and its load to be moved under the cutting tool, then reversed and returned. This cycle of operations may be very comprehensively illustrated, in a general way, by a diagram, the diagram to be laid out with horizontal lines at heights which will represent proportionally to a scale the amount of power required for each operation of the cycle. Such a diagram is presented in Fig. 1. The curves of change from one line to the other are drawn approximately only; to get a correct curve from such an action it would be necessary to have an elaborate form of recording apparatus. The diagram shown represents the power required by a certain planer and is given only as an example.

The power required to move the platen forward with no cut was 2½-h.p. To move the platen through return motion at three times the cutting speed, 5-h.p. were used. At the moment of reverse from forward to return the power used increased suddenly to 20-h.p.; at the reversal from return to forward motion the power increased to 18-h.p. With this particular machine the gross power required to take the cut during a test was 11-h.p. The motor used was rated at 10-h.p.

While this diagram is not an accurate representation, it serves to show graphically the varying power demands upon the motor. It will be noticed that twice during one cycle of the platen's movement, the motor must furnish about double its power capacity. The motor may stand this all right, but if it does not then additional power must be furnished momentarily from some other source. Again, if the motor does stand the extra load all right, the excess amount of energy suddenly demanded by the motor may produce detrimental effect elsewhere in the power circuit. In either case, the extra power needed may be most easily provided by a fly-wheel placed upon the motor shaft or upon some part that is driven by the motor.

Most planer builders recognize the need of such a device

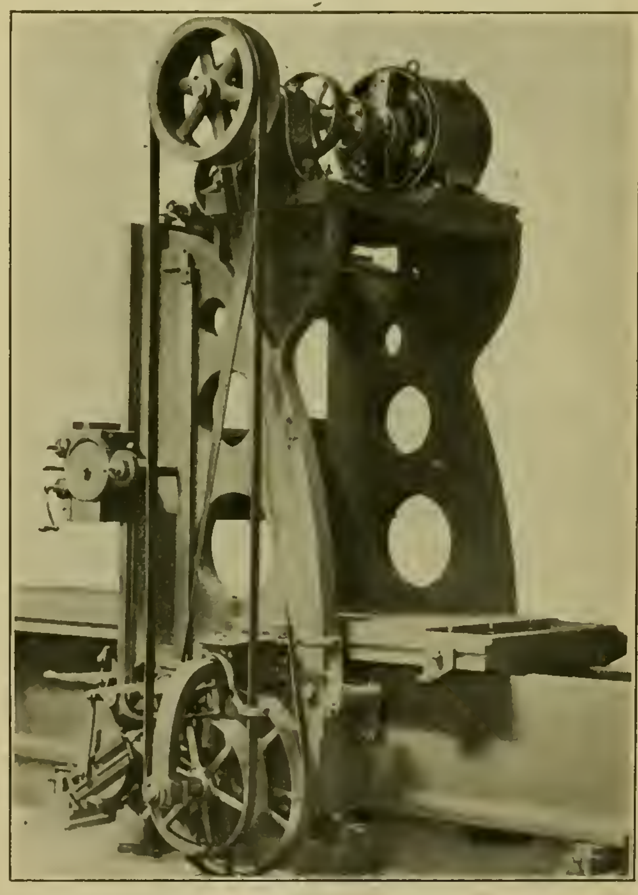


Fig. 2.—Direct-Connected Motor-Drive upon a Gray Planer, Showing Use of Flywheel. Bullock Constant Speed Motor.

and provide for it in some suitable manner. But the question as to how to apply a motor to a planing machine is regulated sometimes by the buyer, and sometimes by the builder; and the lack of uniformity as to sizes and speeds, for motors having the same power rating, leads to corresponding lack of harmony in their application.

Theoretically the correct plan would be to have a reversible, variable-speed motor attached directly to the gearing of the planer, the stopping, reversing and restarting of the motor to be accomplished by means similar to the usual device used for shifting the belts of the present type of machine. A device of this kind offers many advantages, and some years ago one was patented, but it has never been tried to any extent in practice. Obviously the practical objections to this desirable plan are very great.

The general practice at the present time is to retain the usual design of planer with belt driving and shifting mechanism, with the belts driven from a motor-drive countershaft. The question is, as to what is the best plan to follow; no universal method can be suggested that will suit all cases or meet all requirements.

There are various ways by which this arrangement can be effected: First, by making the connection between the motor and countershaft direct; this usually requires a motor of special design which will run at the required countershaft speed. This is the simplest method, as by its use all belts, chains or gears can be done away with. The second method is for the motor to drive the countershaft by means of chain or gears; this allows the motor and countershaft to be brought close together. A third method becomes desirable if the motor is to be placed at some distance from the countershaft, when the connection may be by belt.

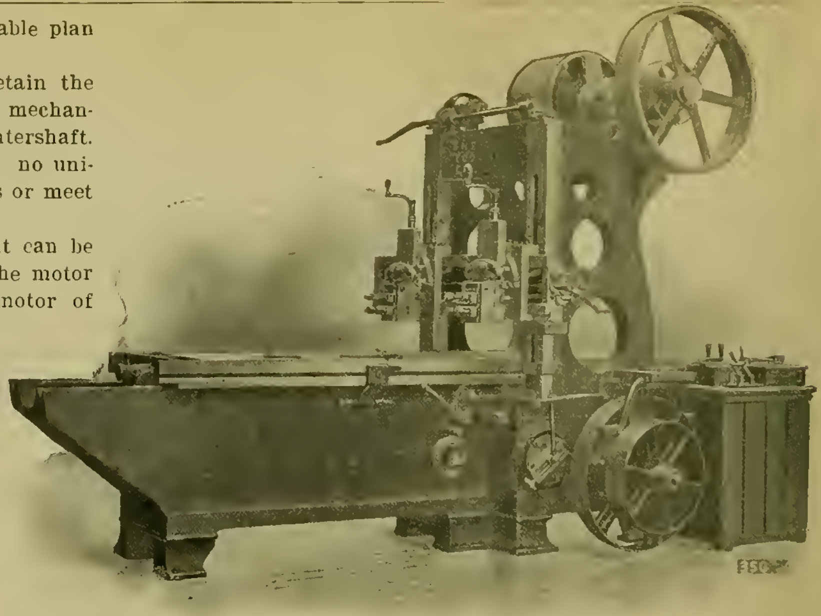


FIG. 3.—DIRECT CONNECTED MOTOR DRIVE UPON A PLANER BUILT BY THE AMERICAN TOOL WORKS COMPANY, SHOWING USE OF FLYWHEEL. BULLOCK CONSTANT-SPEED MOTOR.

With either of these three plans a standard motor can be adopted and run at its rated speed, the speed reduction between motor and countershaft being provided for in the chain, gear or pulley-drive. Whether the lower cost of standard motor, with connecting attachments, renders its selection advisable as against a motor of special design is a question; if the cost were anywhere near equal it would in most cases be best to use the slower speed motor and direct attachment.

The most suitable location for a motor in planer driving will depend upon existing conditions. Where a machine already in use is to be changed from belt to motor drive, the motor can be placed upon the ceiling, or upon the floor and belted to the countershaft. Frequently, however, it is desirable to have the head room free for cranes, etc., in which case the motor can be set upon brackets secured to the housings of the planer. Many of the points above noted are illustrated by the accompanying views of motor-drive applications to planers.

Fig. 2 shows a spur-gear driven planer, built by the G. A. Gray Company, Cincinnati, Ohio, as arranged for motor driving. This machine has the motor, a Bullock motor operating at a constant-speed, located upon a platform which is carried by brackets that are cast integral with the housings. The usual form of countershaft is here replaced by one that is coupled directly to the motor. This shaft carries the pulley for operating the crossrail elevating mechanism, as well as those for driving the machine. In this case the motor is of a special design to run at a speed to suit the countershaft.

One advantage of placing the motor in the position shown is that it is out of the way, and there is no danger of dirt and chips being swept into it. From a critical standpoint it might be said that the overhang of the driving pulleys outside of the bearing was objectionable, but this can be met by use of a sufficiently long bearing and a shaft of sufficient diameter, as is evidently done in this case. The use of one of the driving pulleys as a balance wheel to assist the motor is the noticeable feature of this drive. Taken altogether the entire design of this drive forms a very neat and compact arrangement.

In Fig. 3 is presented an illustration of a motor driving application to a planer built by the American Tool Works Company, Cincinnati, Ohio. In this drive also the motor is direct-connected to the countershaft, so that the above considerations referring to the planer in Fig. 2 are applicable here also. The motor used in this case is likewise a Bullock constant-speed direct-current motor, and the pulley forms a heavy flywheel to assist the motor at reversals.

With this machine the switch, starting box and circuit breaker are mounted upon a stand placed in the rear of the driving pulleys. It would seem to be more convenient if, with any of these drives, the switch and starting box could be placed upon the side of bed near the reverse lever and properly protected from dirt. In this position they would be within easy reach of the operator.

Fig. 4 shows a drive upon a Gray planer in which a silent chain is used as the connection between the motor and countershaft. As before mentioned, this arrangement allows the use of a standard motor of high or moderate speed, the reduction in speed being provided for by making the sprocket wheels of the proper ratio. The difference in cost between a standard motor, with the extra cost of chain, or gears, etc., may be enough less than a special motor to justify the use of the standard type; but all other things being equal or nearly so, the direct connection from the special motor seems to be the better plan.

In this case a General Electric direct-current motor is used. The countershaft is carried by inverted hangers upon a platform supported by the housings.

With a spiral geared planer the driving pulleys are set with their axis parallel to the bed and platen, and the arrangement of motor must be somewhat different from that of the above

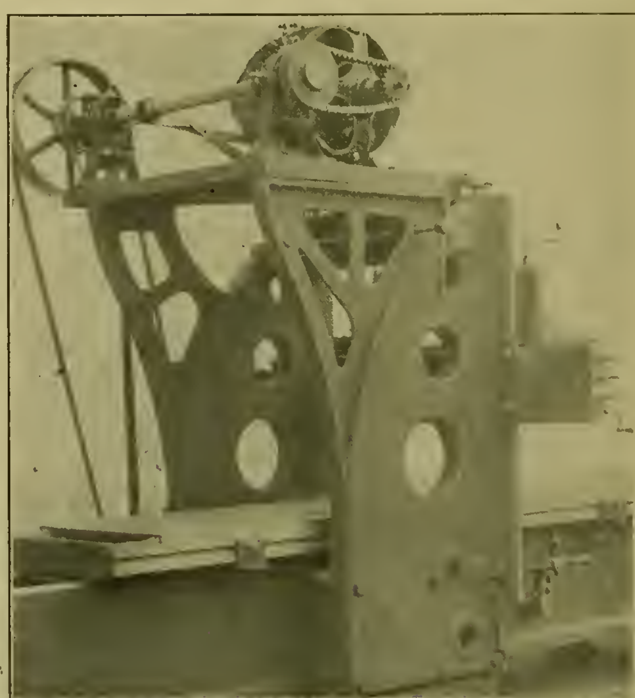


FIG. 4.—A MOTOR APPLICATION TO A GRAY PLANER, USING THE CHAIN-DRIVE. GENERAL ELECTRIC MOTOR.

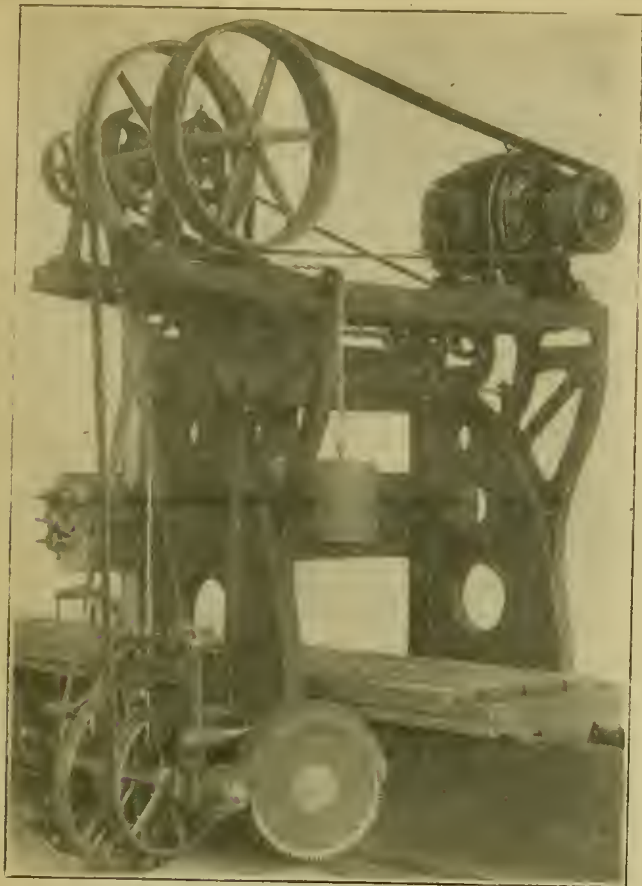


FIG. 5.—BELTED DRIVE UPON A GRAY PLANER—FLYWHEELS STILL RETAINED. JANTZ & LEIST CONSTANT-SPEED MOTOR.

types. Fig. 5 shows a planer of this class, also built by the G. A. Gray Company, with the motor belted to the countershaft. The motor, in this case a Jantz & Leist constant-speed motor, sets upon a sub base and can be adjusted for taking up the slack of the belt. With this arrangement the belt can be cemented instead of laced, so that it will run smoother than otherwise. While the belt drive is probably cheaper than the

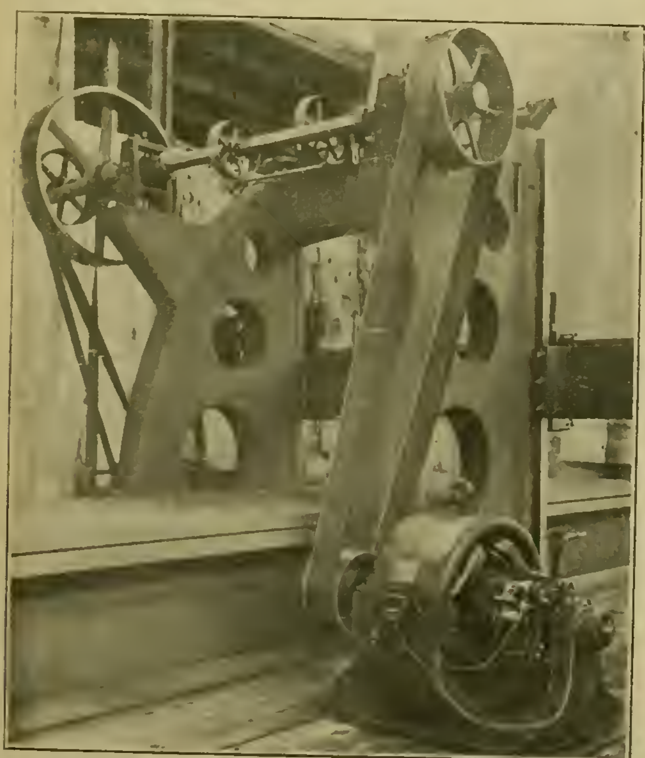


FIG. 6.—BELTED DRIVE UPON A PLANER BUILT BY THE BETTS MACHINE COMPANY, SHOWING USE OF FLYWHEEL.

chain or gear drive, it requires more attention than either of the others.

It will be noticed also that with the three above described arrangements, an advantage is gained in that the supporting brackets can be utilized as supports for the counterweights when side heads are used, making a more sightly appearance than when they are carried up to the ceiling. The latter style of drive does not have the compactness of that shown in Fig. 2, however, the difference being accounted for by the difference in design of the two machines.

For belted drives, that shown in Fig. 6 is undoubtedly more desirable. In this application, which is upon a planer built by the Betts Machine Company, Wilmington, Del., the motor is set upon the floor and belted up to the countershaft. The countershaft is here supported by inverted hangers carried upon brackets cast upon the housings. It will be noticed here

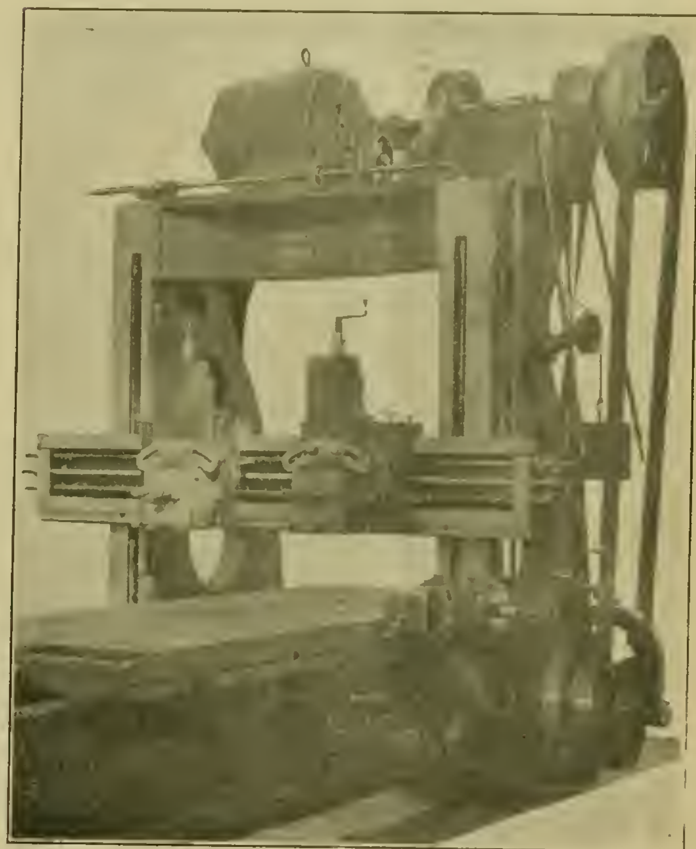


FIG. 7.—GEARED DRIVE UPON A PLANER BUILT BY THE CINCINNATI PLANER COMPANY, USING GEAR BOX FURNISHING VARIABLE CUTTING SPEEDS AND CONSTANT RETURN. JANTZ & LEIST CONSTANT-SPEED MOTOR.

also that a pulley with a heavy rim is used to obtain the flywheel effect to assist the motor at reversals.

One feature in connection with planer driving is not usually given the attention it deserves—that is a variable cutting speed to the platen. Usually when this is provided for, the return speed is affected also, but it should not be the case, as too high a return speed frequently makes trouble. There are devices upon the market by use of which the cutting speed can be made variable, while the return speed is constant; this is the proper method. With the motor drive this result may be obtained in several ways.

Figs. 7 and 8 illustrate a motor-driven planer of the Cincinnati Planer Company, Cincinnati, Ohio, which is equipped with the device for giving a variable cutting speed and a constant rate of return speed. The device consists essentially of a gear box containing a set of driving and driven gears of different ratios, which are used in connection with the usual pulleys for driving the platen forward and back.

The connections between the gears are changed by means of the two levers shown at the side of the machine in Fig. 7.

The advantage which comes from thus being able to change the cutting speed to suit a varying class of work should be readily apparent. While many planers used upon a regular line of work are all right with but one speed, there are many cases where a variable speed machine can be used with profit.

The motor in this case can be of standard design and runs

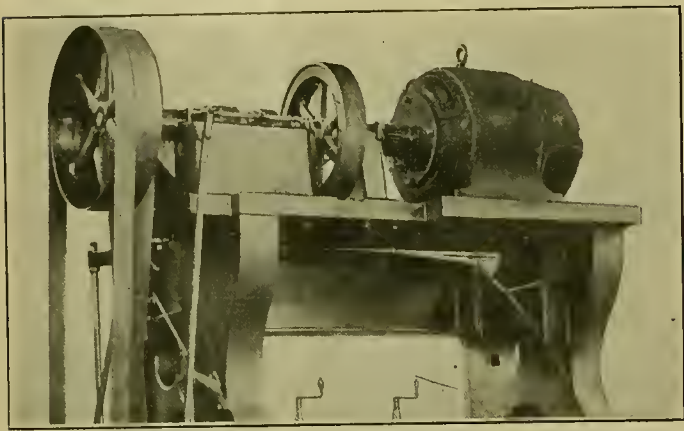


FIG. 8.—REAR VIEW OF THE GEARED DRIVE UPON THE CINCINNATI PLANER, SHOWING GEAR BOX, AND ALSO THE HEAVY FLYWHEEL.

at a constant speed, and is connected to the rear or constant-speed shaft by gears that are proportioned to give the desired rate of return speed to the platen. Besides the return driving pulley, an unusually heavy fly-wheel is also located upon this shaft.

The subject of motor driving is comparatively a new one, and, while both the users and the builders are doing all they can to arrive at the best results, we must look to the future for a satisfactory solution of the problem.

WATER SOFTENING—UNION PACIFIC RAILWAY.

Important records, obtained in the use of eleven Kennicott water softeners on the Union Pacific, were placed before the Associations of Superintendents of Bridges and Buildings at their recent convention in the following report, showing the actual results. This report is signed by Mr. J. B. Berry, chief engineer of the road. A noteworthy feature is the plain statement of cost as presented in the accompanying table.

magnesia and the non-incrusting solid sodium sulphate. The water from each station to be treated is analyzed and solutions are prepared of the proper strength for treating these waters. These solutions are introduced automatically into the untreated water in the proper proportion for the volume of water passing through the softener. As time is an important feature in chemical reaction, the water towers are constructed of a size to allow ample time for reaction in passing through the tower. The treated water flows off through a pipe at the top of the tower to the regular railway storage plant.

"The cost of chemicals for treating waters will vary with the analysis. By referring to the table, you will note that this cost varies from 0.3 to 3.6 cents. In the ten plants we are treating 1,441,000 gallons per day at an average cost of 1⅛ cents per thousand. By referring to the table you will note that the waters containing the larger quantities of sulphates of lime and magnesia are the most expensive to treat. At the same time it is worth more to remove these sulphates of lime and magnesia, as they form the hardest scale and are the most difficult to remove from boilers. The additional cost for labor is but little, one man being added to the rolls as an assistant to the chemist and whose duty it is to keep on the road visiting the various softeners and seeing that they are properly attended to. The preparation of solutions is attended to by the regular pumpers at all except gravity supplies and where city water is used. At such places some other employee is delegated to attend to this matter, as it does not take more than half an hour daily at the largest plants.

"The saving in boiler repairs certainly warrants the expenditure of the amount necessary to treat the waters at all points where we either have or are erecting water softeners. Another saving is in locomotive fuel, which will be no small item as the evaporative power of boilers will be increased or, as locomotive firemen express it, "she steams easier."

"The value of treating will depend on the quantity of water used daily and the character of such water. While we have been unable to state in exact figures the saving to the company, we are satisfied that at any point where 75 pounds or more of incrusting solids can be removed from the water daily, it is an economy to treat such water.

"Referring to the table again, in the ten plants we are removing 2,790 pounds of solids per day. Cost of chemicals for this work is 58¼ cents per hundred pounds of incrusting solids removed. Even though this figure were doubled it would still be an economy, as any experienced man knows that 100 pounds

UNION PACIFIC RAILROAD.

Statement Showing Results Obtained in Treating Waters for Boilers, Giving Analyses Before and After Treating, in Grains per Gallon, and Pounds Incrusting Solids Removed Daily at Each Plant.

	Council Bluffs, Ia.		Valley, Neb.		Columbus, Neb.		Grand Island, Neb.		Kearney, Neb.		North Platte, Neb.		Julesburg, Colo.		Sidney, Neb.		Cheyenne, Wyo.		Point of Rocks, Wyo.	
	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.
Silica	1.97	1.57	1.73	1.81	2.54	1.84	1.49	1.52	2.42	2.00	2.86	2.01	2.83	2.27	3.17	2.92	2.42	2.19	1.92	.63
Oxides of iron and aluminum	2.33	.36	.13	.06	.44	.47	.44	.21	.20	.15	.26	.26	.11	.35	.44	.12	.14	.15	.39	.20
Calcium carbonate	14.19	1.48	6.52	1.93	14.22	1.20	5.42	2.50	10.01	1.33	7.94	1.98	7.40	1.28	6.68	1.45	9.29	1.31	8.19	2.55
Calcium sulphate	8.32	...	1.19	...	1.67	...	1.86	...	1.10	...	4.53	...	2.10	...	2.14	...	...	...	...	...
Magnesium carbonate	.84	1.50	1.46	.54	2.94	1.43	.79	.54	2.24	1.26	1.35	1.08	3.56	.96	2.16	.44	2.34	.91	4.08	.88
Magnesium sulphate	10.35	...	.95	...	2.81	...	1.41	...	.38	...	2.43	...	1.74	...	.44	...	...	...	3.47	...
Total incrusting solids	38.00	4.91	11.98	4.34	24.62	4.94	11.41	4.77	16.35	4.74	19.37	5.33	17.74	4.86	15.03	4.93	14.19	4.56	18.05	4.26
Non-incrusting solids	9.00	29.37	3.74	5.38	6.12	15.61	2.10	7.88	5.33	10.28	9.12	19.89	7.52	13.93	1.78	10.47	2.46	3.91	23.74	27.26
Total solids	47.00	34.28	15.72	9.72	30.74	20.55	13.51	12.65	21.68	15.02	28.49	25.22	25.26	18.79	16.81	15.40	16.65	8.47	41.79	31.52
Cost of chemicals per 1,000 gals.	3.6 cts.		0.4 cts.		1.3 cts.		0.9 cts.		1.1 cts.		1.2 cts.		1.3 cts.		0.9 cts.		0.3 cts.		1.0 cts.	
Gallons water treated per day	130,000		89,000		140,000		180,000		56,000		170,000		122,000		140,000		270,000		144,000	
Incrusting solids removed per day	615 lbs.		96 lbs.		393 lbs.		171 lbs.		93 lbs.		340 lbs.		224 lbs.		202 lbs.		372 lbs.		284 lbs.	

"We have in operation on the Union Pacific Railroad eleven Kennicott water softeners, varying in size from a capacity of 8,000 gallons per hour to 20,000 gallons, and are erecting twenty-five more softeners at the rate of about three per month. I enclose herewith a table showing the results obtained at ten of the plants that have been established for some time.

"The water is treated by the cheapest of chemicals, common lime being used to precipitate the carbonates of lime and magnesia, which are held in solution because of carbonic acid in the water; soda ash is used to react on the sulphates of lime and magnesia, producing the insoluble carbonates of lime and

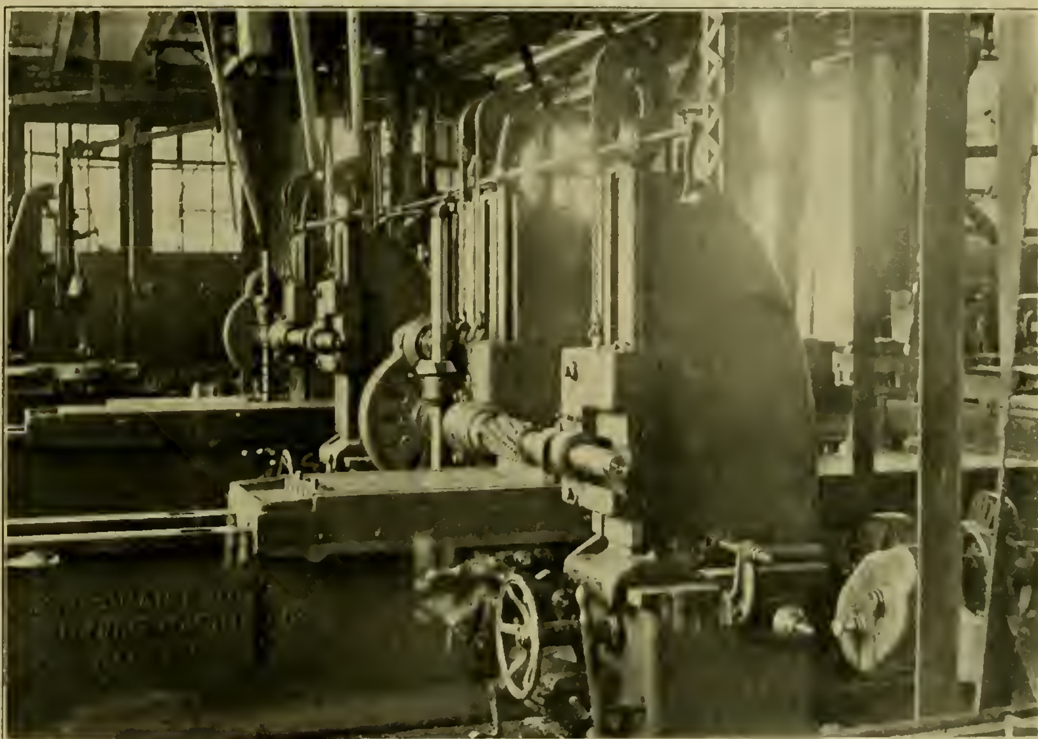
of scale cannot be removed from boilers for any such figure.

"The analyses of water shown in the table were made in the laboratory of the Union Pacific Railroad and show the average results we are obtaining when plants are properly looked after. Weekly analyses are made in order to keep check on the employees and see that they are properly attending to their duties. Besides this check, the traveling assistant to the chemist is liable to visit the plants at any time without giving notice and, as he is provided with a simple outfit for making tests, the character of the work is kept up to a good standard.

THE PLANER-TYPE MILLING MACHINE IN RAILROAD SHOPS.

Topeka Shops.—Atchison, Topeka & Santa Fe Railroad.

The recent increasing use of the slab milling machine in the railroad shops of this country is worthy of note as attesting the interest that is being taken in improving machine shop performances and securing increased outputs. For many classes of work such as the surfacing of side rod and other large forgings of steel, this horizontal type of milling machine is most efficient and rapid; with the inserted tooth milling cutter, results are being obtained with this class of tool which cannot even be paralleled by the planer.



VIEW OF THE TWO 26 BY 32 INS. BECKER-BRAINARD PLANER-TYPE MILLING MACHINES AT THE TOPEKA SHOPS.—ATCHISON, TOPEKA & SANTA FE RAILWAY.

In the accompanying engraving we present a view of a portion of the heavy tool section of the new Topeka shops of the Santa Fe, showing two large planer type milling machines which were built by the Becker-Brainard Milling Machine Company, Hyde Park, Mass. Owing to the importance of the classes of work to which these tools are applicable, a description of them will be of interest.

These two machines are both the standard 32 ins. by 26 ins. by 10-ft. bed horizontal milling machines of the Becker-Brainard Company, which are especially designed for the extremely severe work that is encountered in railroad shops. This design of tool is intended to fulfill the most exacting requirements of the new high-speed tool steels and withstand the heaviest modern machining operations. It is of very heavy construction, strength, rigidity and power being aimed at. The bed is extra deep, extending to the floor for a solid foundation, and is securely braced by heavy cross girders inside, evenly spaced.

The spindle is 5 ins. in diameter, of hammered crucible steel, has a threaded nose and runs in self-centering bronze boxes with an adjustment to compensate for wear. The spindle carrier is very heavy and is held firmly to the upright by long gibs. It is elevated by a screw with adjustable dials graduated to thousandths of an inch and has counterbalance for ease of operation. The spindle is driven by a 5-in. belt on a five-step cone, giving gear ratios of 13½ and 27 to 1. By means of a hand lever and quick change gearing the speed is easily adjusted, 20 changes of speed being thus available.

The table is of a very heavy design, and is built with five T slots lengthwise and an oil channel the full length and at each end. It travels on flat ways with heavy gibs, and has a quick return motion operated by power from a separate countershaft; it can also be moved by the usual hand wheel.

The feed motion of the table is operated directly through a positive gearing drive from the main driving cone, giving a range of feed through eight changes from 3-64 to 3-8 ins. These changes of feed can be made instantly by means of a lever without stopping the machine.

The principal dimensions of this interesting type of tool are presented below:

SPECIFICATIONS:

Working surface of platen	120 ins. x 26 ins.
Length of bed	168 ins.
Longitudinal feed, automatic in both directions	120 ins.
Greatest distance from center of spindle to table	28 ins.
Least distance from center of spindle to table	2 ins.
Greatest distance from end of spindle to center of table	16¾ ins.
Least distance from end of spindle to center of table	6¾ ins.
Greatest distance from end of spindle to tail stock spindle	37 ins.
Least distance from end of spindle to tail stock spindle	17 ins.
Net weight	25,000 lbs.

THE MACHINE TOOL OUTLOOK FOR 1904.

With the large number of improvements that are planned for this year by the railroads, little apprehension need be felt for a continued activity of the machinery trade among railroad shops. A large number of shops are now either in process of erection or rebuilding, and will be completed ready for the machinery in the early part of this year; on the other hand, in several instances, large appropriations for shop expenditures and for large renewals of machine tools, which have been deferred until 1904, will soon be acted upon.

The Pennsylvania Railroad Company have extensive improvements under way and are planning for still more. Extensive repair shops are under construction at Fairview, opposite Harrisburg, Pa.; it is estimated that the buildings alone for this installation will cost about $500,000. A new wheel shop and a large foundry are being built at Burket's Station, near Altoona, Pa., the principal building to be over 600 feet long.

Extensive repair shops are also planned for the New York division of the Pennsylvania, at Trenton, N. J., where a large site was purchased last year. At Wilmington, Del., the new shops in connection with the Philadelphia, Baltimore and Washington system are nearing completion and need a large amount of machinery. These are the more prominent points connected with the shop extension plan of this system which will require immediate action as to equipment this spring. Very little machinery has been purchased during the last six months in relation to the extent of the shop improvements that have been instituted on this system.

The purchases which the Erie Railroad Company have made during the latter half of last year are said to have been but a small portion of what is planned in the way of the improvement of the shop system of this road. As will be remembered, $10,000,000 was appropriated last year for improvements on the Erie. A similar amount was likewise appropriated by the Union Pacific, which road is said to be considering an elaborate scheme for shop extensions.

The large new shops in process of construction at Sayre, Pa., for the Lehigh Valley Railroad have not been provided for as to machine tools, although the traveling cranes, the power plant equipment and other important features were purchased a short time ago. The Delaware, Lackawanna & Western Railroad will also be in the market for an elaborate machinery equipment for their new car shops; the buildings are being erected at a cost of some $750,000.

Only a small portion of the equipment needed for shop improvements now under way has been purchased by the Southern Railway; this company is erecting new shops at Knoxville and Spencer, but the appropriations for the necessary machinery have so far been deferred. Specifications were issued several months ago for machine tools to cover the equipment of five large shops. The Seaboard Air Line have plans for a large shop which was deferred until this year. Their plan is to establish a system of repair, and car and locomotive-building shops at Atlanta, Ga., of a size sufficient to take care of their entire line.

The Louisville & Nashville Railroad Company have purchased a portion of the necessary machine tool equipment for their large shops which are now in process of construction at Louisville, Ky. This is a very large shop involving the most modern construction and will require an immense equipment. The steel work of several of the more important shop buildings is now completed and work will be pushed to completion early this year. This will be one of the most important railroad shops in this country.

It is expected that the New York Central and its allied lines will require a large amount of machine tool equipment as a result of their desision to modernize all of their repair shops and standardize all of their equipment, track materials, etc. Mr. J. F. Deems, general superintendent of motive power, rolling stock and machinery, is carrying out this plan. He has spent a great deal of his time visiting the various shops along the system and, while small changes have been made at various points, the work has only faily begun.

The Denver & Rio Grande Railroad system are planning to enlarge their shops at Salt Lake City, Utah, and it is reported that they will expend some $200,000. It is also stated that Wm. O. Herin, superintendent of machinery and equipment of the Missouri, Kansas & Texas Railway system, located at Parsons, Kan., has prepared extensive plans for the enlargement of the shops at Parsons. This matter is scheduled to come up for decision early this year. The rebuilding of the large shops of the Père Marquette Railroad Company, at Saginaw, Mich., was deferred until next spring, when it will probably be taken up and carried through to completion.

It is said that a large shop will be erected at Allendale, Ontario, by the Grand Trunk System, which will require a large amount of new equipment. The Wabash Railroad are also to build shops in Canada, and J. B. Barnes, superintendent of motive power and machinery, Springfield, Ill., is preparing the plans. The Chesapeake & Ohio have a project for the establishment of new shops at Clifton Forge, Va., which is said to be another case of holding back for a 1904 appropriation.

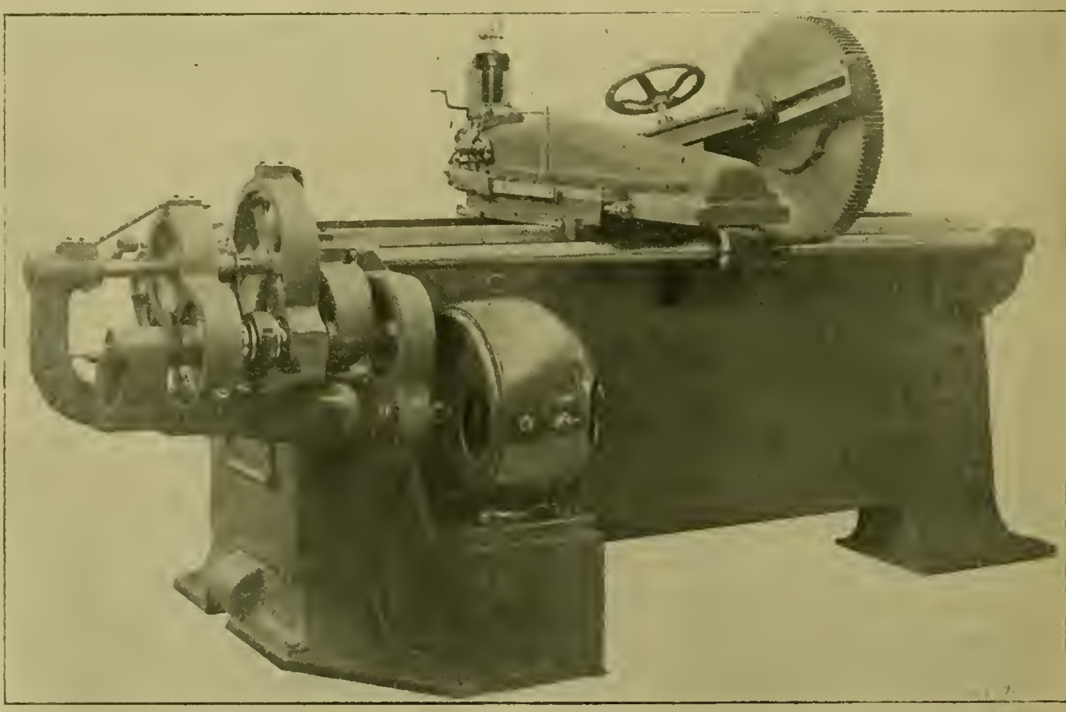
The large new car building plant, which has been under consideration by the Armour Car Lines of Chicago, is now under way. This embraces the installation of a complete shop system for the building of cars. Another car plant for which a great deal of machinery will be purchased in the near future will be built at Henderson, Ky., by the newly formed Henderson Car Works Company of that city. It is also said that the Central Car & Foundry Company will expend $200,000 on a car building plant at Vincennes, Ind., to have a large capacity for building and repairing cars.

MULTIPLE VOLTAGE DRIVING FOR A SINGLE-HEAD TRAVERSE SHAPER.

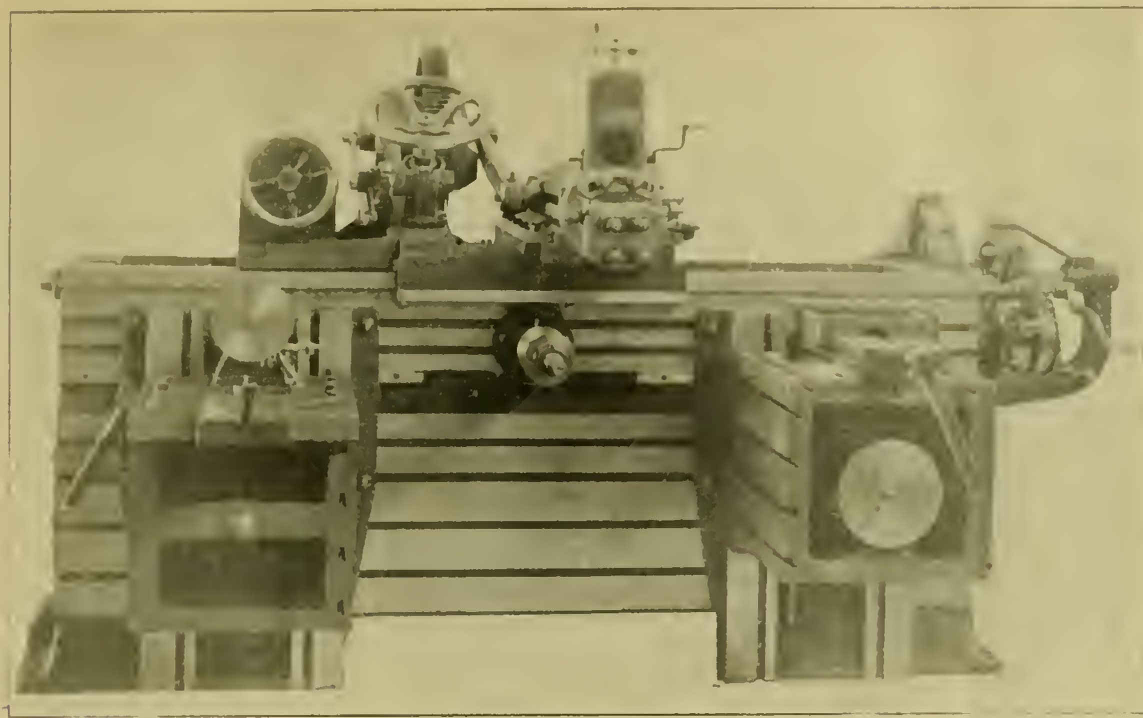
McKees Rocks Shops.—Pittsburg & Lake Erie.

In view of the very interesting series of articles by Mr. R. V. Wright, which are appearing in this journal, descriptive of the methods used for equipping the old tools at the McKees Rocks shops of the Pittsburgh & Lake Erie, these two accompanying illustrations will be of interest. These views present an interesting special design of motor driving for a single-head traverse shaper, which was built for the new McKees Rocks shops by the Cincinnati Shaper Company, Cincinnati, O., who applied to the same a convenient and neat arrangement of motor driving as shown.

Particular attention should be given to the compact arrangement of the motor and driving connections, as well as also to the arrangement of the controller for varying the speed of the motor; this arrangement of the controller upon the head is admirable for not only its convenience to the operator, but also



REAR VIEW OF THE NEW MOTOR-DRIVEN CINCINNATI TRAVERSE SHAPER FOR THE M'KEES ROCKS SHOPS OF THE PITTSBURGH & LAKE ERIE, SHOWING ARRANGEMENT OF THE CROCKER-WHEELER MULTIPLE-VOLTAGE DRIVE.



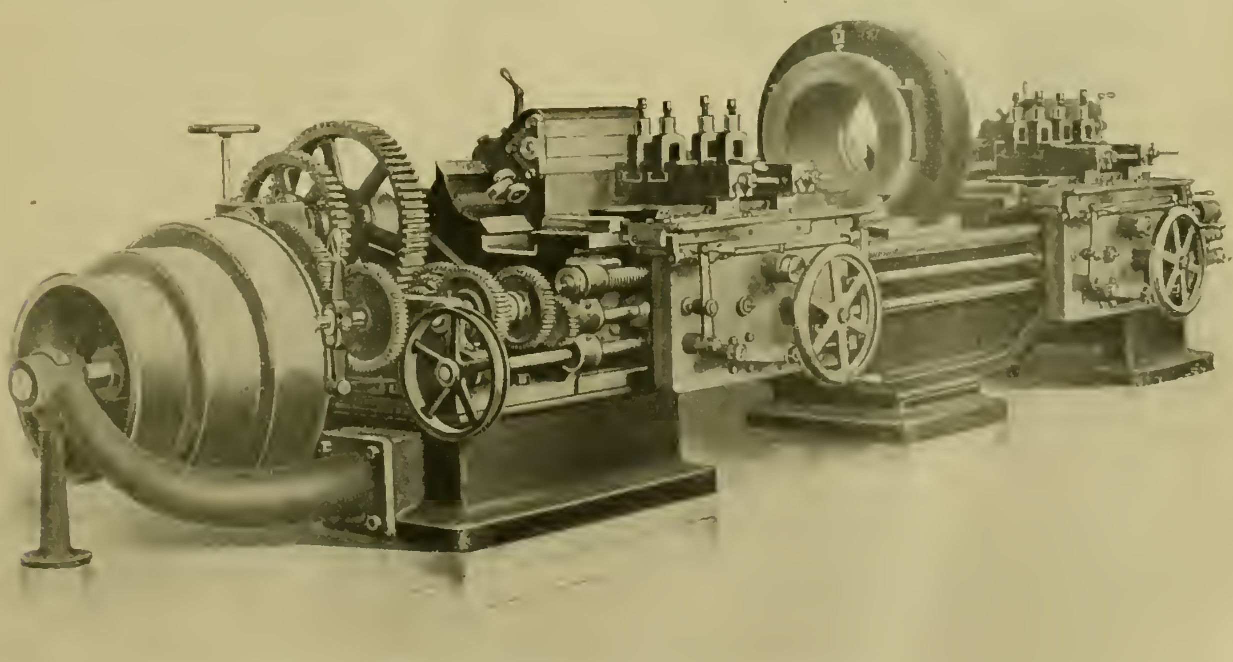
THE NEW 24-IN. TRAVERSE SHAPER, WITH CROCKER-WHEELER MULTIPLE-VOLTAGE DRIVE, FOR THE M'KEES ROCKS SHOPS OF THE PITTSBURGH & LAKE ERIE RAILROAD.—CINCINNATI SHAPER COMPANY.

for its unobtrusiveness in that position. This feature contributes greatly to the rapid and economical handling of the tool. This is undoubtedly one of the neatest motor drives that we have seen applied to a shaper.

The motor used on this tool is a Crocker-Wheeler 7 horsepower variable speed motor operating upon the 4-wire multiple voltage system. It is attached to the base at the rear of the machine as shown in the photograph. The pinion on the motor shaft meshes with a gear on an intermediate shaft, carrying a positive clutch, which may be thrown into one or the other of the two sets of gears, connecting with the driving shaft of the shaper, thus furnishing two runs of speeds. This is very clearly shown in the photograph.

The controller for the motor is mounted on a bracket attached to the saddle, as shown in the front view of the machine. With this method of attaching the controller the operator has full control of the machine when standing in position in front of it, as on this shaper all the feeds are operated directly from the saddle.

This tool, which is the standard 24-in. by 8-ft. traverse shaper, with single head, built by the Cincinnati Shaper Company, is of a very heavy and rigid design. The principal features of the traverse shapers built by this company were referred to in an article on page 425 of our November (1903) issue. The ram is operated by a Whitworth motion, giving a quick return, and is easily and quickly adjusted for length of stroke and position over work. The aprons are rigid, having a full bearing on the face of the bed, and the two tables have vertical adjustments upon the apron. One of the tables is arranged to swivel through an arc of 90 degrees for circular shaping and has a worm feed.



NEW RAPID-REDUCTION DOUBLE-END AXLE LATHE FOR THE READING SHOPS OF THE PHILADELPHIA & READING RAILWAY.—LODGE & SHIPLEY MACHINE TOOL COMPANY (SEE NEXT PAGE).

A NEW RAPID REDUCTION DOUBLE-END AXLE LATHE.

THE LODGE & SHIPLEY MACHINE TOOL COMPANY.

The accompanying engravings illustrate a double end axle lathe of an entirely new design, which has recently been built by the Lodge & Shipley Machine Tool Company, Cincinnati, O., for the Philadelphia & Reading Railway. It involves many interesting features, departing from usual practice in this class of tools, to which we desire to call attention in detail.

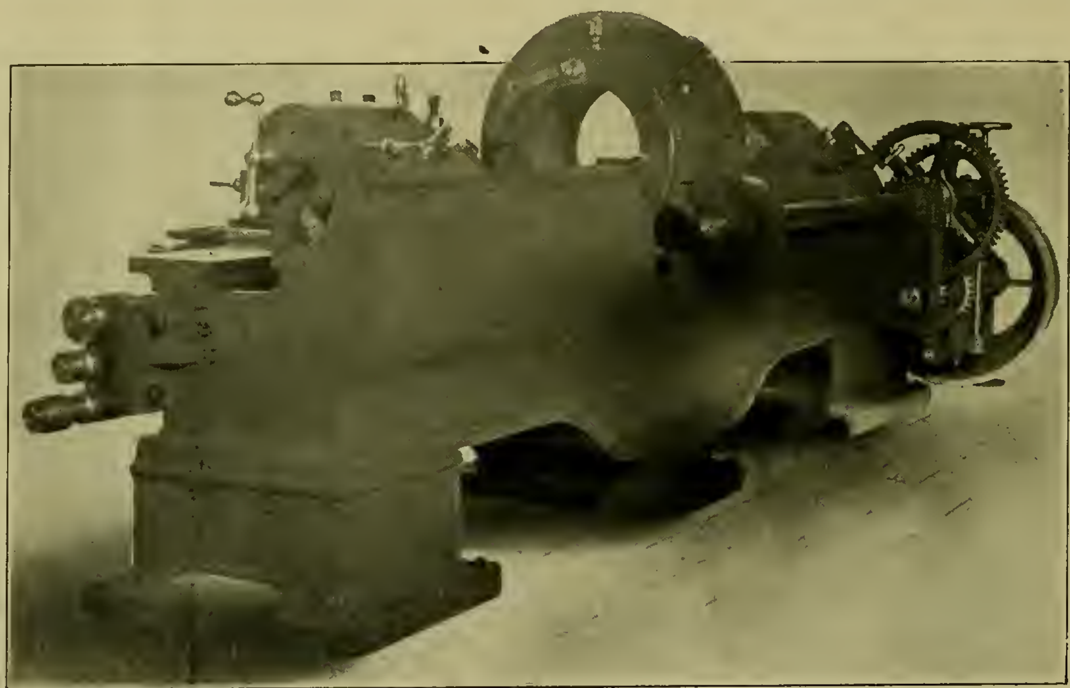
The massive construction of this new tool, which is made apparent in the accompanying engravings, gives evidence of sufficient strength provided to withstand any strain that may be placed upon the machine through the employment of the highest grade tool steels. The rapid reduction idea was also evidently kept in view throughout the entire design.

It may be noted from the illustrations that the bed is of a distinctly new and unique design, providing unusual massiveness and rigidity. Special ways set on an angle of 45 degrees are used for the tail stocks; in this way the upward pull or stress on the tail stock is received directly by the bed and not on clamping bolts. The tail stock spindle or slide is dovetailed directly into the tail stock, and to increase its rigidity is gibbed at both top and bottom.

driving gear are 6.1 to 1 and 20.9 to 1, which, with the three changes on the cone pulley, gives six cutting speeds.

The carriages are arranged to take one or more tools, which can be placed anywhere along their length and at varying distances apart. The feed, instead of being obtained through a rack and pinion, is provided by a bronze nut 14 ins. long, which completely encircles a stationary lead screw, with double thread of 1-in. lead. By revolving the nut on this screw a more powerful feed is obtained, and greater wearing qualities are obtained, than by the rack and pinion movement. The nut is revolved for the regular feed by a feed rod driven by gears from the cone pulley shaft. Another feed rod directly under this runs constantly at a high speed, being driven by an independent belt, and affords a means of moving the carriage rapidly in either direction by power instead of the slow and laborious method of the hand wheel.

At the front of the apron are three levers; the one at the left starts or stops the feed; the lever at the bottom is for reversing, and that at the right applies the quick movement to the carriage. A safety device is provided in the apron to prevent both the feed for turning, and that for the quick movement, being engaged at the same time. Automatic stops are provided in both directions for each carriage, and calipering stops can be applied to each tool for duplicating diameters; this combination does away with considerable measuring and calipering.



REAR VIEW OF THE LODGE & SHIPLEY DOUBLE-END AXLE LATHE, SHOWING THE UNUSUALLY HEAVY CONSTRUCTION OF THE BED AND BRACING FOR THE INCLINED TAIL STOCK WAYS.

The carriages are provided with separate ways from those used for the tail stocks, and are calculated to properly take care of the heavy stresses in cutting directly.

Throughout the entire length of the bed are four vertical beams, or webs, so placed that the thrusts on the tail stock act up through the two rear webs, while the two front webs come directly under the carriage and receive the entire downward pressure of the cutting tool.

The driving mechanism of this tool is particularly of interest. It consists of a three-step cone, having diameters of 20, 25 and 30-ins. by 6½-in. face, and the inner end of its shaft is connected through two changes of gearing directly to a short driving shaft at the rear of the lathe as shown. This driving shaft is geared into the central driving headgear, 30 inches in diam. by 4-in. face, mounted between bearings at the center of the bed. A special equalizing driving plate, having for an extreme a 15-in. opening through the center greatly facilitating the insertion and removal of axles, transfers the power to the axle. The ratios of gearing between the cone pulley shaft and central

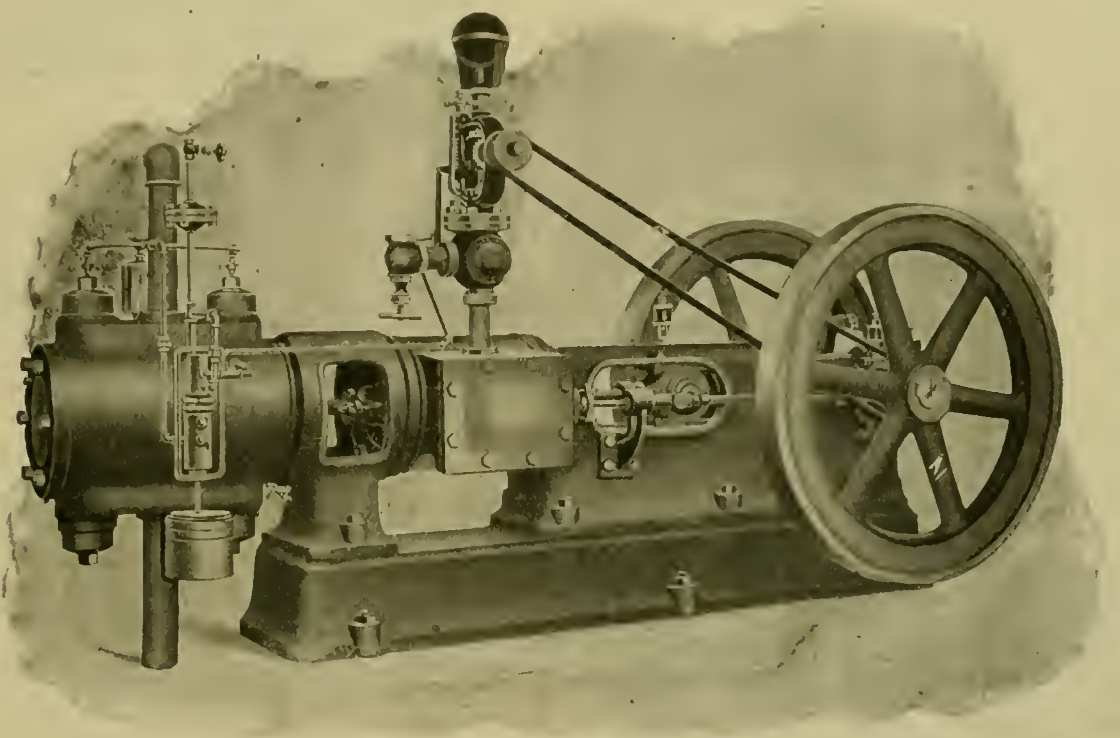
The tail stocks are shaped so as to allow the carriages to pass them when starting a cut at the end of the axle; in using more than one tool this feature is of the greatest importance. A rack and pinion movement facilitates the movement of both tail stocks to accommodate different lengths of axles, and a pawl at the rear of each engaging in this rack, forms a positive lock against outward movement. The tail stock spindle, instead of being round, is made in the form of a dovetail, and a gib is provided at the bottom for taking up wear.

The feeds obtainable on this lathe are six in number, as follows: 3, 5, 8, 11, 16 and 32 to 1 inch, anyone of which can be obtained by a simple movement of a lever at the head of the lathe while the machine is running. All gears, with the exception of the large central driving gear, are cut from steel. Gear covers are provided for the exposed gears and add greatly to the handsome appearance of the machine. This tool is fitted with an oil pump, piping and pan, and a crane for handling the axles. The weight of this lathe, complete with regular counter shaft, oil pump and pan, is about 19,000 pounds.

A NEW DESIGN OF AIR COMPRESSOR.

Chicago Pneumatic Tool Company.

The air compressor shown in the accompanying engraving is a new type of compressor which was recently brought out by the Chicago Pneumatic Tool Company and is being built at their air compressor works at Franklin, Pa. This new compressor is designed to meet the growing demand for an efficient, simple and compact compressor furnished at a moderate price, and represents the highest development in this class of machinery. They are building this form of compressor in a variety of sizes and styles, starting with a minimum capacity of 30 cu. ft. of free air per minute, single, duplex or compound, actuated by steam, belted, chain driven, or geared to an electric motor.



VIEW OF THE NEW TYPE OF AIR COMPRESSOR.—THE CHICAGO PNEUMATIC TOOL COMPANY.

The frame is of box section design, with large factor of safety to withstand the strains when working at maximum load; it is withal graceful in outline, with the style of bored cross-head guide, and enclosed provisions for catching and removing drip from bearings and stuffing boxes. When furnished complete with base, as shown, the compressor is entirely self-contained, obviating the necessity of expert services in erecting, and also reducing the cost of foundations.

The type of steam valves used on cylinders under 12 ins. diameter is the plain slide type, and they are accurately scraped to seat and securely fastened to the rod. When the cylinders are 12 ins. in diameter and larger, the Meyer system of adjustable cut-off valves and gear is provided.

The air valves are of the poppet type, made from high grade steel, having removable seats and guides, easily renewed or repaired and thoroughly guarded from entering cylinder in case of breakage. They are placed radially in cylinder, making them readily accessible, ensuring accurate seating, and reducing wear to a minimum. The air cylinder and its heads are completely water jacketed, with thorough circulation of water, affording equal cooling at all points.

The pistons are of the solid type with cast iron spring rings accurately fitted. The shaft is of the center crank type, with exceptionally heavy crank arms, and is made very heavy of the best open hearth steel. The cross-head is of cast iron with adjustable shoes at top and bottom and the connecting rod is fitted with bronze cross-head pin boxes, having the wedge adjustment; the crank pin end is of the marine type, lined with genuine babbitt metal. The compressor has two balance wheels, one on each side, of sufficient weight to insure smooth operation.

A pressure regulating governor is provided, to automatically control the operation of the compressor in accordance with the demand for air, working in connection with a speed governor for regulating the speed of the engine. An unloading device is provided to relieve the compressor of all load when the desired air pressure is obtained, and automatically cause it to resume delivery when the storage pressure becomes reduced.

These compressors are submitted to a working test before shipment and although designed primarily to supply compressed air power for operating pneumatic tools in railroad shops, machine shops, foundries, shipyards, and stone yards they are equally suitable for actuating rock drills, coal cutters and other machinery in mines, tunnels, and quarries, pumping water by the air lift system and for every other purpose to which compressed air is applied.

AMERICAN BRAKES IN RUSSIA.

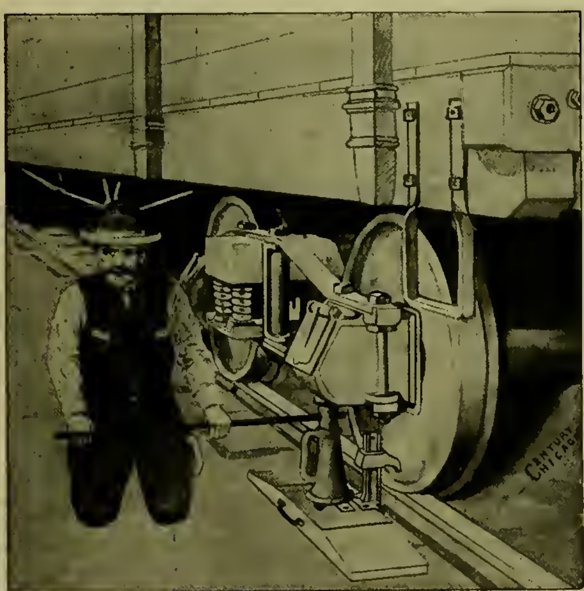
The manner in which the equipment of the Russian railways with American air-brakes received its greatest impetus has not been widely known, and may be of interest. A very serious accident occurred on one of the Russian state railways about the year 1895, when a hand-braked train ran into and telescoped a train that was standing on the track ahead of it, thereby killing several people and doing a great deal of damage. At that time it was the custom of the Government Railway Department to equip only its passenger trains with the air-brake, leaving the freight brakes to be applied by hand. In the course of the inquiry that followed this freight-train disaster, the Emperor asked the Minister of Ways and Communications to explan how it had happened, and that official stated that if the freight service also had been equipped with American automatic air-brakes, the accident would not have occurred. To this the Emperor replied, "Why were they not so equipped?"

Such a reply from that monarch was equivalent to a command; all the previous troubles in the way of lack of funds were speedily put to the vanishing test, and a commission was formed from the Ministry of Ways and Communications to study up and recommend the best automatic air-brake. After some time this commission decided to put to the test five companies who were competing for the five-year contract for $7,000,000 worth of brakes which the Government needed at that time, They consequently invited each company to send equipments for a 50-car train, which was to be equipped with each type of brake in turn, and put through the same series of tests. As a result, the Westinghouse air-brake was chosen, and as the Government contract stated that the brakes should be made in Russia, a Westinghouse factory was at once started in St. Petersburg. From the day that the report of the commission was accepted to this the Westinghouse Company has supplied all the railway brakes for the Russian Government. A statement was recently made that a large order for locomotive brakes had been given to a competing American concern, but this is erroneous. The order was for 1,000 sets of Westinghouse locomotive brakes. The policy of the Russian Government demands that all material which is to be used in connection with Government contracts must be made in Russia by a Russian company. There is no other Russian brake company in existence at the present time than the Westinghouse; none other has received a charter.

THE "HANDY" JOURNAL BOX JACK BLOCK.

For the Removal and Renewal of Journal Brasses and Wedges.

While the removal of journal bearing and wedges and the insertion of fresh ones is in a way a very simple operation, it often becomes very troublesome because of the lifting of the car-wheel, when the load is lifted by the jack under the journal box. The result of this lifting of the wheel is that the bearing and wedge are not freed so that they can be taken out; the usual procedure under such circumstances is to gather from two to four men to assist the man with the jack-block, bars and levers being required to hold the wheel down so as to free the hot or worn bearings, from all load and permit them to be lifted out, without loss of time, for the insertion of the new bearings. Trains are often delayed and blockades caused by the time consumed in changing bearings on the road. There is

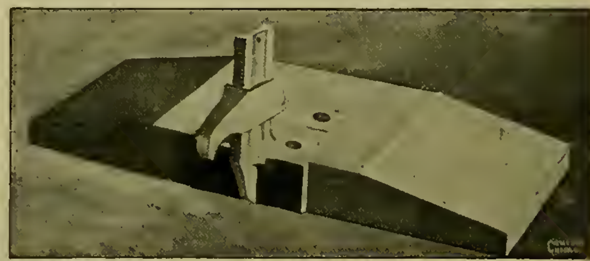


METHOD OF OPERATING THE "HANDY" JOURNAL BOX JACK BLOCK.

also, of course, a great deal of unnecessary time and labor spent in the repair yards in changing bearings with the usual methods.

The device here illustrated is designed to reduce the time and labor in changing bearings both on the road and in yards. It is claimed that one man with any good journal-box jack and with this Handy journal-box jack block can change bearings in from five to ten minutes.

The device consists of a base, or block, of oak, 9 ins. x 2½ ins. x 26 ins., which is intended to rest on the ties or ballast beneath the journal box and carry the journal box jack. On the inner edge of the block a malleable casting is secured by top and bottom flanges for riveting through, which casting has a vertical post with teeth on the edge next to the wheel; fitting loosely over this post is a hook-like piece, as shown, also of malleable iron, having a tooth or lip for engaging with the teeth on the post to prevent it from slipping upwards when the strain is applied—in this way it resists the tendency of the wheel to lift by projecting over and engaging the rim of the wheel. Ample adjustment for varying heights is provided by the teeth extending the full length of the post, for locating the hook at different positions on it. A handle is provided on the opposite



VIEW OF THE "HANDY" JOURNAL BOX JACK BLOCK (WHEEL SIDE).

edge of the block from the post for carrying the device by. Further particulars regarding this interesting and convenient tool can be secured from the manufacturers, the Handy Car Equipment Company, 890 Old Colony Building, Chicago, Ill.

BOOKS AND PAMPHLETS.

Iron, Steel and Other Alloys; a Treatise on Alloys. By Henry M. Howe, Professor of Metallurgy, Columbia University. Published by Sauveur & Whitting, 446 Tremont Street, Boston, Mass. Price, $5.

This book is a thorough and concise summary of present knowledge regarding theory and practical applications of metallography. The work gives the essential features of the processes now used for production of iron and steel, together with a clear statement of the principles and effects of heat treatment. It will be found a most useful aid to manufacturers having to do with iron and steel products, as well as also to the student and beginner.

The Daughter of a Magnate. By Frank H. Spearman. Published by Charles Scribner's Sons, 153 Fifth Avenue, New York. Price, $1.50.

The railway is one of the greatest human institutions and the manner of its development and character of its service to mankind renders it a field for romance, which thus far has been but little cultivated. Mr. Spearman has been very successful in this story, which has the real fire and life of the railroad and gives an idea to the uninitiated of the inspiration of railroad life. The book will be read with pleasure by those who live in the atmosphere of railroad work and with interest and profit by those who only know of it by hearsay.

Threads and Thread Cutting. By Colvin-Stabel. 32 pages, 6 x 9 inches, in pamphlet form. The fourth of a series of practical papers, each complete in itself. Published by the Derry-Collard Co., 256 Broadway, New York. Price, 25 cents.

This is another of the series of practical papers published by this company, which will be of interest to every machinist. Thread cutting has its little mysteries for one until the matter contained in this pamphlet is studied. It makes clear many of the intricacies of thread cutting and serves as an introduction to all kinds of thread cutting. It contains a number of handy little kinks, gives many useful tables, and includes also the subject of thread milling. The pamphlet is well illustrated and is well printed on an excellent paper, making a very attractive pamphlet and one that will be appreciated by any machinist.

Fowler's Electrical Engineers' Year Book, and Directory of Lighting and Power Stations, for 1904. Published by the Scientific Publishing Company, Manchester, England. 539 pages, pocket size, bound in imitation leather. Price, 1s. 9d.; probable cost in this country, about 75c.

This well-known little reference book has been brought up to date by the addition of the Institution of Electrical Engineers revised general rules for wiring, and the Board of Trade regulations and statutory rules relating to tramways, light railroads and electric lighting. Many portions have been rewritten, as, for instance, those on measuring instruments, electric distribution, meters and dynamos. New matter has been introduced relating to alternating-current transmission and induction motors. The directory of electric light, power and traction stations of the United Kingdom, which is a feature of this book, has been revised and brought up to date, and the particulars of over 500 installations are given. The success of this little work is to a large extent due to the continuous and painstaking efforts that have been made to improve its usefulness and keep it abreast of the times, and its favorable reception is a warm testimonial of its value. While the book is primarily adapted to the use of British engineers, it is also of value to those who may have frequent need of a ready reference to subjects and principles pertaining to electrical engineering.

Machines and Tools Employed In Working Sheet Metals, By R. B. Hodgson, Published by the Technical Publishing Co., Limited. D. Van Nostrand Co., Warren St., New York, 1903 Price Four Shillings and Six Pence.

This book is by the author of Emery Grinding Machinery, and the work first appeared serially in the pages of *The Practical Engineer*, being now put into book form at the request of many readers of the articles. This subject is generally understood only by the press-tool makers, because of the fact that many points of technical detail surround the processes of pressing work from flat sheets. The author has had a wide experience in this line of development and presents the work in the hope of aiding engineers and manufacturers in overcoming some of the difficulties met in technical schools and workshops. While this sort of machinery is a distinct specialty, it is well to know where to look for such thorough treatment of the subject, as this work presents. The book deals with materials and measurement, gauges, presses, dies, metal spinning, drawing, stamping, tools, blank dimensions and pressures for cutting blanks. It is a valuable book for those who work in sheet metal.

Suplee's Mechanical Engineer's Reference Book. A Hand-Book of Tables, Formulas and Methods for Engineers, Students and Draughtsmen. By Henry H. Suplee, B. Sc., M. E., Member American Society of Mechanical Engineers. Pocket Size, 834 pages. Bound in Red Leather. Published by J. B. Lippincott Co., Washington Square, Philadelphia, Pa. Price, $5; with patent thumb index, $5.50.

This excellent hand-book has been in preparation for several years by Mr. Suplee, being intended as a successor to the formerly well-known reference book edited by John Nystrom and also published by the J. B. Lippincott Co. It is, however, an entirely new work, and nothing of the old hand-book has been retained except with the necessary complete revision to bring it up to date. This work is particularly well equipped with tables, and has an unusually large amount of reference matter. It is divided up into departments, according to the various engineering subjects, each of which is treated very fully, and the entire work is carefully indexed. The metric system has received careful attention, and full conversion tables have been incorporated in the work. This work will take an important place with the other modern hand-books for engineering practice, and will be highly appreciated by those desiring a modern mechanical engineering hand-book. The book is well printed on a fine quality of paper, and is beautifully bound in red leather, with gilt edges. An innovation has been introduced in the patent thumb index, on the dictionary plan, which gives marginal indexes to the various engineering subjects treated in the volume; this will prove a great convenience for quick reference work.

We beg to acknowledge receipt of calendars from the following firms: Morgan Engineering Company, Alliance, Ohio; Cleveland Pneumatic Tool Company, Cleveland, Ohio; Ashton Valve Company, Boston, Mass.; National Electric Company, Milwaukee, Wis.; Kennicott Water Softener Company, Chicago, Ill.; Ingersoll-Sergeant Drill Company, New York; the G. Drouve Co., Bridgeport, Conn.; H. B. Underwood & Co., Philadelphia; American Steam Gauge and Valve Company, Boston, Mass.; Springfield Machine Tool Company, Springfield, O.; Brady Brass Company, New York; Photo Engraving Company, New York.

B. M. Jones & Co.—We are in receipt of a beautiful little vest-pocket diary and memorandum book entitled "A Daily Reminder of Important Matters," which has been issued by B. M. Jones & Co., Boston, Mass. It is artistically bound in a pretty mottled leather, and includes, besides interesting tables and formulæ, several comprehensive maps of portions of the United States and its island possessions. This little volume calls attention to the fact that their R. Mushet's special high-speed tool steel has been adapted to recent requirements and is capable of cutting at high speeds, coarse feeds and heavy cuts, and will also turn the hardest materials in either cast iron or steel. Their long experience enables them to guarantee uniformity in every bar supplied.

NEW WORTHINGTON PLANT.

An extensive pump manufacturing plant, the largest in this country and probably in the world, is now under construction at Harrison, N. J. It is to be occupied by the firm of Henry R. Worthington, who employ about 3,000 men in their present works at South Brooklyn, L. I., and Elizabethport, N. J. The new plant at Harrison will accomodate from 4,000 to 5,000 men and will cost in the neighborhood of $2,000,000. It consists of a main machine shop with side galleries over 1,000 ft. long, an erecting shop 592 ft. long and of the same section as the machine shop and a high erecting shop 210 ft. in length and four galleries in height in the side bays connecting the two shops. The main foundry is 600 ft. in length and there is also a special foundry for small work, 410 ft. in length, with a building 200 x 60 ft. in size for cleaning castings connecting the two. The pattern building is four stories high and 550 ft. long, and is divided by fire walls into four sections. The north section will be used for offices and drafting rooms; the adjoining section for the pattern shop and the balance of the structure for pattern storage. The power house, which will be equipped with the most modern boilers, engines and generators, is a building 172 x 102 ft. Electric power distribution is to be employed throughout, and the grounds will be illuminated by electric arc lights. There are many other buildings which will be used for packing, storing and shipping goods, etc. The buildings are so arranged that additions can be built when the work demands it. All will be connected by a complete system of railroad tracks entering the ends of the buildings and placing the works in direct communication with the Delaware, Lackawanna & Western, the Erie and the Pennsylvania Railroad systems. The new plant will be devoted entirely to the manufacture of water works machinery, water meters, cooling towers, condensers, feed-water heaters, centrifugal pumps and steam pumps of all kinds.

EQUIPMENT AND MANUFACTURING NOTES.

The Chicago Pneumatic Tool Company.—In an opinion rendered December 21, 1903, the United States Circuit Court of Appeals (now the court of last resort in patent litigation) sustained the validity of the Boyer patent No. 537,629 of the Chicago Pneumatic Tool Company, issued April 16, 1895, and declared the pneumatic hammers manufactured by the Keller Tool Company and sold by the Philadelphia Pneumatic Tool Company to be an infringement of claims 42, 45, 46, 47 and 48, awarding a decree for an accounting and a perpetual injunction against the further manufacture, sale or use of infringing tools. Injunctions will therefore issue against the Keller Tool Company and the Philadelphia Pneumatic Tool Company and all other manufacturers, dealers in and users of infringing tools.

In the lower court the bill was dismissed on the ground of non-infringement, and it was in the Circuit Court of Appeals approached from that side. The patent in suit, issued to Joseph Boyer in 1895, expressed the features of the invention in a large number of claims, but only two groups were the subject of consideration in the court below. These cover the means for controlling the supply pressure to the mechanism by valves and ducts incorporated in the handle of the tool and used in connection with passages leading to the air cylinders through portions of the handle which is grasped in operating it; these claims were shown to be infringed. The defendant was found to be making use of a throttle valve similarly located in the handle as described in the Boyer patent; it operated equivalently to control the admission of fluid pressure into and through the duct. So far as the Boyer claims 42 to 45 are concerned, no particular form of construction or mode of operation was specified in them, and none is, therefore, to be imposed; the combination is simply that of a throttle valve in the handle in conjunction with a supply duct running through it, and that is all that is required to fulfill their terms.

The utility of the invention was assailed on the ground that no tools are now constructed in accordance with the patent, and have not been, as it is said, from almost the time it was granted; but this did not fairly present the evidence. The plaintiff testified that some 200 tools of the exact construction there described were made and sold in 1894 and 1895, but were recalled on account of improvements which were added to make the machine more durable; these were embodied in two subsequent patents, one the same year, in November, 1895, and the other in January, 1897, but were for changes in other parts of the instruments, the combination which is here involved being strictly maintained and followed. It is, of course, true that the flexible rubber tube method of closing the valve chamber was given up and a valve of somewhat different character substituted. But the combination in issue does not depend, as we have seen, on the particular kind of valve employed, and the change was therefore no abandonment of its essential features, which still obtain, and in accordance with which thousands of tools have been manufactured and disposed of. Their extended use in the shipyards, railroad shops, boiler works and other similar industrial establishments throughout the country testifies unanswerably to their utility and value.

This unanimous decision of the United States Circuit Court of Appeals in favor of the Chicago Pneumatic Tool Company gives them the exclusive right to manufacture, sell and permit others to use the modern pneumatic hammer, as every other pneumatic hammer on the market infringes their sustained claims. They state most plainly that all makes of pneumatic hammers are declared infringements by this decision, and that pneumatic tools can be purchased only from them without liability to injunction and heavy damages.

O. C. Gayley, manager of the New York office of the Pressed Steel Car Co., has been elected a director of the Safety Car Heating & Lighting Co., succeeding Edward Lauterbach, recently resigned.

The many friends of the Coffin-Megeath Supply Company will be interested to learn that upon January 1 the firm name was changed to the Franklin Railway Supply Company. The headquarters of the company will remain at Franklin, Pa., as before. It is expressly stated that the change in title does not in any way affect the personnel of the company, and no change has been made in the officials.

Mr. Willis C. Squire, mechanical engineer, has been elected vice-president of the Locomotive Appliance Company, with offices at 1614, 1615 and 1616 Chemical Building, St. Louis, Mo. Mr. Squire is well known as mechanical engineer for the 'Frisco system, and previous to that as engineer of tests for the Sante Fe system. Mr. Squire's large experience in railroad and locomotive work especially fits him for the business in which he is now engaged.

We are pleased to learn that the Ajax Metal Company, of Philadelphia, Pa., have purchased the business, plant, good-will and fixtures of the late Bates Metal Company, of Birmingham, Ala., and will continue the metal business in all its branches, under the name and title of the Ajax Metal Company of the South, at Birmingham, Ala. This new departure will materially assist the Ajax Metal Company in caring for its extensive business in the South, and will be welcomed by their many friends in that territory. The Ajax Company has the best wishes of this journal for a prosperous year to come.

At a recent meeting of the board of directors of the Consolidated Railway Electric Lighting and Equipment Company, held January 13, Colonel John T. Dickinson, heretofore their general agent, was elected second vice-president, in charge of negotiations with the railway companies for the use of the Consolidated "Axle Light" system of electric car lighting. It will also be remembered that the company's general offices were recently moved from 100 Broadway to the Hanover Bank building, corner Pine and Nassau streets, New York City.

The Loomis-Pettibone Gas Machinery Company has, after their recent increase in capital, been merged with the Holthoff Machinery Company, of Milwaukee, Wis., under the new corporate name of Power and Mining Machinery Company. Extensive improvements and additions are now being made to their Milwaukee plant to meet the increasing demand for the American Crossley Gas Engines, the Loomis-Pettibone Gas Apparatus, and Holthoff Mining Machinery. The Loomis-Pettibone gas producers have established for themselves a world-wide reputation as the only gas producers successfully generating a fixed gas for power and metallurgical work from either anthracite or bituminous coals, coke or wood. The Crossley gas engine, of which there are over 50,000 in operation, and which this company are now building as the American licensees, effects remarkable economies; it is assured by their guarantee to produce power with a consumption of 1 lb. of good bituminous coal per brake horsepower hour. The manufacture of mining, smelting and milling plants and machinery will be continued under Mr. Holthoff's personal supervision.

Owing to a large increase in their business throughout the West, Manning, Maxwell & Moore have, for the benefit of their customers, arranged to establish a Western branch office and salesroom at Nos. 22, 24 and 26 South Canal street, Chicago, where they will carry a full and complete line of the goods manufactured by them, thus enabling them to fill orders from the Western territory with promptness. The Western office will be in charge of Mr. H. S. Whitney and Mr. M. A. Hudson, who have been connected with this firm for a number of years. All of the friends and customers are invited to call at the new office, where they will find a most complete assortment of goods manufactured by the Hayden & Derby Manufacturing Company, the Ashcroft Manufacturing Company, the Consolidated Safety Valve Company, and the Hancock Inspirator Company, in stock ready for immediate delivery.

One of the features of the new plant of the B. F. Sturtevant Co. at Hyde Park, Mass., peculiarly indicative of the permanent character of the new works now under construction, is the steam tunnel, 4½ ft. in width and 6½ ft. high, extending from the power plant to the most remote part of the manufacturing buildings, a total distance of about 800 ft. This tunnel, which is of concrete construction, will not only accommodate all of the steam piping, but also the electric wires for power, light, telephone, standard-time clock, and other service, together with oil, hot-water and other pipes for general distribution to the various buildings of the plant. None of these features of the equipment will be carried above ground at any outdoor point. While the expense of such an installation is necessarily large, the convenience of access for changes and repairs will in the future much more than offset any fixed charges thereon.

The new mechanical system for operating window sashes and shutters, recently placed on the market by the G. Drouve Company, of Bridgeport, Conn., and known as the Lovell apparatus, is destined to revolutionize business in this important line. The extent of the approval which this apparatus has met from mill owners, railway companies, factories, etc., has been such that equipment for operating over 60,000 feet of window sash has been sold in the past year. With the Lovell system a line of sash 500 feet long can be operated from one station if desired. It makes no difference what kind of sash is to be opened; the apparatus works equally well with sash hung from the top, pivoted at the sides or at the top and bottom, or hinged at the bottom; it can also be applied to sliding or ordinary lifting windows. As the operating station for an entire building is, unless otherwise ordered, always placed on the wall at the end or side of a building, in case of fire the windows can be quickly closed, while the people are leaving the building—this is a feature which will appeal at once to owners for use in large factories and mills, railway shop buildings, etc. Owners of factories and shops have long been looking for a system which would give perfect ventilation and permit of being operated easily and quickly in case of storm or emergency. This aparatus is strong, durable and practical, and the Drouve Company justly feel that they have at last succeeded in producing a perfect opening device, and they will cheerfully submit estimates for erecting the apparatus in any part of the country. Their skylights and sheet-metal work are favorably known everywhere.

That veteran but gay and graceful minstrel, George H. Primrose, who has been nearly thirty-five years on the stage, and still gives the impression of perennial youth, had something to say recently about the Proctor playhouses, in which he is at present playing a somewhat extended engagement at a joyful salary of something very close to $1,000 per week. "I have never passed a more pleasant engagement," said Mr. Primrose, "than I am now enjoying on the stages of Mr. Proctor's various theaters. They show most conclusively the high degree of perfection attained by the modern vaudeville playhouse. Twenty, yes, even ten, years ago, I would not have believed it possible that the patrons of what we were then wont to call a variety show would ever be enabled to enjoy their favorite form of entertainment amid luxurious surroundings, managed with such rare skill, and affording so much delight to the thousands of people gathered within the four walls. Not alone does the beauty of the theaters themselves compel attention, but in the careful detail of the handling of the stage there is much to wonder at and praise." An advantage of the Proctor theaters is that they are safe and protected from fire.

WANTED.—Copies of the AMERICAN ENGINEER AND RAILROAD JOURNAL for the months of February, March, April and May of 1899. Address replies to this office.

(Established 1832.)

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MARCH, 1904.

RAILWAY SHOPS.

BY R. H. SOULE.

XI.

THE FOUNDRY.

Although but few of the present railway shop plants actually include an iron foundry, yet the importance of promptly securing castings is so obvious that the foundry becomes an important factor in the output results of any large shop; and, now that output is recognized as the criterion by which both the design and the operation of a plant are to be judged, it is probable that a greater proposition of railway shop foundries will be built in the future than have been in the past. Nearly every railway has its own brass foundry; while none, in this country at least, undertakes the manufacture of either malleable iron or steel castings. There are so few thoroughly modern foundries to be found in connection with railway shops that it will be necessary to include outside foundries in a consideration of the question.

Assuming that there is but one foundry on a system it should preferably be a component part of the principal shop, and the foundry building should be located as closely and conveniently as possible to both the machine shop and the storehouse—the machine shop as the point of greatest local consumption, and the storehouse as the shipping point for forwarding castings to outlying points; for it will be found that no other department of a shop ships away so great a quantity and weight of materials as the foundry does. The location of the foundry building having been determined by these considerations, the pattern shop and pattern storehouse should be kept in close proximity to it. At the new shops of the Locomotive and Machine Co., at Montreal, Canada, the foundry forms a wing to the machine shop—an unusual arrangement, but one making a very convenient working combination, and particularly justified by Canadian weather condtions.

The foundry floor plan does not necessarily conform to any very definite type, as practice furnishes examples of many different shapes and proportions, but the desire to use traveling cranes instead of depending entirely on swing cranes leads to the use of buildings with one or more main longitudinal bays, and with side bays for auxiliary purposes. Beyond this generalization it can be said that there is no such thing as a foundry plan for universal use, but that each plant should be adapted to its special conditions. The cupolas are always at one side of one of the crane-served bays, but not always at the middle of its length, as it saves time and steps to have the cupolas located near the light work, which is hand poured, leaving the heavy work to be reached by the crane ladle; this feature of cupola location is to be found, for instance, at Schenectady, N. Y. (General Electric Co.), Chicago Heights, Ill. (The Sargent Co.), and Reading, Pa. (Philadelphia & Reading Railroad).

In the side bays are found all such subsidiary features as light moulding, machine moulding, core ovens, flask-makers room, blower room, lavatories, cleaning and shipping facilities, and in a few instances, the brass foundry. The operation of cleaning castings, while in general done somewhere within the main building, is often provided for (especially in the treatment of light castings) by special rooms or wings. Sand storage is always provided for in modern foundries, generally in separate sheds, but, in a few cases, within the main building itself; one authority advocates providing for sand storage in the original design by brick walled sheds on the outside of the main walls of the building, the moderate amount of heat transmitted to the sand through the main wall serving to keep the sand in workable condition throughout the winter.

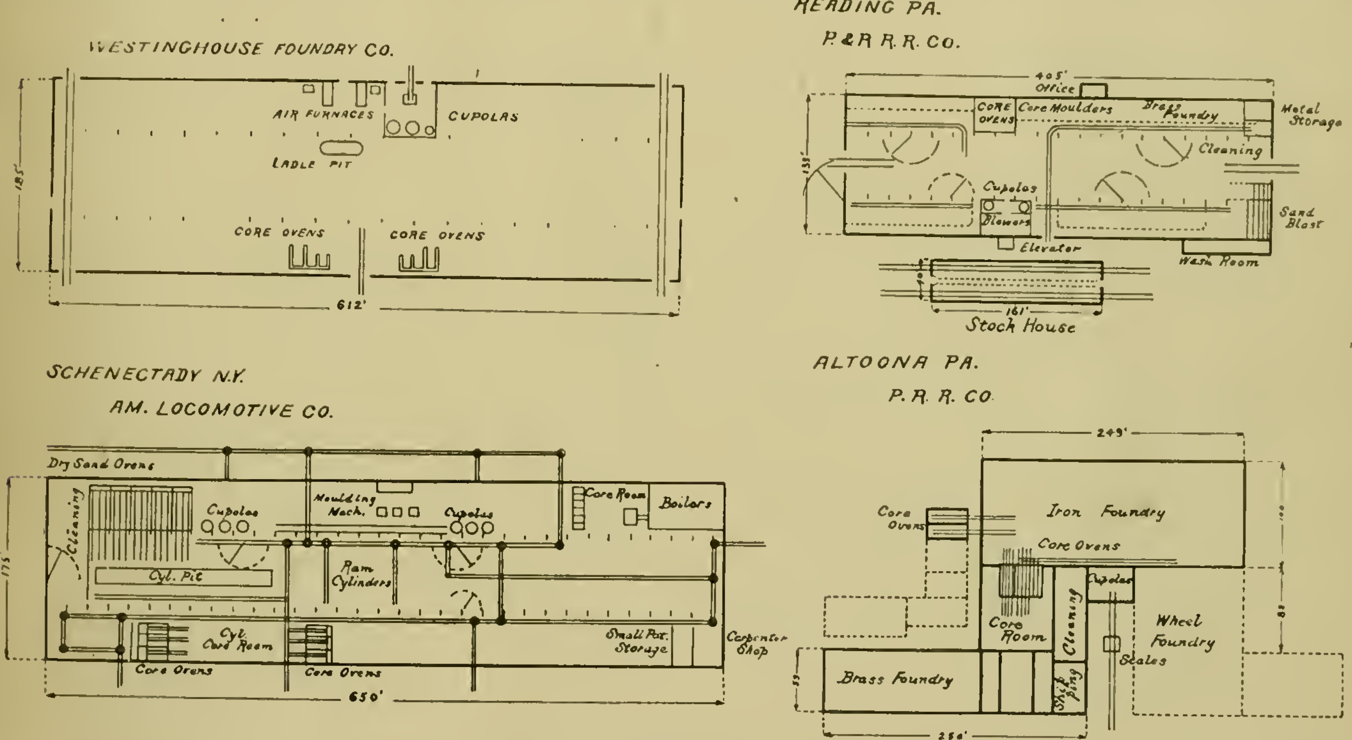


FIG. 6.—PLANS OF FOUR REPRESENTATIVE IRON FOUNDRIES.

The section of the three bay type of foundry is influenced by several factors, the principal one of which is the crane span of the central bay; the over all width, in five recent examples, is as follows: Trafford City, Pa. (Westinghouse), 184 ft.; Schenectady, N. Y. (American Locomotive Co.), 175 ft.; Burnham, Pa. (Standard Steel Works, owned by the Baldwin Locomotive Works), 158 ft.; Harrison, N. J. (Henry R. Worthington), 143 ft., and Reading, Pa. (Philadelphia & Reading Railroad), 130 ft. The height from floor to lower chord of roof trusses in the central bay would be influenced largely by the size of the castings to be handled. In the case of the Reading Foundry—the only railroad foundry of the five—this height is 35 ft. The new foundry of the Montreal Locomotive & Machine Co. is of the two-bay type and the height is only 29 ft., but as an active foundry develops gas, smoke and steam, good light and ventilation are desirable, and a height of 35 ft. is preferable. The spacing of the columns (longitudinally) varies greatly; for instance, at Schenectary, N. Y. (General Electric Co.) it is 40 ft.; at Trafford City, Pa. (Westinghouse), 32 ft.; at Reading (Philadelphia & Reading Railroad), 20 ft.; and at Harrison, N. J. (Worthington's Light Casting Foundry), 12 ft. The wider spacing makes the use of the floor more flexible, and permits post cranes (whether fixed or portable) to sweep wider areas of central and side bays. The 12 ft. spacing at Harrison is a special case, as the light castings foundry floor was to be divided into transverse working strips 12 ft. wide, each having its own overhead crane; this required that the roof trusses should be placed on 12 ft. centers.

Traveling cranes are a feature of all the newer foundries, and their capacities will be found to range from 150 tons (Trafford City) down to 1 ton. The main crane at Reading is of 10 tons capacity, and at Montreal, 15 tons, which latter size is more likely to be taken as a precedent in railway practice. These traveling cranes are liberally provided; at Hamilton, O. (Niles Tool Works), there are 8, at Schenectady, N. Y. (General Electric Co.), 7; at Burnham, Pa. (Standard Steel Works), 5, and few good foundries have less than 3. Traveling or portable jib cranes are also a notable feature; in a few such cases the traveling is done by power, but in more cases by hand, while the hoisting is always electric. The portable jib crane is moved from column to column by the main traveling crane, and takes its hoisting current by means of plugs and local sockets; there are six such portable jib cranes in the foundry of the General Electric Co. at Schenectady, and four at Reading (P. & R.).

It will be found a great convenience to have two trolley hoists on the main crane, and this is getting to also be a feature of modern practice in foundries. An auxiliary light hoist will also be found to facilitate many floor operations. At Roanoke, Va., (N. & W.) a traveling crane has been introduced in the foundry, which had been built 20 years.

Standard gauge tracks are required for bringing in supplies and making shipments. Every foundry has at least one such track; the Trafford City foundry has four, one inside (transverse) at each end, and one outside (longitudinal) at each side; the Reading foundry has a similar equipment, except that the inside end tracks are longitudinal instead of transverse. Narrow gauge tracks (varying from 18 ins. to 30 ins.) are found in eleven foundries out of those under consideration; some use turntables and no curves, others use curves and no turntables, the majority use some of each, on the general plan of using turntables in the buildings and curves outside. At the new Hyde Park, Mass., foundry of the B. F. Sturtevant Co., nothing but turntables are used; there are 20 in the foundry, 14 in other buildings, and 30 in the yards, 64 in all. At Reading (P. & R.) it is evident that curves were considered preferable, as they are used both inside and outside wherever possible, the only two turntables to be found being located with restricted clearances where curves were not practicable.

Cupolas are of pretty well defined types, with numerous variations of the details such as the height and section of tuyeres, arrangement of spout, slag hole, drop bottom, etc. Cupolas of 72 ins. diameter are common in railway foundries, and will yield from 15 to 20 tons per hour each. Few railway foundries have more than two cupolas, while at Schenectady the American Locomotive Co. have six; at Trafford City there are three cupolas and two air furnaces, which can produce a combined melt of 114 tons, so that a 100 ton casting can readily be poured, and a 150 ton crane is provided, as previously stated. In the air furnace, the fuel is not mixed with the iron (as in a cupola), but it is fired separately, the heat being passed over the surface of the metal as in a reverberatory furnace. A much larger single melt may be obtained from an air furnace than from any cupola, and the quality of the casting is finer—two advantages which are of benefit in heavy electrical work.

The charging platform for use with cupolas should be about fifteen feet above general floor level, and should be served by a hydraulic lift of about 3,000 lbs. capacity; a few electric lifts have been installed for this service; but are not found to meet the peculiar conditions as well as the hydraulic lift. At Hyde Park (the Sturtevant Co.), there is a semi-automatic arrangement; a car which has been sent up loaded to the charging platform, is, after being emptied, pushed on to an inclined chute, runs down it some 125 ft. by gravity until stopped by a hydraulic buffer on an elevator platform, causes the elevator to descend by its own weight, and is then pushed off on the general floor level, the elevator returning automatically to its upper position, ready for the next car. At Reading there is a transfer table on the charging platform with several spur tracks leading from it, and on which several loaded cars can be kept, and in such a way that anyone of them can be taken out individually. The charging platform should also have a narrow gauge track scale for weighing each charge before it goes into the cupola.

The core ovens are generally found at one side of the building, but occasionally at one end. It will be found convenient to locate the larger ovens near to the loam and dry sand floors, and it will pay to have the small ovens close to the core makers' benches. The mason work of large ovens should be well and carefully done and all the proper flues, dampers, etc., provided so as to secure the desired uniform temperature and thorough drying effects; the firing for core ovens is usually done from the outside of the building.

At Schenectady (General Electric Company) are to be seen core oven carriages formed with shelves, and fitted with large rectangular end plates which form the door to the oven, thus confining the heat, whether the car is in or out; in this case the car is moved by a horizontal compressed air cylinder. At Hyde Park (the Sturtevant Company) there are six ovens; three are vertical cylinders, 7 ft. diameter, of the "reel" type, the other three being 4 x 9 ft., 5 x 9 ft., and 7 x 9 ft., and each having a car for heavy cores. At Schenectady (American Locomotive Company) there are 27 tracks leading into cylinder core ovens.

The work of cleaning the heavier castings is naturally done in one end of the main crane bay, but several modern foundries have separate cleaning departments—sometimes simply a space in a side bay, but not infrequently a special room equipped with facilities, such as tumbling barrels, emery wheels, sand blast, hydro-fluoric pickling baths, etc., where the medium sized and smaller castings are handled. Emery wheels and tumbling barrels are now often fitted with suction connections by which the dust is drawn away.

The shipping facilities of a railway foundry ought always to include a spur track (standard gauge) extending at least a car length into the main crane bay. At Altoona (P. R. R.) there is a very handy hydraulic platform lift adjacent to the shipping room, by which loaded handbarrows or trucks can be lifted from foundry floor level to car floor level, when a car is being loaded for shipment.

The storage of pig iron, coke, sand and general foundry supplies is being provided for in modern plants, whereas formerly the open space adjacent to the foundry was used without the provision of any special structures. At Hyde Park (the Sturtevant Company) all supply materials are kept inside the foundry walls, the bins being accessible from the adjacent outside track. At Reading (P. & R.), a special stock house is provided, with two tracks (on general ground level) on trestles rising up from a basement floor; the idea was that supplies could be dumped direct from hopper bottom cars into the bins below, whence they would be taken by narrow gauge track, through a tunnel, to an elevator, and thence either to the main floor, or the charging platform, as wanted. This stock house has been used just as intended for sand, coke, etc., but has been found inconvenient for pig iron, which is stacked in the open yard, nearby. At Harrison, N. J. (the Worthington foundry for light castings), the entire building has a basement, into one end of which sand is unloaded (through trap doors) from a track entering one end of the building on ground level; similarly, when the molds are shaken out the sand from them falls through floor gratings into the basement, where it is mixed and tempered, and from whence it is again raised by special elevators to overhead hoppers, to be drawn by the molders, as needed.

Similarly, pattern storage is being better provided for than formerly, and fire proof or slow burning structures are found in several places. At Hyde Park and Harrison there are four-story buildings, and at Trafford City and Reading three-story buildings. At the new Readville, Mass., car shops of the N. Y., N. H. & H. there is an excellent one-story pattern storage building with solid side and end walls and with top light only.

Flasks may be a source of great expense and therefore afford an opportunity for economies; at Hyde Park (the Sturtevant Company) there is a flask shop, 60 x 80 ft., equipped with band saw, cross cut saw, split saw, boring machine, lathe, etc. Where a foundry has a great deal of standard, or repetition, work (as always in a railway foundry) floor space may be saved and the output increased by gradually substituting gray iron, or better, malleable iron flasks, for the wooden flasks. The economy of using snap flasks for producing large numbers of shallow molds is, of course, well understood.

Fig. 6 shows, on a uniform scale, the ground plans of the foundries at Trafford City, Schenectady, Reading and Altoona; the latter is old and well known, while the other three are new. This group of four plans shows the tendency to do things on a large scale in foundry practice. The location and general arrangement of the stock house at Reading may be noted. In this connection it should be stated that the Pennsylvania Railroad is about to abandon this old Altoona foundry in favor of a new and much larger one which is being erected at Burket, near Altoona.

Table 18 gives the output of six well known iron foundries, the unit adopted being the tons of castings produced per month per each 10,000 sq. ft. (100 ft. sq.) of ground area covered by the building, and including not only the floor space used for molding, but also that used for core making, cleaning, etc. The output of a foundry will vary with the character of the work done, and, in general, coreless castings of medium size and simple outlines will permit maximum output. The average unit output for the six foundries listed is 281 tons (per month per 10 000 sq. ft. of ground area), and it would seem that in designing new iron foundries to be used in connection with railway shops a unit output of 250 tons could safely be assumed.

The brass foundry admits of wide variation of design, from the simple one or two pot furnace plant up to the highly developed modern large plant, such as that of the Siemens and Halske Company (88 ft. x 327 ft.) at Berlin, as illustrated and described in a recent number of *The Foundry*.

There has been a tendency of late to adopt melting outfits larger than the old traditional crucible which could be lifted out of its furnace by one man working with tongs, and most modern plants which handle metal in large quantities use furnaces of the Schwartz or Paxon type, resembling the Bessemer converter on a small scale, using crude-oil, fuel-oil, or gas as fuel, and yielding a melt of from 250 to 4,000 lbs. per hour. In the brass department of the Hyde Park (Mass.) foundry of the B. F. Sturtevant Company, there is a special furnace of the reverberatory type, which is especially adapted to the melting of babbitt and other soft metals.

Another development of recent years has been the practice of locating brass foundries in the second story of steel frame buildings (where the first floor was needed for other purposes) as at the Baldwin Locomotive Works, Philadelphia, and the new shops of the Locomotive and Machine Company at Montreal. *(To be continued.)*

TABLE 18.

OUTPUT OF IRON FOUNDRIES.

Place.	Owner.	Kind of Castings produced.	Output in tons per month.	Estimated or Recorded	Ground area in sq. ft.	Output in tons per month per 10,000 sq. ft. of ground area
Trafford City, Pa.	The Westinghouse Companies.	Heavy Machinery	2,575	Est.	113,220	227
Hyde Park, Mass.	The B. F. Sturtevant Co.	Light Machinery	1,300	Est.	53,560	243
Roanoke, Va.	The N. & W. R. R. Co.	Loco. and Car	593	Rec.	23,024	258
Burnham, Pa.	The Standard Steel Works.	Locomotive	2,166	Est.	78,000	277
Altoona, Pa.	The Pennsylvania R. R.	Loco. and Car	1,300	Rec.	41,154	316
Schenectady, N. Y.	The Am. Locomotive Co.	Locomotive	4,160	Est.	113,750	366
		Average Unit Output.				281

A METHOD FOR DETERMINING RATES AND PRICES FOR ELECTRIC POWER.

Under the above title, an interesting and important paper was read at the December (1903) meeting of the American Society of Mechanical Engineers by Mr. Frank B. Perry. The purpose of the paper was to point out the inequalities and injustices of the step system of rates which is ordinarily in use for charging for electric current supplied in large quantities. In this system, the contracts which the electric companies draw up with their customers frequently provide such a scale of rates that for a consumption between 1,800 and 2,160 kw. per month the current supply shall be charged for at a rate of $31.50 per kw. per annum, while between 2,160 and 2,520 kw. per month the rate shall be $31. This makes it possible, in extreme cases, for the consumer to secure a lower rate by consuming a single additional kilowatt, and in many cases in the author's experience substantial reductions could have been secured by consuming more power, which might obviously be done by the simple expedient of burning lamps in the daytime.

After explaining these irregularities of the usual method of basing rates, the author deduced a method which, while providing the same average prices per month, shall avoid these anomalies by doing away with the abrupt steps in the rates. Below a certain minimum and above a certain maximum consumption the rates are fixed, but between these points there is a gradual decrease in the rate which is read from a diagram, which diagram also gives the amount of each month's bill directly from the watt-meter reading.

A table was presented in which a comparison is made of the usual method of monthly charges for varying consumptions of power, and by the one proposed. While the averages are substantially the same, the charges for different amounts of power consumed are sometimes greater by one method and sometimes by the other; but the charges by the new method are consistent with one another, while those by the old method are not. This appears to be the only rational method of charging for varying amounts of current that has been devised, and is, consequently, of importance.

An apprentice course of instruction for draftsmen has been established by the General Electric Company at the Schenectady works. It is under the charge of Mr. J. W. Upp, and is intended to qualify applicants for work in the drafting rooms of the company.

COMPARATIVE TESTS OF BRAKE BEAMS.

Steel vs. Wooden Beams.

Tests were recently made by a prominent road of all of the makes of metal brake beams used on that road in freight service, and comparisons were drawn with a trussed wooden beam with respect to deflection and permanent set. The information thus obtained will doubtless lead to a test of all of the well known metal beams in order to ascertain whether any of the others will make a better showing against the wooden beams. These tests proved that the trussed wooden beam met the Master Car Builders' specification for deflection, while none of the four metal beams satisfied this requirement. It has been generally accepted as a fact that a trussed wooden beam would not stand the M. C. B. test. This is probably true of wooden beams tested in the past, and is due to the fact that the construction and design were defective. These tests prove conclusively that a wooden beam properly trussed will meet all requirements for freight service. There is no question of the fact that the wooden beam is superior to any of these steel beams, and they are all very well known makes. For obvious reasons the names are not given. It is not easy to use trussed wooden beams for inside hung brakes.

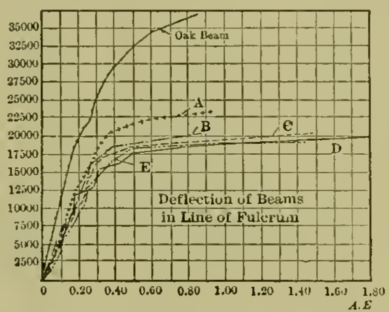


FIG. 1.

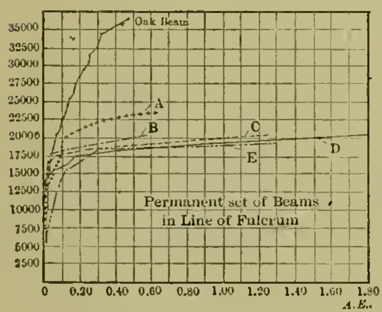


FIG. 2.

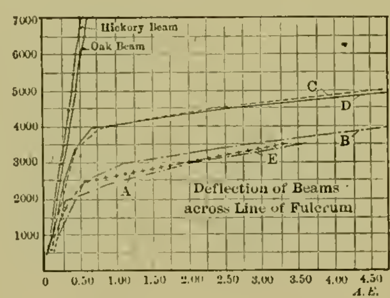


FIG. 3.

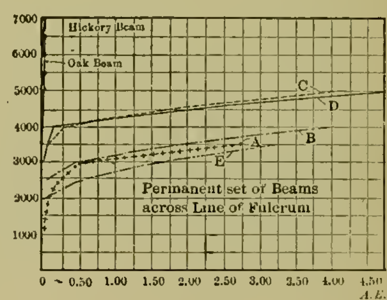


FIG. 4.

COMPARATIVE TESTS OF BRAKE BEAMS.

The surprising results of these tests will doubtless lead to a study of the problem and probably to an improvement in metal beams.

These tests show that the metal beams began to deflect with a relatively light load, and that they were not elastic. One of the facts brought out is the weakness across the fulcrums. The wooden beam stood far higher in all respects. As a result of this investigation there is at least some hesitation on the part of this road to adopt metal brake beams until they make a better showing against wooden ones. In the matter of cost there is little choice between wood and metal, and the officers of the road believe they will have no trouble to secure good oak and hickory in sufficient quantities.

The M. C. B. specifications require that "all beams must be capable of withstanding a load of 7,500 lbs. at the center without more than 1-16 in. deflection." There is no specification of the deflection across the fulcrum. In view of these results it seems advisable to specify that deflection also. It is difficult to state just what the deflection ought to be in this direction, but as many beams fail in that direction the matter should be settled.

These 5 metal beams vary in weight from 67 to 119 lbs. Probably an increase in weight will be necessary. Undoubtedly the effort in the direction of reducing the prices has led to a sacrifice of strength, and when the attention of the manufacturers is called to this comparison a great improvement will be made. The accompanying diagrams illustrate the comparison and indicate the great superiority of the wooden beam over the metal ones used. These metal beams are represented by the letters A B C D and E. They represent the construction of some of the leading brake beam manufacturers. This may not be exactly a pleasant surprise to the metal brake beam people, but it is well to know the facts in order that they may be acted upon.

One of the principle arguments which has been constantly used in demanding the advance of wages by railroad men is the increased cost of living, and this reason is still alleged as justifying further demands. Careful figures show that the average increase in cost of living in Chicago is 11.3 per cent. over that of five years ago, while the increase in wages has been greatly in excess of that amount, that of railway employees being from 15 to 18 per cent. According to the best, as well as most conservative opinion, wages, at least so far as railway employees are concerned, have reached their maximum, and any further demands in that direction will of necessity be refused. Unfortunately it is next to impossible to convince the lower classes of railway employees that large earnings do not necessarily mean large profits. They seem to have an idea, that because the receipts run up into the millions the profits are correspondingly large. That railroads have done extraordinarily well for the past few years is known, but that present indications presage anything but a continuance of this prosperity is also well understood. The more intelligent of the employees will find it to their advantage to check any attempts on the part of those not so well posted to exact higher wages, because if insisted upon such a course can only result in a stoppage of work.—*The Railway and Engineering Review.*

The officers elected for the American Society of Mechanical Engineers for this year are as follows: President, Ambrose Swasey, Cleveland, Ohio; vice-presidents, Prof. D. S. Jacobus, Hoboken, N. J.; M. L. Holman, St. Louis, Mo.; W. J. Keep, Detroit, Mich.; managers, George I. Rockwood, Worcester, Mass.; J. W. Lieb, Jr., New York City; Asa M. Mattice, Pittsburgh, Pa.; treasurer, William H. Wiley, New York City, reelected. The next meeting will be held at Chicago.

We are informed that an oil-engine-propelled motor coach is to be tried by the Great Northern Railroad, in England. The car is to be of the standard gage, with a capacity for 30 passengers. The engine will be the Roots type of oil-engine, developing 40 horse-power, and four speeds will be provided forward and reverse by gear mechanism. There will be a cab at either end of the car for the accommodation of the motorman, or engineer, so that it may be propelled in either direction, with the engineer always at the front of the vehicle. The engine is to be available for various kinds of liquid fuel, such as ordinary petroleum oil, gasoline or kerosene. In the first car attention will be devoted more to reliability and efficiency in the motor than to speed. The highest speed will not be greater than 35 miles per hour.

EDITORIAL CORRESPONDENCE.

Impressions of Foreign Railroad Practice.

(*Continued from Page* 51.)

The English railway carriages of the old, but most numerous type, with closed compartments, are veritable *chambers of horror*. How such an intelligent class of people can endure them is an impenetrable mystery. These vehicles are descended from the stage coach of our ancestors. The lineage is too direct. It is sometimes a good thing for new blood to come into a family to improve the stock. An occasional marriage of the leading daughter to the coachman does no harm. This carriage is simply ridiculous, barbarous, dangerous and absurd. English railroad men know better, as they have shown by building corridor cars, which are very comfortable. But the older type of carriages (without toilet arrangements) stands as a blot upon foreign railroad practice which is not confined to England. Rather usual absence of steam heat and other inconveniences may be forgiven but the practice of shutting people up in a closed cell with absolutely no opportunity for communication with the surrounding humanity is not to be admitted to have any place in modern facilities for traveling. Of course, one may, to a certain extent, select his traveling companions by searching every compartment of a train at a station and that is what is done. Seclusion seems to be the object of English travelers and it often leads to what we would call—"plain hog." A sixpence to the guard will tend to "seclude" a compartment to the knowing traveler, and you may look long and far for the guard to let you into one of these. On the other hand, the seclusion is not always what it appears to be. A lady traveling alone, need never be embarrassed, if she knows the ropes and fees a guard to put her into a compartment reserved for ladies, but there is positive danger in omitting this precaution. A sad case was brought to the writer's notice, in which it is to be hoped, for charity's sake, that the man concerned was an escaped lunatic. People sometimes pay dearly for this fad of exclusiveness and after all on a crowded train one is in closer contact with his neighbors than in our cars.

It is, on the other hand a pleasant surprise to find such comfortable cars in the specially good trains. The improvement of the last ten years has been very great, and it is to be hoped that further progress will be made. These criticisms apply to the older type of "carriages" without corridors and other improvements of the later part of the nineteenth and the present centuries. English railroads lay themselves open to criticism because they do not retire this old equipment at a more rapid rate. The situation requires heroic treatment.

Coal is hauled in boxes with two axles, the capacity being from 6 to 8 tons and the dead weight about the same as the load. There are notable exceptions, but many coal cars of this sort are now in service. The maximum total width of passenger cars is 9 ft. 3 ins., and I found no goods wagons wider than 8 ft. It is worthy of note that the capacities of the freight equipment which is being discarded at home, are larger than that in use here. Instead of increasing the capacities of cars and locomotives, the English roads have merely increased the number of trains, and this has led to increasing the number of tracks on which to handle the heaviest traffic. Perhaps this was the best thing they could do, because of the vast expense of increasing clearances, but it merely puts off the evil day because roads with small clearances cannot haul heavy trains. As business increases more tracks will need to be built, and probably the cost of this will be more than that of enlarging the clearances. But this question is a difficult one, which the writer is glad he is not called upon to decide.

Some of the roads are building larger coal cars. The Caledonian has some excellent large steel cars (see American Engineer October, 1899, page 320) and is taking up self-clearing cars. I am told that the Clearing House has taken official action to prevent the use of large hopper cars by the owners of private cars, though I cannot imagine a satisfactory reason for such a position.

There are good reasons to believe that the best relief of the transportation problem in England will be the use of electric traction. This will solve the locomotive difficulty and the cars may then be attended to at leisure. The traffic is dense and the only obstacle is the fact that the roads are likely to find it very difficult to provide the capital necessary for the change.

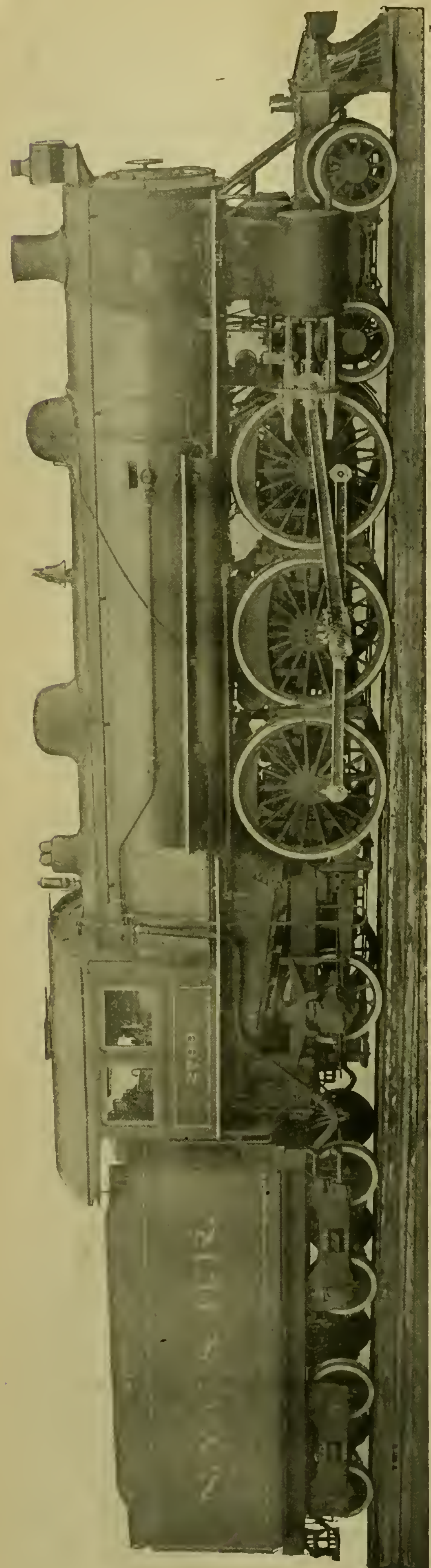
The sleeping cars of the east and west coast trains are very comfortable. A passenger has a small space all to himself, with separate toilet facilities and it is not necessary for him to go out of his compartment until fully dressed. The hot coffee brought in by the attendant begins the morning in good order and renders the traveler good natured all day. Ladies have something better than a curtain as a shelter. In several respects these sleeping cars are in advance of ours.

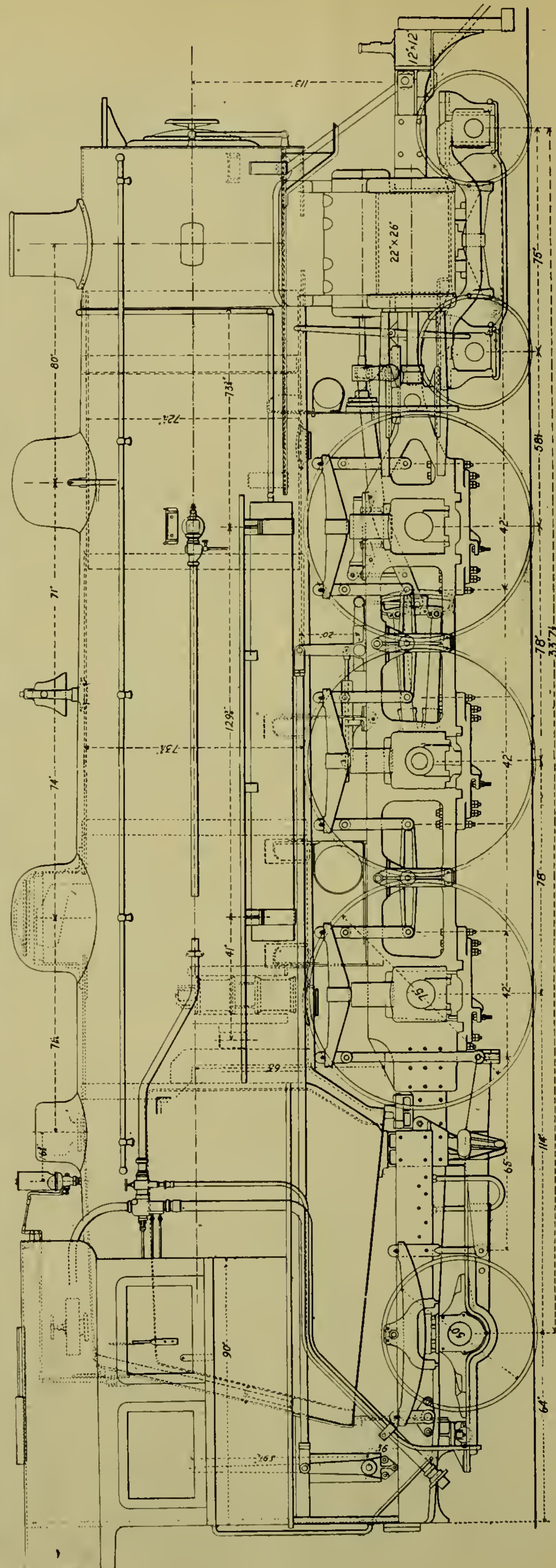
While American coaches are more comfortable than the English, they weigh far more per passenger. On the Caledonian Railway, for example, an ordinary first-class carriage with 7 compartments seating 56 people, weighs 22 tons or about 0.4 ton per passenger. An ordinary third-class carriage, 48 ft. in length, seats 80 passengers and weighs 21 tons—0.26 ton per passenger. English cars are of frail construction, compared with ours, and they lack platforms, but there is something very attractive in their light weight. They ride well and also run easily. It was interesting and amusing to see on the London & Northwestern, at Crewe, a so-called heavy baggage van placed on the main line for loading, by a horse. He was an able-bodied animal and gave the car a sudden short pull, after which he hustled along to keep out of its way, while it coasted perhaps 40 feet. Now what impression would a horse make on one of our modern baggage cars? This goes to show that these trains pull easily.

Premiums to locomotive engineers are the rule in England. Various methods for alloting them are followed on the different roads. On the London & Southwestern, Mr. Drummond very carefully figured the coal consumption of all important runs, taking an average for a number of years and after adding to this average about 15 per cent., he established an allowance for each. The enginemen are paid a cash premium of 20 per cent. of the value of the coal they save, that is to say, that proportion of the amount they use, deducted from the allowance. On this road cash prizes are paid also for meritorious service of any kind which leads to a saving of expense to the company. The discovery of a broken rail or anything of that kind is thus rewarded. Premiums are paid to the engineers on the Midland and are based upon all around service, considering the consumption of coal and engine supplies, punctuality and the general standing of the men in their efforts to save their employer's money and improve the service. This road pays out a large sum annually in this way. Punctuality is a very important factor in judging the premiums and for this reason the engineers do their utmost to have their engines kept up in good condition all of the time. They are supported and encouraged by the officials, to refuse to take out an engine which is in bad condition or not ready in every way for the best work. Other roads also pay cash premiums and it may be said to be a feature of English practice, which contributes toward getting excellent work out of locomotives.

"It is an unpardonable sin to have a train delayed by a locomotive failure." This remark was made in answer to a question which the writer has asked pretty generally all over Europe. It was made by the general manager of an English road. His standing in motive power matters is secured by over ten years as locomotive superintendent of the road and by the fact that he had the American Engineer in bound volumes in his book case and the latest issue was open upon his desk, when the writer called. He has read this journal for many years and several years ago was invited to preside over the entire operation of the road. (Let the young reader at home take special note of this.) He said, "We cannot afford to have locomotive failures, for they would tie us up tight as a drum." This is a fact. Passenger service has become so exacting here as to compel great attention to the conditions of locomotives.

G. M. B.





SIX COUPLED PASSENGER LOCOMOTIVES 4-6-2 (PACIFIC) TYPE, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

J. F. DEEMS, *General Superintendent Motive Power.* AMERICAN LOCOMOTIVE COMPANY (SCHENECTADY WORKS), *Builders.*

SIX COUPLED PASSENGER LOCOMOTIVES.

4-6-2 (Pacific) Type.

New York Central & Hudson River Railroad.

Until now the heaviest passenger locomotives on this road were those of the 4-4-2 type illustrated in this journal February, 1901, page 35, which have given excellent service. We now illustrate one of two new designs, from which very heavy six-coupled engines have been built by the American Locomotive Company at Schenectady. The heavier and larger design is shown, and by referring to the description of the Chicago & Alton engine of the Baldwin Works (March, 1903, page 87) it will be seen that the new New York Central engine is a close second for the honor of being the largest and heaviest passenger locomotive in the world. It has a boiler 72 1-16 ins. in diameter at the smallest ring, which, with the exception of the 2-8-0 type engine of the Colorado Midland (February, 1902, page 49), is the largest boiler ever put on a passenger engine. As the Colorado Midland engine is for special mountain service, it is not exactly in the class of this new design, which indicates a tendency toward securing improved circulation by providing the maximum possible amount of room for water in the boiler. This boiler has 303, 2¼-in. tubes, with ¾-in. spaces. The total heating surface is 3757.7 sq. ft., which indicates the appreciation of the necessity for space for circulation. It is further indicated in the 4½-in. water spaces all around the firebox at the mud ring. With the six-coupled driving wheels and a wide firebox, long tubes are necessary. Their length in this case is 20 ft., the same as those of the Chicago & Alton engine already referred to.

These engines have inside admission, piston valves with direct valve motion, cast steel frames with slab (or plate) rear sections and no joints in the frames, except at the rear of the rear diving axles. They have a new design of radial trailer trucks with radius bars and outside journals, and among the detail parts cast steel is liberally used. The pedestal binders are of cast steel, of a modified form of the old strap type, having slots 2 ins. deep for projections extending that depth into the binders. This road has given up the bolt form of binder because on engines of recent design, they would be too large to be properly tightened up in the roundhouse.

It will be remembered that the 4-4-2 type locomotive of this road are equipped with trailing trucks having outside journals. The new engines, having a very long wheel base, required a radius bar truck and a new one was designed for them. It has a frame of triangular form turning about a radius 75 ins. long when measured from the center of the axle to the center of the bearing. The form of the truck is indicated in the engravings. It was the intention to show a detail drawing of this truck, but it is omitted from this description, because a change is contemplated, which will facilitate changing the trailer wheels. The outside journal construction was used because it provides room for a good ash pan.

The frames of these engines are secured to a front deck casting in front of the cylinder, they are braced laterally by another similar casting over the front driving axle and by a third heavy casting at the back ends of the frames. The engine has self-cleaning front ends, which have now become usual practice on this road.

These heavy engines are used on the Mohawk and the Western divisions. Other engines of the same type and generally similar dimensions, by the same builders, are giving excellent service on the Boston & Albany division. In the accompanying tables the chief dimensions of the latest design, (which is known as "Class K") ratios, and some comparative figures are given.

SIX-COUPLED PASSENGER LOCOMOTIVES, 4—6—2 TYPE.
NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

RATIOS.

Heating surface to cylinder volume	=	328.4
Tractive weight to heating surface	=	37.4
Tractive weight to tractive effort	=	4.92
Tractive effort to heating surface	=	7.58
Heating surface to grate area	=	74.8
Heating surface percentage of tractive effort	=	13.2
Total weight to heating surface	=	58.2

COMPARISON WITH OTHER LARGE PASSENGER LOCOMOTIVES.

Road.	Engine Number.	Total Weight.	Total Heating Surface	Total Weight divided by heating surface.
C. & A.	601	219,000	4,078	53.7
N. Y. C.	2,794	218,000	3,757	58.2
El Paso & So. Western	——	209,500	3,818	54.8
No. Pacific	284	202,000	3,462	58.3
A. T. & S. F.	1,000	190,000	3,738	50.1
C. & O.	147	187,000	3,533	52.9
L. S. & M. S.	650	174,500	3,343	52.2

GENERAL DIMENSIONS OF NEW YORK CENTRAL 4—6—2 TYPE.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous Coal
Weight in working order	218,000 lbs.
Weight on drivers	140,500 lbs.
Weight Engine and Tender in working order	340,400 lbs.
Wheel Base, Driving	13 ft. 0 ins.
Wheel Base, Rigid	13 ft. 0 ins.
Wheel Base, Total	33 ft. 7½ ins.
Wheel Base, Total, Engine and Tender	67 ft. 6¾ ins.

CYLINDERS.

Diameter of Cylinders	22 ins.
Stroke of Piston	26 ins.
Horizontal thickness of Piston	6½ ins.
Diameter of Piston Rod	3¾ ins.
Kind of Piston Rod Packing	U. S. Metallic

VALVES.

Kind of Slide Valves	Piston type
Greatest Travel of Slide Valves	6 ins.
Outside Lap of Slide Valves	1 in.
Inside Clear of Slide Valves	⅛ in.
Lead of Valves in full gear line and line full forward motion	¼ in. lead at ¼ stroke cut off.
Kind of Valve Stem Packing	U. S. Metallic

WHEELS, ETC.

No. of Driving Wheels	6
Diameter of Driving Wheels outside of Tire	75 ins.
Thickness of Tire	3½ ins.
Driving Box Material	Cast Steel
Diameter and Length of Driving Journals	9½ ins. diameter by 12
Diameter and Length of Main Crank Pin Journals (Main Side 7½ by 4¾)	7 ins. diameter by 6½
Diameter and Length of Side Rod Crank Pin Journals, F. & B.	5 in. diameter by 4¾
Engine Truck, journals	6¼ ins. diameter by 10 ins.
Diameter of Engine Truck Wheels	36 ins.
Kind of Engine Truck Wheels	Krupp No. 3 Cast Iron spoke center
Trailing Wheels, diameter	50 ins.
Trailing Truck journals	8 by 14 ins.

BOILER.

Style	Straight top radial stayed
Outside diameter of first ring	72 1-16 ins.
Working Pressure	200 lbs.
Thickness of plates in barrel and outside of fire box	½ in., 9-16 in., 23-32 in., ¾ in., and 1 in.
Fire Box length	96⅛ ins.
Fire Box, width	75¼ ins.
Fire Box, depth	Front 79½ ins., back 64¾ ins.
Fire Box plates, thickness	Sides, ⅜ in., back, ⅜ in., crown, ⅜ in., tube sheet, ½ in.
Fire Box Water Space	Front, 4½ ins., sides, 4½ ins., back 4½ ins.
Fire Box, Stay Bolts	Taylor Iron 1 in. diameter
Tubes, number	303
Tubes, diameter	2¼ ins.
Tubes, length over tube sheets	20 ft. 0 in.
Fire Brick, Supported on	Water tubes
Heating surface, tubes	3,553.8 sq. ft.
Heating surface, water tubes	23.6 sq. ft.
Heating surface, fire box	180.3 sq. ft.
Heating surface, total	3,757.7 sq. ft.
Grate surface	50.23 sq. ft.
Exhaust Nozzles	5⅜ ins., 5⅝ ins. and 5⅞ ins. diameter
Smoke Stack, inside diameter	20 ins.
Smoke Stack, top above rail	14 ft. 6 ins.

TENDER.

Style	Water bottom
Weight, empty	52,400 lbs.
Wheels, number	8
Wheels, diameter	36 ins.
Journals, diameter and length	5½ ins. dia. by 10 ins.
Wheel Base	16 ft. 9½ ins.
Tender Trucks	Fox Pressed Steel
Water Capacity	6 000 U. S. gallons
Coal Capacity	10 tons
Brake	Westinghouse American combined

We take pleasure in announcing that we have turned over the management of our book department to the well known publishers, the Norman B. Henley Publishing Company, 132 Nassau street, New York, who will hereafter handle all book orders placed with us and answer any inquiries regarding prices or the choice of books on technical subjects or devoted to the trades. The Henley Publishing Company have published a large number of valuable books upon railroad, as well as other technical subjects, which they are prepared to supply promptly, and they are furthermore prepared to obtain any technical book, whether published in this country or abroad. Their varied and extensive experience in this line places them in position to be of great service to those in need of technical publications.

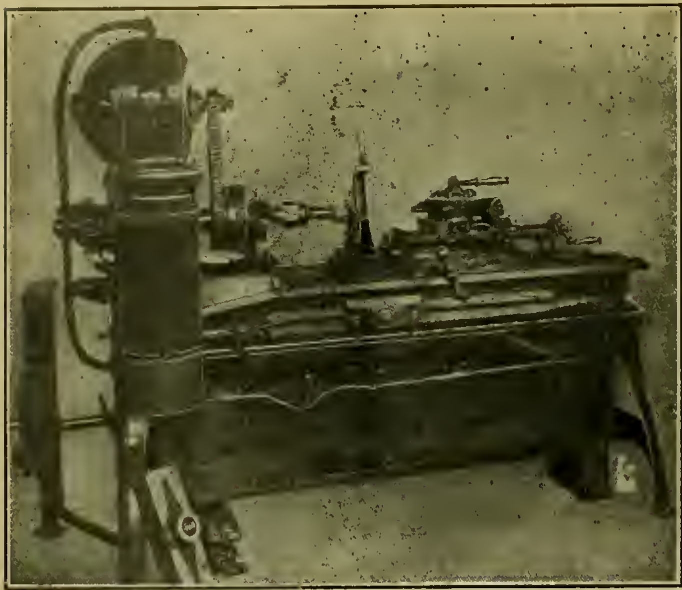


FIG. 37.—THE APPLICATION OF MULTIPLE-VOLTAGE INDIVIDUAL DRIVING TO THE OLD 18-INCH BRASS TURRET LATHE.—CROCKER-WHEELER SYSTEM.

THE APPLICATION OF INDIVIDUAL MOTOR DRIVES TO OLD MACHINE TOOLS.

McKees Rocks Shops.—Pittsburgh & Lake Erie Railroad.

BY R. V. WRIGHT, MECHANICAL ENGINEER.

VIII.

TURRET LATHES.

Reference was made in considerable detail to the methods employed in equipping the various types of lathes for individual motor driving at the McKees Rocks shops, in the second, third and fourth articles of this series (pages 165, 219 and 410 of the preceding volume, 1903), but it has been impossible heretofore to discuss the details of the changes which were made upon the turret lathes. In this article the application of the individual motor driving to two of the old turret lathes, which were used at the old shops, will be described.

Figs. 37 and 38 illustrate the motor application to an old 18-in. turret lathe, which is used for brass work. Fig. 40 shows details of the cast iron bracket that was used to carry the motor above the head stock, as shown; while Fig. 39 presents a detail of the combination latch-plate and sleeve, which was the only other change required upon this machine.

As this lathe is used exclusively for turning brass, and, as ordinarily only small work is handled upon it, it was seen that the slow run of gears would seldom be used, and it was thus decided to retain the original method of throwing the back gear in and out, in place of adding a more elaborate system of gear changes, using clutches. In order to adjust the back gear ratio to suit the speed range of the motor, only two new gears, A and B (see diagram of the drive, Fig. 38), had to be provided. Thus it was only necessary to replace the four-step belt cone by a combination latch plate and sleeve (shown in Fig. 39), upon which sleeve was keyed the new gear, A, and the large sprocket for the Morse silent-chain drive from the motor.

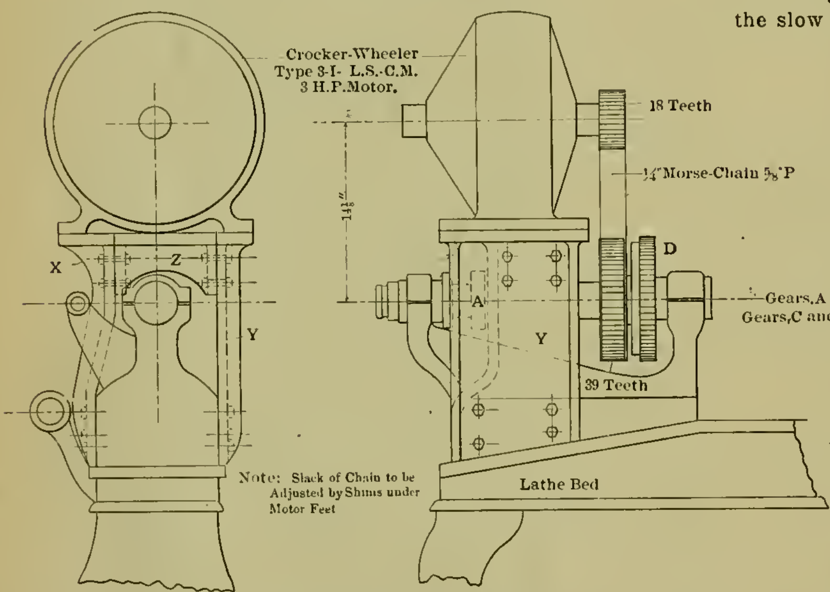


FIG. 38.—DETAILS OF THE ARRANGEMENT OF MOTOR DRIVING FOR THE 18-INCH TURRET LATHE FOR BRASS WORK.

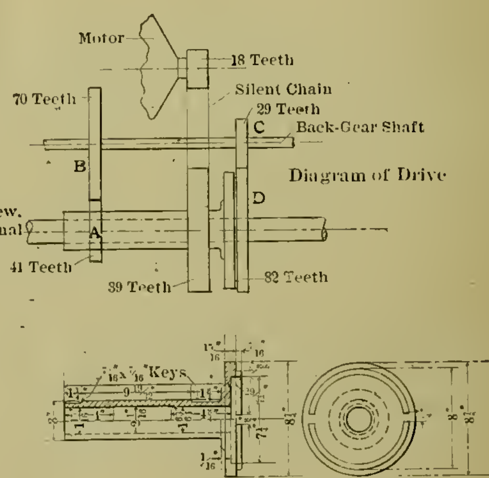


FIG. 39.—DIAGRAM OF THE NEW ARRANGEMENT OF DRIVE, AND DETAILS OF THE NEW SPECIAL SLEEVE.

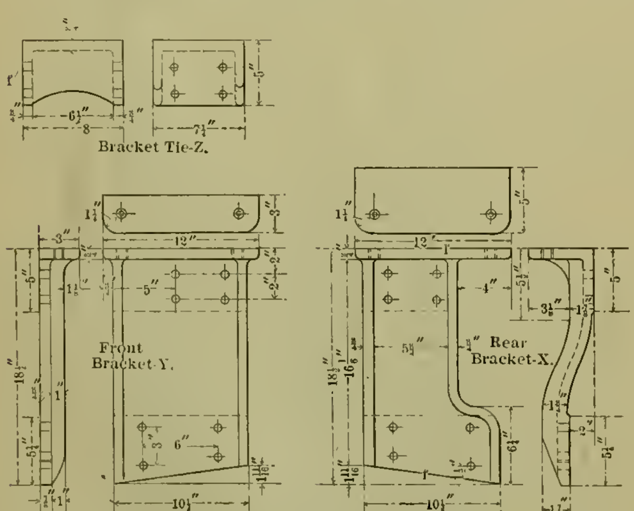


FIG. 40.—DETAILS OF THE MOTOR SUPPORT BRACKET FOR THE 18-INCH TURRET LATHE.

The motor, which is a Crocker-Wheeler type 3 I-L-S.-C.M multiple-voltage motor, developing 3 h.p. at 240 volts, is supported by the set of simple cast iron brackets, shown in Fig. 40. The controller is the type M.F.-21, Crocker-Wheeler multiple-voltage controller, and is attached to the bed of the lathe in front of the head stock, as shown in Fig. 37. With this arrangement, the operator can easily manipulate it with his left hand while watching the work.

The range of speeds thus available at the spindles and also the power available at each of the various speeds is indicated upon the diagram, Fig. 41. It will be noted that the minimum horse-power provided by the motor with this arrangement of driving, between spindle speeds of 28 and 614-rev. per min. is 1.09, while it is much greater than this at most points.

It is no uncommon sight to see the operator of this tool change the speed for each operation provided upon the turret head, where pieces of work requiring several different operations are handled. With the belt drive, more time would usually be lost in similarly changing the speeds than would be gained by the changes, when made, and ordinarily the several different operations would be done at the same speed,

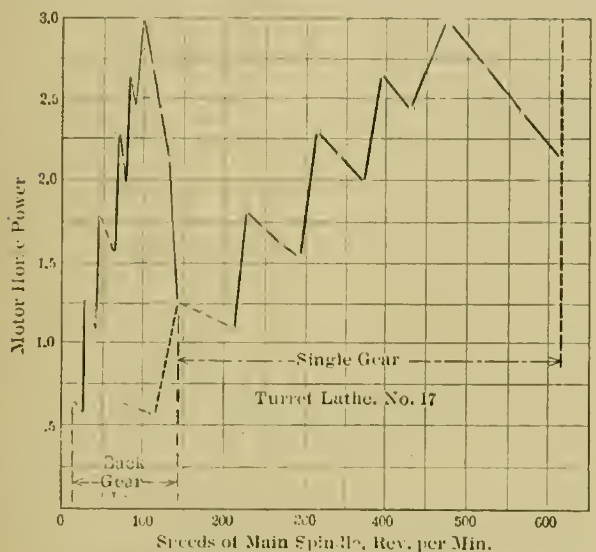


FIG. 41.—DIAGRAM SHOWING VARIATIONS OF POWER AVAILABLE AT THE VARIOUS SPEEDS OF THE MOTOR WITH THE MULTIPLE-VOLTAGE SYSTEM.

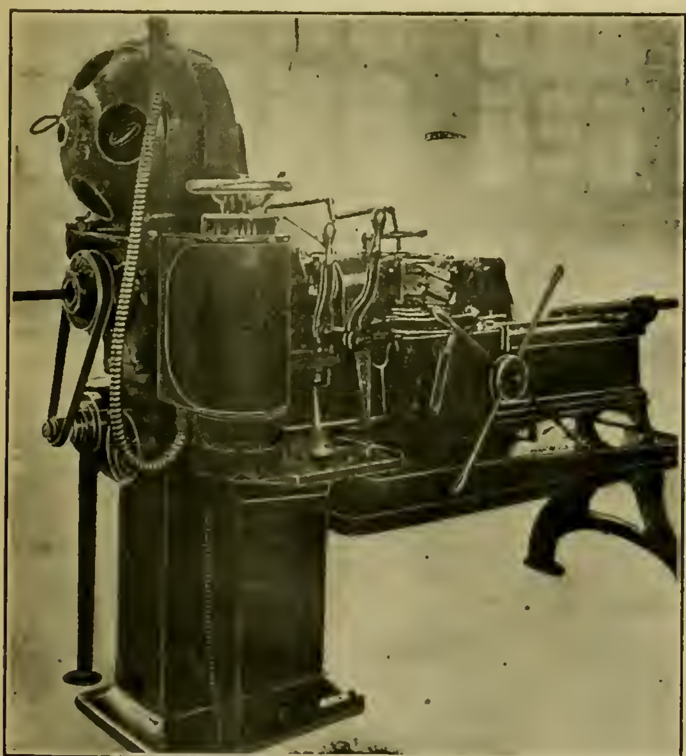


FIG. 42.—THE JONES & LAMSON FLAT TURRET LATHE, WITH THE NEW MULTIPLE-VOLTAGE DRIVE.—CROCKER-WHEELER SYSTEM.

which would be that required by the largest diameter, and thus the slowest.

Figs. 42 and 43 illustrate the application of motor driving to a Jones & Lamson flat turret lathe. This application was designed by the Jones & Lamson Machine Company, Springfield, Vt., and is very simple. The speed cone was merely replaced by a sleeve upon which the large Renold chain sprocket is keyed; the motor is supported by a plain cast iron bracket, which is made in a single piece. A light cast iron guard is provided to cover and protect the silent chain. The belt, which operates the oil pump, and which was formerly driven by a separate pulley on the countershaft, is, by the use of two idler pulleys, as shown in the end view, made to pass in through a hole in the rear side of the motor support bracket, to the sleeve on the main spindle from which it is now driven.

The controller, which is a type M.F.-21, is in this case attached to the front side of the lathe, in a manner similar to that in above-mentioned turret lathe, as shown. As this tool is rather light, a pipe was extended from the floor up to the controller to assist in carrying its weight.

The motor which is used for this drive is a Crocker-Wheeler type 5-I.-L.S.-C.M. multiple-voltage motor, developing 5-h.p. at 240 volts. The range of speed of the spindle is practically the same as that provided on the standard Jones & Lamson belt-driven turret lathe, but the number of intermediate speed steps provided is between two and three times greater. The wide range of speeds required on a tool of this type accounts for the large size motor. The nominal power provided through this speed range is about 2-h.p., but it will, of course, be greater than this at most points.

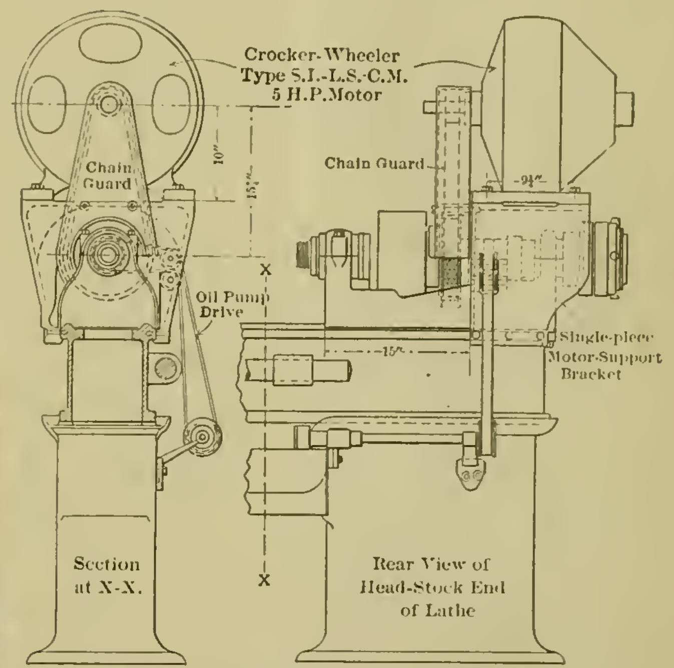


FIG. 43.—DETAILS OF APPLICATION OF THE INDIVIDUAL DRIVE TO THE JONES & LAMSON TURRET LATHE, SHOWING SPECIAL ONE-PIECE MOTOR SUPPORT.

In an exchange it is stated that standard railroad track will safely sustain from 225 to 300 lbs. per car wheel for each yard-pound of rail.

The Hudson River tunnel of the New York & New Jersey Railroad Company is almost completed, only about 300 feet remaining to finish the tube. Soon after March 1 the projectors expect to be able to join the headings and pass the first car across under the river. The finishing of the structure and construction of equipment will soon follow. It is understood that the cars will be absolutely fireproof.

The New York, New Haven & Hartford Railroad have large improvements under way at Bridgeport, Conn., involving line straightening, track elevation through the city, a new rolling-lift bridge, and a large new station. Important new work will soon be undertaken to increase the capacity of several large bridges on the main line between New York and Boston, which are old and prevent the running of locomotives weighing more than 157,000 lbs., and it is not considered safe to run loaded cars of 100,000 lbs. capacity. The allowable loads of both locomotives and loaded cars on many of the branches are much less, and in many cases are such as to make the operation of the branches complicated and unduly expensive.

AN IMPORTANT NEW TERMINAL-YARD LIGHTING AND POWER PLANT.

WEEHAWKEN, N. J.

WEST SHORE RAILROAD.

II.

With an Inset.

(*Continued from page* 46.)

The details of construction of the power plant building, which were briefly referred to in the preceding article, are herewith shown in the engravings presented in the accompanying inset. By reference to the cross section drawings, the important features of building construction, as well as the arrangement of apparatus within, may be seen. A longitudinal elevation of the boiler room is also presented in addition to the plan drawing; the longitudinal elevation of the engine room will appear in the following issue.

One of the most noticeable features of the power house is that the basement is located above ground level, the basement floor being on a level with the base of rail level of the adjoining terminal yard tracks; the ground level is just below the water table of the building, and but a few inches above maximum high tide. This brings the basement high enough to make it not only light and conveniently accessible, but also to permit of its being kept well ventilated and dry—this is important in power plant conditions. Ample head room of nearly 12 ft. is provided in the engine room basement; under the boiler room 8 ft. between floor levels is provided.

An important feature of the arrangement of the building is the provision for bringing machinery into the engine room. At the south end of the basement there is a large double door, with an opening 9 ft. 8 ins. wide by 8 ft. 6 ins. high, through which large pieces of machinery may be delivered onto the basement floor. In the engine room floor over the space immediately in front of this wide double door, there is a large hatch opening, 12 ft. square, through which the hoisting hook of the engine room traveling crane may be lowered to hoist the weight. This makes a most convenient method of bringing the heaviest pieces into the engine room. The hatch opening is protected by a 3 ft. railing of pipe construction, which may be removed when desired.

The massive character of the foundations for the engines and stacks is well shown in these drawings. All the heavier foundations rest on piling, the piles having been driven down to rest on solid rock. The footing courses of the walls are laid upon scrap rails to spread the weight, and is carried upon piles driven to solid rock. As before stated the foundations are all of concrete, composed of one part of Portland cement to two parts of clear, sharp sand and four of broken stone, and they were laid very carefully without joints so as to form a solid monolithic structure in each case. The foundation for the brick stack was built extra heavy to provide for possible extension; the original height of the stack is to be 225 ft., but the foundation is proportioned for an increase of its height by 50 ft., should the property on the Palisades above, become a residence district. This foundation is square at the base, but changes in section to octagonal a short distance below the boiler room floor, and the shaft to a circular section just below the roof.

The steel work of the building is particularly heavy and substantial. The general design of the roof trusses may be seen from the cross sections. In the engine room they have a clear span of 52 ft. from wall to wall. The boiler room trusses extend only to the columns at the face of the boilers, the columns are connected longitudinally and to the face of the exterior wall by plate girders, which support the coal and ash storage bins, thus leaving the space above clear for the conveying apparatus, as shown.

The craneways in the engine room, which consist of 42-in. steel plate girders, located 50 ft. between centers, are carried on the tops of the heavy steel columns in the side walls, which are spaced 35 ft. between centers. The stairways, to the galleries, between floors, etc., are built up of 10-in. channels with cast iron treads, and are provided with 3-ft. railings of pipe and fittings, which are also used to protect the gallery, the wheel pits around the engines and the hatchway opening in the engine room.

COAL AND ASH HANDLING SYSTEM.

A very complete system of conveyors and elevated storage hoppers has been provided for the handling and storage of coal and ashes. The arrangements of this system, which comprises a transverse belt conveyor to carry the coal from the receiving hopper and a longitudinal bucket conveyor to elevate the coal or ashes to the storage bins above, are well shown in the accompanying drawings in the inset. This, in conjunction with a coal trestle at the rear of the building by means of which car loads of coal are dumped directly into a receiving hopper and crusher, provides a perfectly automatic system of coal and ash handling, the capacity of which is for handling 30 tons of "run-of-mine" coal, either anthracite or bituminous, per hour.

The elevated pockets for coal, of which there are four, are of steel construction, as shown. They are large, 13½ by 15 ft. square at the top; the chute opening at the bottom is 19 ft. above the boiler room floor. The two ash pockets are of similar construction, but slant toward the outside wall, instead of toward the boilers, in order to deliver into cars on the coal trestle outside. These hoppers are carried partly on the side wall construction and partly by steel columns rising at the boiler fronts, which extend up to the roof trusses. Each hopper has a capacity of 35 tons of coal, making a total storage capacity of 140 tons of coal in all; the ash hoppers are calculated to take care of a three days' accumulation of ashes.

Coal is delivered to the power plant by hopper cars on the coal trestle shown alongside the rear wall of the building. From this track the cars dump direct into the receiving hopper underneath in an extension of the boiler room basement, the details of which are well shown in section D-D. From the receiving hopper the coal is directed into a large coal crusher which is capable of taking care of 30 tons per hour; it is of heavy construction and capable of reducing lumps in either anthracite or bituminous, to sizes suitable for the Rony stokers.

From the crusher the coal is delivered into the conveyor system, which consists of a belt conveyor, leading transversely a distance of 18 ft., and a bucket conveyor, receiving the coal from the belt conveyor and carrying it to the storage pockets, without manual labor. The belt conveyor is of the usual type, 18 ins. wide, and is designed for a belt speed of 400 ft. per minute. The main bucket conveyor is of the usual link type, with pressed steel buckets, 18 by 26 ins. in size at the top and spaced 28 ins. between centers in the driving chain. Automatic trips are located over the storage pockets to dump the buckets in any desired location. This conveyor is driven by a reversible, variable-speed three-phase alternating-current motor, the transverse belt conveyor and the coal crusher being driven through a countershaft by a similar but non-reversible motor.

Ashes are discharged into the main bucket conveyor directly from the ash pits under the boilers, as shown, an apron being provided to permit their being scraped into the passing buckets. After accumulating in the ash hoppers above, they are dumped into cars standing upon the trestle track at the rear and drawn away. The details of the discharge chute leading through the wall and cut-off gate outside, are well shown in section D-D. This entire conveyor equipment, including the crusher, will be furnished and installed by the Exeter Machine Works, Pittston, Pa., under a rigid guarantee for efficient and satisfactory operation.

BOILERS, STOKERS AND SUPERHEATERS.

The boiler equipment consists of four 500-h.p. horizontal water-tube boilers, set in two batteries of two each, one on either side of the stack. The boilers were built by the Aultman & Taylor Machinery Company, Mansfield, Ohio, and each is equipped with a Foster superheater supplied by the Power Specialty Company, New York. The rating of the boilers is based upon 10 sq. ft. of heating surface per boiler horse-power, and also upon the A. S. M. E. standard of 30 lbs. of water evaporated per hour from feed water at 100 degs. F., to steam at 70 lbs. pressure, and they are designed for 50 per cent. overload capacity.

The boilers are carried upon wrought iron supports, entirely independent of the brick work, and expansion is carefully provided for to insure air-tight settings. The details of the settings, and the provision for the superheater tubes, are shown, in general, in the drawings. All brickwork showing at the fronts is of white enameled brick. Further interesting details of the boiler equipment are given in the following table:

BOILERS.

Nominal Horse Power	500 H. P.
Heating Surface	5,000 sq. ft.
Working Pressure	150 lbs.
Test Pressure after erection	200 lbs.
No. of Sections	21
No. of Tubes	252
Kind of Tubes	"Knobbled," Hammered Charcoal Iron
Diameter of Tubes	4 inches
Length of Tubes	18 ft.
No. of Steam Drums	3
Length of Steam Drum	23 ft. 3⅝ ins.
Diameter of Steam Drum	36 ins.
Thickness of Steam Drum Plate	⅜ in.
No. of Mud Drums	1
Diameter of Mud Drum	12 ins.
Length of Mud Drum	12 ft. 6 ins.
Thickness of Mud Drum Plate	1¼ ins.
Size of Steam Opening	10 ins.
Number and Diameter of Dry Pipes	3—5 in.
Outside Dimensions of Setting	23 ft. 3 ins. by 15 ft.
Maximum Height of Boiler Above Floor Level	18 ft. 3 ins.
Shipping Weight per Battery	196,000 lbs.

SUPERHEATERS.

Type	Flue Fired
Square Feet of Superheating Surface	1,250 sq. ft.
No. of Tubes	24
Diameter of Tubes	4 inches
Shape of Tubes	⊃
No. of Sections	3
Diameter of Connections to and from Superheater	3—5-in. pipes

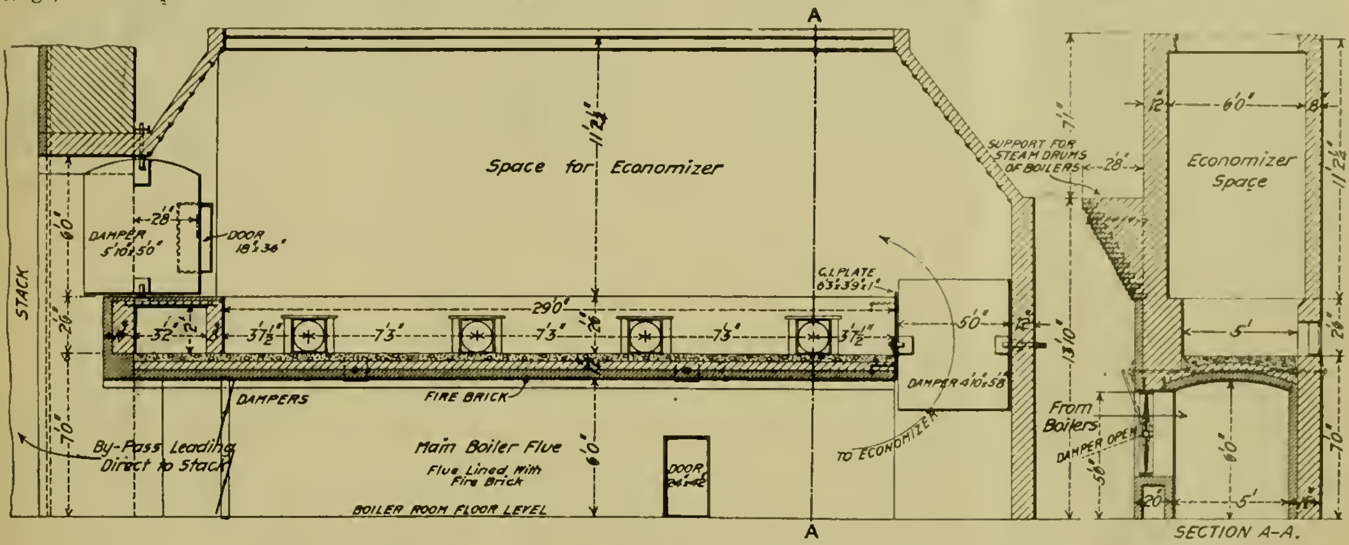
STOKERS.

Type	Roney Overfeed
Width, Over All	12 ft. 6 ins.
Length, Over All	8 ft. 2 ins.
Grate Area	112 sq. ft.
Weight, Each	21 600 lbs.
Size of Stoker Engine	4½ in. cylinder diameter, and 4-inch stroke
Horsepower of Stoker Engine, at 80 lbs. steam pressure	5 H.P.
Horsepower Required to Operate Each Stoker	1 H.P.
Draft Required by Stoker, inches of Water	⅜
Draft Required at 150 per cent. Overload, Inches of Water	½
Rating, Coal per sq. ft. of Grate per Hour	15 lbs.
150 per cent. Overload Rating, Coal per sq. ft. Grate per Hour	22 lbs.

The boilers are equipped with safety high and low water alarms, which, together with the other boiler fittings, are finished in polished brass. The feed and other auxiliary pipe connections are of heavy brass and the blow-off piping is fitted with flange connections. A special feature of the boiler and superheater construction is that all joints are made, metal to metal, without packing of any kind. The tubes of the boiler are expanded into "flowed" steel headers.

The superheaters, as shown in cross-section E-E, are located in the setting above the water tubes and form an integral part of each boiler. They are, however, provided with proper connections for by-passing, so that the boilers may deliver saturated steam, if desired. The superheater fittings are of extra heavy cast iron, of special mixture for this service. The superheaters are designed to raise the temperature of steam delivered from each boiler, at its rated pressure of 150 lbs. per sq. in., to 550 degs. F.; this provides that the temperature be measured at points in the main steam header 5 ft. beyond the boiler, and with the furnace gases leaving the boiler at not over 600 degs. F.

The stokers are the well known Roney stokers, installed by Westinghouse, Church, Kerr & Co., and are arranged for easy renewal of grate bars and sections. Each battery of two stokers is operated by a Westinghouse special stoker engine, each of which engines is large enough to operate all the stokers in case of accident. With coal supplied in proper size and proper firing, the stokers are guaranteed to consume the coal completely and smokelessly. A special feature of the furnace design is that they are proportioned for burning refuse dust and clippings from the grain elevators—an important economic feature under these conditions.



DETAILS OF THE FLUE CONSTRUCTION AND ECONOMIZER SETTING, SHOWING BY-PASS TO STACK.

ECONOMIZERS.

Two fuel economizers will be installed in the smoke flues at the rear of the boilers by the Green Fuel Economizer Company, which are utilized for heating the boiler feed water. Their location is shown in the plan and on cross-section E-E, and the details of the setting, together with the flue connections to the boiler, and the by-pass to the stack, are shown in the accompanying drawing on this page. Each unit consists of eight vertical cast-iron tubes, connected to headers at top and bottom, each row forming a section. All joints are metal to metal with machined contact faces. The feed water enters at the cooler end of the flue and leaves at the end nearest the boiler. The usual scraping devices are employed for removing soot from the tubes, which are driven by three-phase alternate-current induction motors. The principal features of the economizers are indicated in the following table:

ECONOMIZERS.

No. of Tubes in Each Section	8
No. of Sections in Each Economizer	44
Length and Diameter of Tubes	10 ft. by 3¾ ins. diameter
Total Heating Surface of Each Economizer	4,576 sq. ft.
Power Required to Operate Scrapers	2 H.P.
Size of Scraper Driving Motors	2 H. P.
Test Pressure for Economizer and Fittings	350 lbs. Hydrostatic

The economizers are guaranteed to raise the temperature of the feed water passing through them, according to the conditions of load, as given below:

Load on Boiler.	Temp. Gases Entering.	Temp. Gases Leaving.	Temp. Feed Water Entering.	Temp. Feed Water Leaving.
500—B. H. P.	450° F.	210° F.	100° F.	210° F.
1,000—B. H. P.	550° F.	342° F.	100° F.	200° F.
1,500—B. H. P.	650° F.	460° F.	100° F.	185° F.

FLUES AND STACK.

The stack is of the radial brick type and is of ample size to easily handle normal and 50 per cent. overloads on the present boiler equipment and the two additional boilers for which space is reserved. It is 225 ft. high, with an internal diameter of 10 ft., but is proportioned for an increase of 50 ft., or 275 ft. future height. The stack foundation is of concrete on piles, and ends at 8 ft. below the boiler room floor level. The base of the stack is square, but changes to half octagonal above the boiler room floor; the base ends and the chimney, which is round in section, begins just above the economizers. The chimney was built to a special design by the Alphons Custodis Chimney Construction Company. Its principal dimensions are as follows:

STACK.

Height Above Foundation	233 ft.
Height Above Boiler Room Floor	225 ft.
Height of Base Above Foundation	33 ft.
Side of Base, Outside	22 ft. 2 ins.
Diameter of Base, Inside, At Top	13 exposed ft. 10 ins.
Diameter of Base, Inside, At Bottom	13 ft. 2 ins.
Height of Round Shell	200 ft.
No. of Sections of Shell of Different Thicknesses	13
Weight per Cu. ft. of Radial Brick	120 lbs.
Thickness of Fire-Brick Lining in Base	4½ ins.
Width of Air Space Betweeu Lining and Shell	2 ins.
No. of Flue Openings	5
Wind Pressure Designed for	50 lbs. per sq. ft. of exposed surface

There are five flue openings, two on each side above the boiler room floor, as shown, and one below, on the side opposite from the office, which was installed to provide connection for the two future boilers. The details of the connections at the rear of the boilers leading to the economizer settings and to the by-passes, are made clear in the accompanying drawing. The main boiler flue, below, has a row-lock fire-brick arch over it; this is covered with a similar arch of common brick and then bedded over deeply with a strong cinder concrete for the floor of the economizer chamber. The economizer space is roofed at the sloping ends with courses of brick laid on cast-iron tees, spaced 9 ins. apart, and covered with a cement mortar. The arrangement of dampers for diverting the flue gases through the economizer, or by-passing, is clearly shown. The base of the stack is provided with a 12-in. baffle wall of fire brick, built diagonally across between the flue openings, to take the impact of the entering hot gases. This wall is spaced, as shown in the plan, to one side of the center to provide for the future boiler capacity.

(To be continued.)

NEW LOCOMOTIVE AND CAR SHOPS.

McKEES ROCKS, PA.

PITTSBURGH & LAKE ERIE RAILROAD.

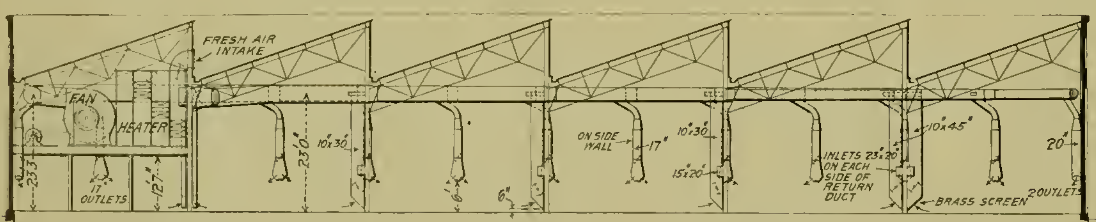
IV.

THE PAINT SHOP.

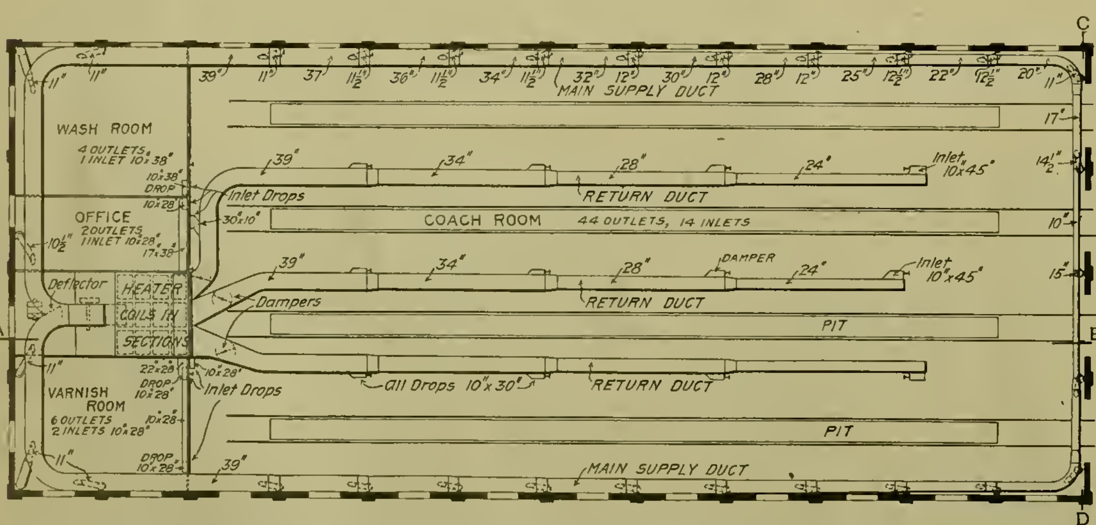
As may be noted by referring to the layout plan of the McKees Rocks shops, which was presented on page 396 of the November, 1903, issue, the paint and color shops are peculiarly located with respect to the remainder of the shop plant, being situated in a convenient Y-shaped corner formed in the west side of the shop grounds by existing track locations outside; they are not far removed from the main buildings, but are still far enough, being located nearly 200 ft. from the nearest corner of the main locomotive shop building, to protect them in case of a dangerous fire in the paint stores. Convenient access is had to both paint and color shops by tracks leading from the west side of the shops.

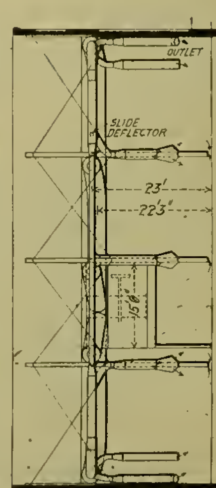
The paint shop involves some interesting features, both as to construction and as to facilities. It is a steel frame building, with saw-tooth roof construction to provide ample daylight lighting, as shown in the accompanying half-tone engravings. The general features of the building construction are well shown in the accompany sectional drawings and in the detail of roof construction, which shows also the details of the steel column construction. The outside appearance of the paint shop is greatly modified, however, and the usual peculiar exterior so noticeable in most saw tooth roofs, is avoided, by carrying the side walls above the ridges of the saw teeth; this permitted harmonizing the general exterior appearance with that of the other buildings of the shop group.

The paint shop, as shown in the plan drawing, is 204 x 85



SECTION A-B.



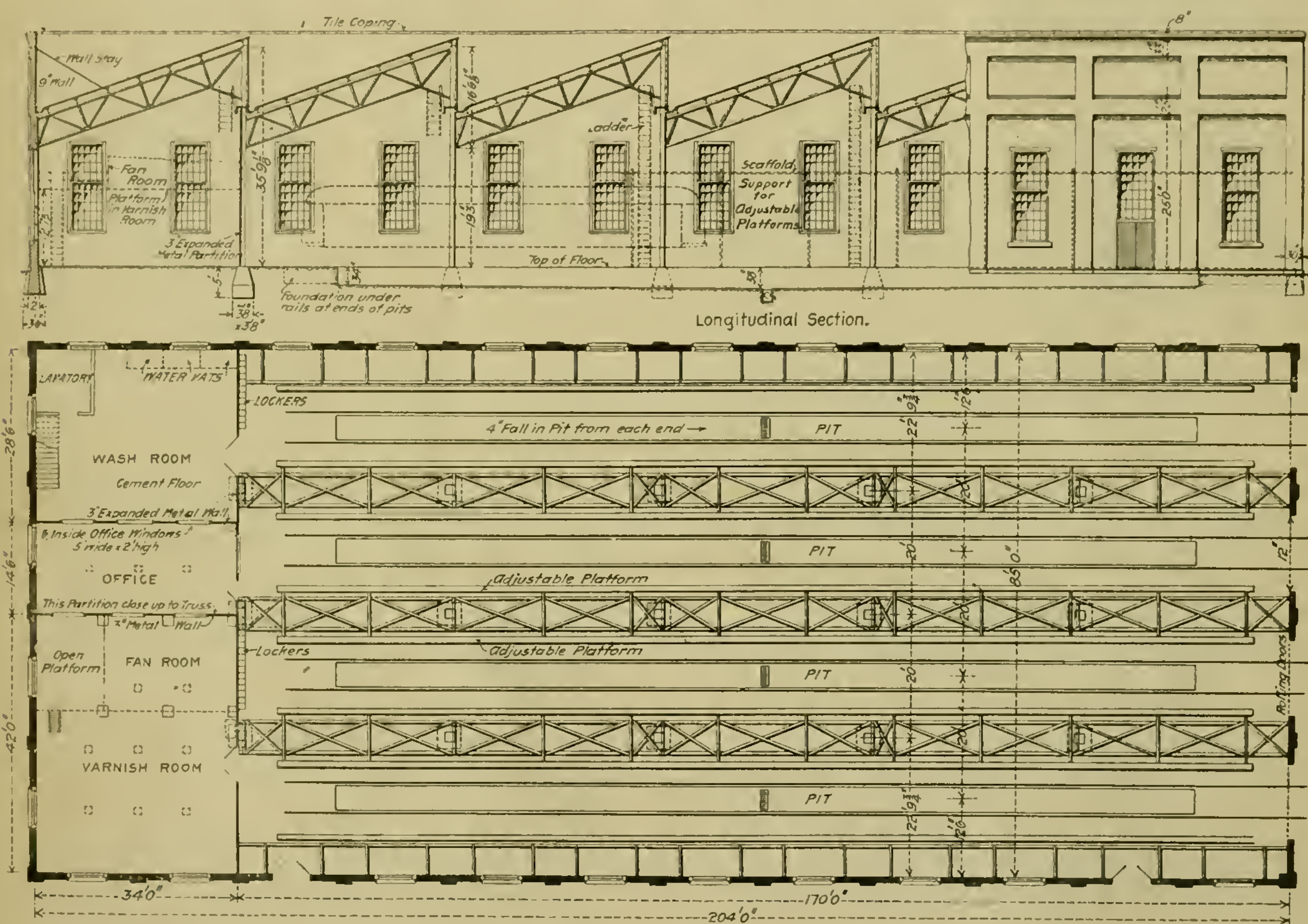


SECTION C-D.

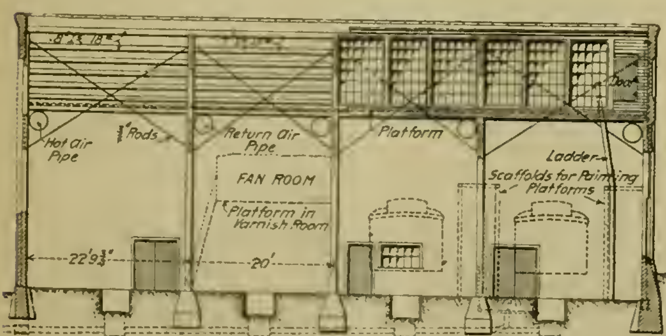
PLAN OF HEATING SYSTEM: ARRANGEMENT OF DELIVERY AND RETURN HEATING DUCTS FOR RECIRCULATING SYSTEM IN PAINT SHOP.

VIEW OF THE EXTERIOR OF THE PAINT SHOP BUILDING. (TAKEN FROM ROOF OF ERECTING SHOP.)

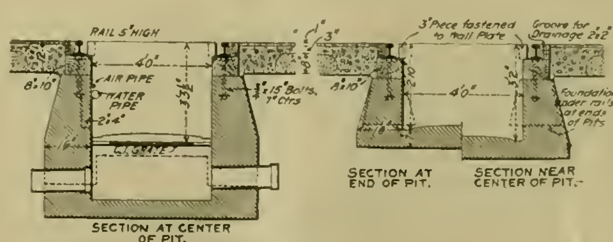
INTERIOR VIEW OF PAINT SHOP, SHOWING PROFUSE CHARACTER OF THE DAYLIGHT LIGHTING FROM THE SAW-TOOTH SKYLIGHTS.



PART LONGITUDINAL SECTION AND PART ELEVATION, AND PLAN OF THE PAINT SHOP, SHOWING ARRANGEMENT OF FRAMEWORK BRACING FOR ADJUSTABLE SCAFFOLD SYSTEM.



CROSS SECTION OF PAINT SHOP.



DETAIL SECTIONS OF PITS.

McKEES ROCKS SHOPS.—PITTSBURG & LAKE ERIE RAILROAD.

ft. inside, with a clear distance of 19 ft. 3 ins. under the lowest portions of the roof trusses. The roof is supported between walls by three rows of steel columns, of five columns each, dividing the building into six sections. The section at the south end, 34 ft., is partitioned off to provide accommodations for the washing and varnishing departments, office, etc., which are arranged across this end of the building, as shown; the partitions are built of concrete, 3 ins. thick, on expanded metal, all of which are carried up to the roof trusses or roof. A most light and convenient shop has been secured; the character of the daylight lighting, which is northern exposure, may be judged from the interior view of this building looking toward the saw-tooth skylights. The convenience of the workmen is provided for in an excellent arrangement of lavatories and water closets in one corner of the washing room; the water closets are located on an elevated platform or gallery, 9 ft. above floor level, beneath which are the lavatories.

Four longitudinal tracks lead into the paint shop, spaced 20 ft. 0 ins. between centers, as shown on the plan. These tracks extend 165 ft. into the building, or within 15 ft. of the partition across the south end, and are provided with pits which are of concrete construction, as is the floor throughout the building. The construction of these pits is shown in the detail cross sections, one at the drainage point at the middle and the other at different points of depth; each pit is 140 ft. long and 34 ins. deep at the ends, dropping to 38 ins. deep at the drainage points at the middle. The drain connections are shown in the cross-section view of the buildings; each drain is covered at the pit by a cast-iron grating. A feature of this building is also to be found in the system of inside roof drainage and the provision of steam heating pipes (see detail of roof construction) beneath the gutters to thaw out ice that may form there in winter.

HEATING AND VENTILATING SYSTEM.

One of the most important features of this shop is the heating and ventilating system, which was designed with great care to properly fulfill the special requirements. The requirements of the modern paint shop in this particular were very concisely stated by Mr. W. O. Quest, master painter of the P. & L. E. R. R., in a recent paper before the Railway Club of Pittsburgh, as follows:

"The essentials of heating and ventilating a railway paint shop according to requirements, should be so mathematically adjusted as to conform to interior shop space in such a manner as to prevent these opposite elements from conflicting with shop cleanliness. A controlled volume of circulated air should be secured through a series of easily manipulated ventilator openings located in the ceiling, or other similar mechanical appliance that will insure a fresh air supply, and at the same time prevent the generated heat from being carried away from work line of shop. Without question, all heat should be either generated or discharged at a low floor line, in order that all moisture resulting from car washing, etc., will quickly dry up. According to the available practical authority, the installation of the recirculating system of hot air heating and ventilating, the shop should be so constructed as to insure a fifty to sixty per cent foul air displacement in a given time, as it is claimed that the constant churning over of foul air of a paint shop, without taking in at least fifty per cent of fresh air hourly from outside, will be productive of bad results in the form of both moisture and a poisonous gaseous air, which are extremely injurious to both fresh applied paint and varnish and to the health of the men compelled to work under such conditions. There is an inevitable law that all heat ascends and never descends only when in such volume as to entirely displace the pure air, showing conclusively that all heat should be generated as near floor line as possible, which will, with necessary top ventilation, produce an ideal shop atmosphere on an old established law which, when put to the test, usually shows that it is the most practical, and not the most scientific of heating and ventilating system that is wanted in the railway car paint shop."

On account of the importance of this subject, as well as the excellent manner in which these requirements were provided for at this shop, we illustrate the heating system in detail. It consists of a motor-driven ventilating blower equipment, located in the varnish room, and connected up with return suction and delivery pipes for recirculating the air in the shop. The main delivery ducts extend under the roof around the outside walls of the building as shown; the ventilating system plan; the delivery outlets, which are spaced 17 ft. apart, extend down the side walls to within 6 ft. of the floor, and are provided with double-ported deflector openings to divert and scatter the hot blast. The return ducts are carried under the roof along the three lines of roof-supporting columns and the suction openings extend down at every column with large screen-covered openings at the floor. These delivery and return mains, as well as the outlets, are all of galvanized iron ducts of sizes shown on the plan.

The motor and fan are mounted, at an elevation of 12 ft. above the floor, upon a structural iron platform, along the west side of the varnish room, which forms a gallery with a clear height underneath of 11 ft. This platform also carries the heating coils for adjusting the temperature of the air delivered through the shop. The return suction mains lead to the casing of this heater and the fan takes its suction from the delivery side of the heater; a connection is provided on the intake side of the heater with the roof so that fresh air may be added to the air circulation, as desired, to effect the desired displacement of foul air. Dampers are liberally provided in all intake and delivery outlets and connections, so that the flow of air, and the general temperature effect can be adjusted in a most flexible manner. The low delivery points for the hot blast, and the arrangement of intake openings at the floor to remove the lower strata of cold air, are the important and remarkable features of this system.

NEW DESIGN OF ADJUSTABLE SCAFFOLDING.

A scaffold system of an entirely new and original design has been installed in the paint shop, which is worthy of particular notice. The details of the notched supporting posts and method of bracing them from the main columns of the building, as well as of the malleable iron adjustable brackets used on the posts, are shown in the accompanying detail sketch; the arrangement of the scaffold posts and trussed bracing structure, between the pit tracks, is shown in the plan view of the building.

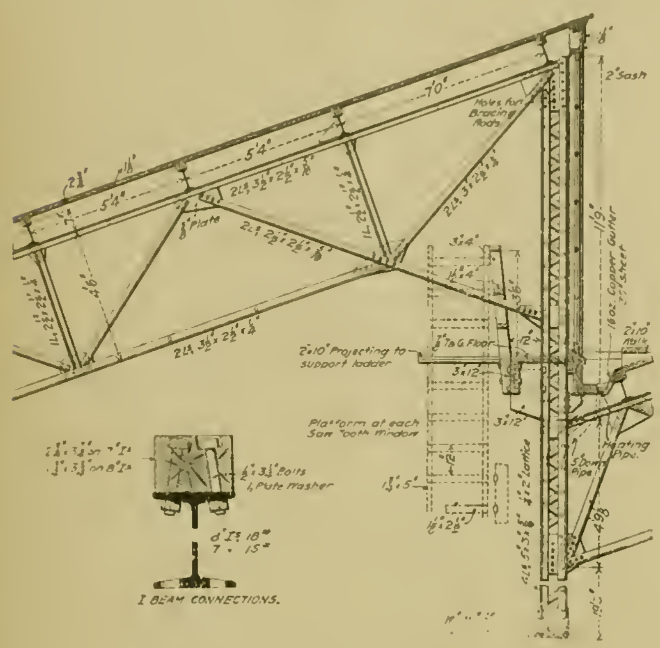
The method of operation is as follows: Each notched post has on it one of the adjustable brackets, which will rest at any notch along its length, as shown on the end elevation. To raise these brackets, which carry the sectionalized scaffold, it is only necessary to pull down on hoisting rope, H, which acts over the pulleys and lifts the brackets up until they catch in higher notches; in lowering the scaffold, the lowering rope, L, is pulled down sufficiently to unlatch the bracket from the notch it is resting in, after which it may be allowed to descend by paying out on the hoisting rope. Inasmuch as the weight of the scaffold comes on the outer edge of the bracket, it will very quickly seek a notch and settle in it. The details of construction of these brackets are very clearly shown in the accompanying detail drawing; it will be noted that pipe rollers are provided in the handle, on the inside, so as to prevent binding in raising and lowering.

An interesting feature of this scaffolding is that the painters can very easily raise or lower the platform while they are on it. By placing one foot on the handle at the rear of the notched post and pulling down on rope, H, they bring the bracket to an unlatched position, after which the platform may be moved up or down; this is made possible by the act of stepping over onto the handle at the rear, which takes part of their weight off the platform. The very interesting and remarkable feature of the scheme is that the constant tendency of the bracket is to seek a supporting notch, so that there is no possibility of dropping; the bracket is tilted into the lowering position only by pulling rope, L, very forcibly, as the scaffold must be lifted; and if rope, L, is quickly slackened the bracket will instantly seek the next lower notch and thus not fall any distance. It is practically impossible to move the scaffold while anyone is on it, as their weight acts so strongly in holding the bracket in the notch.

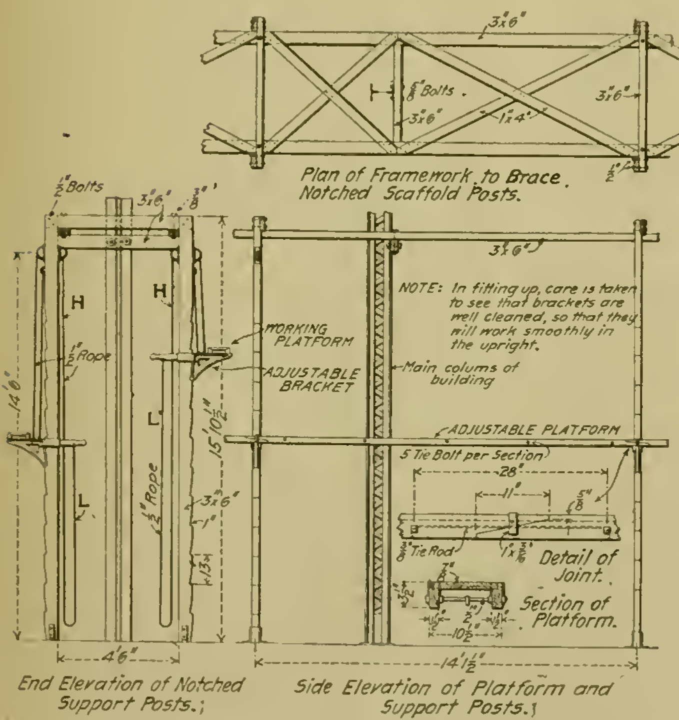
The platforms are built in 14-ft. lengths, and are flexibly connected at the joints; this permits of one section being raised a notch higher or lower than those next to it at either end. A detail of the joint in the platform is shown on the scaffold drawing. By this means the sections of the platforms are held tightly together lengthwise, but are very flexible for raising and lowering. This interesting and valuable system of adjustable scaffolding is the invention of Mr. W. O. Quest, the master painter of this road.

THE COLOR SHOP.

The color shop is a neat brick building, 30 x 60 ft. in size, which is to be used for storing paints, oils, supplies, etc., and is



ROOF TRUSS CONSTRUCTION OF PAINT SHOP.

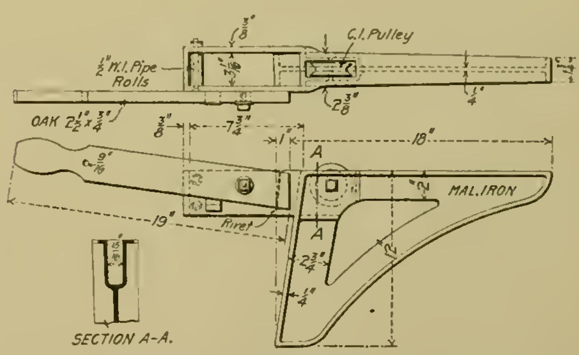


DETAILS OF THE ADJUSTABLE SCAFFOLD SYSTEM FOR THE USE OF THE CAR PAINTERS IN THE PAINT SHOP.

located about 40 ft. to the east of the paint shop. A spur track runs along its west side which is equipped with an unloading platform for direct handling of barrels, etc. Besides the use for storage, the basement of this building is to be fitted up for a modern glass etching, mirroring and embossing plant, and to accommodate sign work and the cutting of standard freight car stencils—a very convenient and useful equipment for the modern railway paint shop.

Power hoist devices for handling ash pit refuse do not appear to increase in popularity. The old fashioned pit with inclined tracks for the cinder cars seem now to be decidedly preferred. Power devices depend upon the power and this part of the plant is tied up by a burst pipe or a leaky gasket, a wornout packing leather or a broken cable. At one large roundhouse it has been found necessary to discard an elaborate air hoist device in favor of an ordinary pit. The number of men required to clean fires is sufficient to clean the pit at times when the other work is not pressing. The officer responsible for this change says he would rather put the cost of the air hoist into another pit and pit tracks in order to clean fires quicker. Of course air hoists can be made to work; but unless great capacity in storage of ashes is provided, the device is likely to be "snowed under" in a time of stress and then the whole thing must be shoveled out—a most inconvenient job. The ideal arrangement seems to be a pit track raised on stilts above an incline of concrete with a cinder car track at a lower level and beside the pit track, so placed as to render the shoveling easy. All that then remains is to put in enough tracks to permit of passing the engines quickly and to make the tracks long enough so that they will not quickly clog up with ash and cinder.

High cutting speeds are specially interesting when accomplished on old machines. In an out of the way corner of a locomotive shop, our representative found an old Niles 36-in. axle lathe which was speeded up to a cutting speed of 51¾ ft. per minute in axle turning. With one of the new tool steels it was taking a ¼-in. cut at ⅛-in. feed at this speed. In the same shop is a ten-year-old, 42-in boring mill. It is too feeble to carry a heavy cut on large works and is used to bore out driving boxes. A large box is set, faced and bored in 30 minutes and the machine does this work very well. The boring alone is often done in eight minutes.



DETAILS OF THE BRACKET USED ON THE NOTCHED POSTS TO CARRY THE ADJUSTABLE PLATFORM.

Large compound locomotives must be provided with devices to facilitate drifting without overheating the cylinders. They are usually liberally provided with relief bypass and water valves and these, with the piston rod and valve stem packings, frequently leak and sometimes enough steam escapes to obscure the view of the engineer. It is strange but true that this difficulty is made the basis of an argument against the compound locomotive in general. Such a complaint is a surprising confession of helplessness, but it is often heard and is not confined to any particular type of compound. The circulating pipe used so successfully on the Southern Pacific meets this difficulty perfectly, except as to the leakage of piston rod and valve stem packing. With piston valves a circulating device is necessary for all cylinders and specially is it necessary for large low pressure cylinders where much drifting is done. The time is past for saying that "compounds are all right for level roads, but on mountain roads the fuel saved on up grades is lost again in drifting."

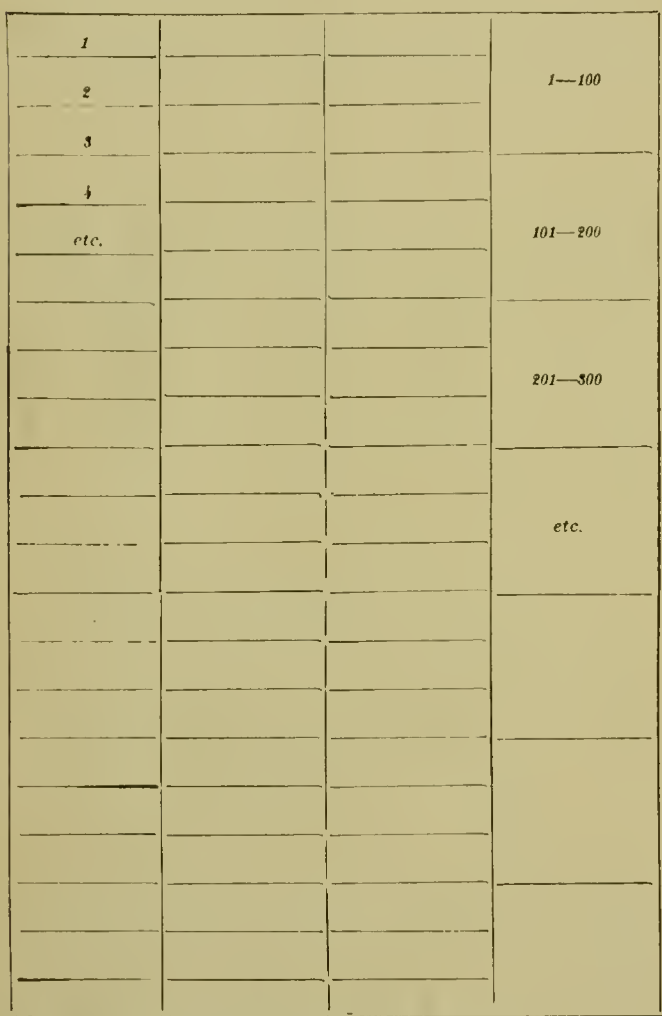
RAILROAD SHOP MANAGEMENT.

By William S. Cozad, Norfolk & Western Railway.

IV.

(*Concluded from page* 58.)

The filing case is divided into small sections, the number of each section corresponding to the number of the man whose card is placed in it. On the right will be noticed boxes numbered 100, 200, etc.; these boxes serve as a temporary file. Piece-work cards from 1 to 100, after being entered in the time book, should be placed in box 100, cards from 101 to 200 in box 200, and so on. In small shops these boxes may be numbered from 1 to 50, etc., if desired. Fig. 9 represents a front view of this Card Record case. This case should be made with doors and of sufficient size to accommodate the shop, or department, each man's number to correspond to one number in the case.



Front view of card record case.

FIG. 9.

One of the claims made for this system of time-keeping is that each workman entering the shop *must* be accounted for. If he does not see that he is registered, he alone is responsible if he loses his time. It also precludes the possibility of allowing an employee time when he is not in the shop, or of failing to allow him time when he is at work, except on account of clerical error. It may be claimed that it is taking an unreasonable view of the matter to suppose that errors of such a nature will occur, but a number of such instances have come to the personal knowledge of the writer; in one case a car repairer was carried on the time book an entire month, his time was put on the pay-roll and a check made for it, when he was not inside the shop-yard gate at any time within the month. This was in a department of a shop employing several hundred men, where the foreman was stock clerk, shipping clerk, time-keeper, and about everything else, except foreman. Experience has proven very clearly that unless specific methods are followed, it is a very easy matter to over-pay or under-pay for half days, or a number of hours, and often very difficult to locate the responsibility for the error.

The brass check system, used in many shops for registering men in and out, is practically no check at all, as checks may be lost, "sent in," left hanging on the board, etc., etc. Many railway shops have no system at all of checking men, either in or out. In a shop in which the writer was employed sometime ago, where several hundred men were at work and where no system of checking was used, employees could be seen coming in at any time up to 8 A. M. and leaving at any time between 5 and 6 P. M. This is demoralizing to the men, and if the boys, who are taken in as apprentices, come up under this condition, to be careless, indifferent men, the officials of the shop are directly responsible for it.

The system described above will be found suitable for any department of a railway shop, either car or locomotive, and if put into the hands of a competent time-keeper and competent piece-work inspectors, it will be found that the occurrence of such instances as outlined will be entirely avoided, and that with the assistance of the piece-work inspectors at the end of the month, one man will be able to handle the time of a large number of employees.

It is not claimed, of course, that this system is entirely perfect, but it is believed that when properly handled it will meet all practical requirements. The writer invites criticism, and will be very glad to attempt to answer the inquiries of any one interested in the subject.

CONCLUSION.

APPRENTICES UNDER PIECEWORK.

Within the past half dozen years many papers have been written on the subject of handling apprentices, not only in repair shops, but in the large iron and steel manufacturing concerns of the country; the effect of this seems to have been not to establish a set of rules which might be followed by all large shops, but to fix more firmly in the mind of the shop superintendent the belief that the methods, which have been in effect for many years past, are sufficient, if properly applied, to meet all necessary requirements.

While all this *general* discussion has been going on, very little, if anything, has been said in relation to handling apprentices in railway repair shops operated on a piece-work basis—as to whether they should be allowed to work piece-work in the blacksmith shop, machine shop, boiler shop, etc., and if so, to what extent, or whether there should be any limit. To discuss this subject intelligently it is necessary to examine certain phases of the question on which the successful application of the piece-work principle must rest, chief of which is the present rate of wages now paid apprentices in railroad shops.

The employment and training of apprentices was a subject of special investigation and discussion before the American Railway Master Mechanics' Association for some three or four years, and on the wage question the following recommendation was made: "Your committee would suggest, as an equitable scale of pay, 50 cents a day for a 10-hour day; that is, 50 cents for the first year and an increase of 25 cents a day for each year thereafter, and for an 8-hour day, 40 cents a day for the first year and an increase of 20 cents per day for each year thereafter."

Since this recommendation was made a great many men, prominent in the motive power department, have written on the subject of training apprentices, some expressing one opinion, some another; but no one has been willing to defend the extremely low scale of wages proposed in the above report (and few roads are paying as little), while many have expressed themselves as believing it to be entirely too low.

We cannot sustain present low wages on the ground that not many years ago boys were glad of an opportunity to learn a trade without any compensation whatever. Times and conditions change. Wages have doubled, and in many instances, are three times what they were a few years ago. Men have advanced in knowledge, are more capable, and the boys who are now put on their time are more intelligent and better qualified for the work before them. They are required to produce more and better work than ever before and there can be nothing more unreasonable than to expect a sober, honest, industrious young man 22 or 23 years of age (24 is the limit) to go into a boiler shop and perform the hardest kind of manual labor for 10 long hours for the very small sum of 50 cents.

A young man, perhaps 18 years of age, is placed in the blacksmith shop as an apprentice. After he has run the steam hammer or a bolt machine for a few months he is put on some heavy work, where he is expected to swing a 10-pound sledge six days in the week, and when Saturday night comes he is obliged to send home for a dollar to make enough to pay his board bill for the week. This furnishes ample reason for the fact that the number of young men applying for positions in the boiler and blacksmith shops are comparatively few.

The helper enters the shop and is paid from the first at the rate of about $1.50 per day for his services; and, while there is no special course laid out for him, if he is intelligent, "keeps his eye on the gun" and attends strictly to his business, he can, at the end of the first two or three years, resign his position, go to some other shop where he is not known and *hire out as a full-fledged mechanic*—and after working three or six months, return to his home shop, and, from that time on, he is a *finished mechanic* and receives all the recognition and wages which belong to his profession. The apprentice whom he left six months ago may now be put with him under instruction and has a year to serve at $1.50 per day or less before he can be considered as well qualified in the profession as his present instructor, who was advanced from sweeper to helper a month after he (the apprentice) was put on his time.

A question is suggested here which ought to receive the sober consideration of all laboring men as well as employers of labor who operate the shops in question: that is, when the foreman finds that he has a young man in his shop who is in every way qualified to do certain lines of mechanical work it ought to be in full accord with the natural order of things to recognize his ability. It doesn't make half so much difference who a man's father was as who his son is, or where a man came from as which way he is going; and after all, the most essential requirement is not a certain number of years apprenticeship, but *ability to perform the service required.* Having character and a good reputation, then, the standard by which human usefulness must be measured is capacity to meet the practical requirements of the department in which we are employed.

Next in order, is apprentices working with mechanics on piece-work jobs. It has been recommended by a committee of the American Railway Master Mechanics' Association that "Apprentices who are working with mechanics on piece-work jobs will be paid their regular hourly rates. Mechanics thus assisted by apprentices on piece-work jobs will be paid only the proper proportion of the piece-work rate."

If a sweeper is taken from the floor to assist in handling a set of steam pipes where piece-work prices prevail, he is usually put on the card with the mechanic and the total amount of the job is divided in proportion to the day rate and the number of hours worked. If a handy man strips an engine, rods, ash pan, boiler mounting, motion work, etc., he receives the prevailing piece-work price of the shop for his service. If a helper assists a mechanic in putting in a set of pistons or hanging a set of guides, he is paid either his proportion as based on day rate or a certain fixed per cent of the total amount earned. This is all right. If, however, an apprentice performs any of the work outlined above—no matter how quickly and how well—he is to be paid according to the above ruling—not what he earns, but "his regular hourly rate."

Why this difference? Why is not the product of the apprentice worth as much to the company as the product of the sweeper or the helper? The only argument in favor of this policy is that piece-work encourages poor work and a desire on the part of the workman to get through as quickly as possible, regardless of the quality of the work. This condition, if it exist at all, is due entirely to improper shop supervision. Such a method is not only wrong in principle, but discouraging to the average young man who would like to make a record, but whose mind is continually absorbed in trying to solve the impossible problem of making a $1 bill pay a $2 debt. It places a premium on indolence! It leads to killing time, working without energy, lounging, hiding when the foreman passes through the shop, talking nonsense, half doing things, and a hundred other things, all of which instead of stimulating the worker to more earnest efforts, lead him to believe that his principal duty lies in putting in 8 or 10 hours a day, no matter how it is done!

It has also been recommended that "The charge of apprentices should be given to one particular and well qualified person, to be known as the foreman of apprentices. This practice is followed in other countries and is undoubtedly satisfactory. We know of no other way of insuring the proper attention being given apprentices without great waste of somebody's time. One person should be distinctly charged with the care of apprentices and should be responsible for them, and much pains should be taken in the selection of the man."

This is the keynote to the entire situation. It will solve the problem in any shop, either large or small, not only from the standpoint of economy on the side of the company, but also in satisfying the desire of the ambitious boy to find the quickest and best way to do things. It will also insure a much higher grade of mechanics in the future. Whether there should be a man assigned to each department to instruct apprentices, or whether one man for the entire shop, to be known as foreman of all apprentices, is a question which could probably best be settled by each individual shop, depending somewhat on the size of the plant. But the recommendation that "much pains should be taken in the selection of the man" is strictly to the point. We believe that the man selected should not only have some technical ability, but should be a mechanic who has had a wide experience in his profession and *knows his business.* He should be a reader and an investigator, as well as a worker in the shop. He should go from one machine to another, study his young men individually, find out their weak points and build them up.

A book account ought to be opened with each apprentice the first day he enters the shop. He should know that he begins work with nothing in his favor and nothing against him, and that his future record with the company is going to be couched in an impartial double entry account. If he comes in late in the mornings, wastes time, is negligent, careless in the use of his tools, spoils work, or is continually complaining about "everything bein' out o' fix," it will be recorded against him, and if, after he has been employed a sufficient time, it is the judgment of the management that he is not fitted for the work before him, he will be dropped from the service. If, on the other hand, he is always on time, attentive, energetic, devotes his spare time to study, and is always making a special effort to improve on his past record, all these facts will be recorded in his favor. The old way of the foreman going up to an apprentice and saying: "Well, Mike, you did fair work on that last job, except it's a little rough, now see if you can't do better next time"; or, if Mike has gone wrong, of flaying him with language more forcible than elegant and threatening to discharge him right on the spot if it ever happens again, ought to be abolished and a record in fact kept; and on that record should hang the young man's future success with the company.

Now as to apprentices working piece-work: It can be demonstrated beyond any possible question, as the following illustrations will show, that by giving apprentices a piece-rating, their interests in the work will be quickened, their energy aroused in the work, and they will very materially increase their earnings over the day rate, while at the same time the cost of output will be very largely decreased to the company.

In the code of rules covering the time of apprentices in the blacksmith shop as laid down by the American Railway Master

Mechanics' Association, the first six months shall be spent on the bolt heading machine or steam hammer. Very good—let us consider an example:

Let A represent a foreman of a shop in which piece-work has been reduced to an exact science. Everything is alive with energy, the foreman being always in the lead. His piece-work rate for heading bolts is $1 per thousand. He has an apprentice working on the bolt heading machine, who was formerly rated at 75 cents per day on day work, the helper having been rated at $1.25 per day on day work. The average output of an ordinary Ajax or Acme bolt machine, run in connection with proper heating facilities, is about 4,000 bolts, ⅞-in. diameter and under, per day. The machine in this shop being run up to its normal capacity, the apprentice and helper on the work make $2 each per day and the bolts cost the company $1 per thousand, as stated above.

B is a foreman running another shop. He believes in standards. He pays his apprentices 50 cents per day and helpers $1.25. He has no foreman of apprentices; never could see the use of so much supervision. They tried piece-work one time, but found it to be a failure. The foreman allows that two men attending strictly to business ought to head about 1,800 bolts in 10 hours. Here he is a little ahead of the procession, for this is a high average in day work shops, although there are some exceptions. At this rate it would take 22 hours to make 4,000 bolts, and they would cost for labor $3.85. The cost of the machine for the extra 12 hours, which is required by this method to make the bolts, being figured at 35 cents per hour, is $4.20; this makes the total cost of the 4,000 bolts, $8.05, or $2.01 per thousand. Hence it will be readily seen that A, by the systematic organization of his work and proper appreciation of the service of his employees, has not only doubled the wages of his men, but reduced by one-half the cost of the product to the company.

Let us take another example: A is foreman of a machine shop. His apprentices are rated at 50 cents per day, first year, but everything is on a piece-work basis. His machines are all in good repair, and on the bolt lathes he has a special chuck which takes the bolt without stopping the machine. He has an apprentice running one of these bolt lathes who just commenced a week ago and pays him ½ cent each for roughing out bolts 8 to 12 ins. long, 1-in. diameter. He has been thoroughly instructed in the work by the foreman of apprentices. The lathe is run at the rate of about 175 revs. per min., or at a cutting speed of about 50 ft. per min., easily rough-turning 30 bolts of the above dimensions per hour, or 200 per day, which, at ¾ cent each, makes the day's earnings $1.50.

B is foreman of another shop, all on day work. Apprentices are paid 50 cents per day, first year. No particular attention is paid to them. John Smith, a boy 17 years of age, commenced work a week ago, was taken over and introduced to an old rickety lathe, and has not spoken to the foreman since. He found the belt in a certain position on the cone, and has been afraid to attempt to change it. The lathe is running about 75 revs. per min., but it looks to him as though it is running 500 revs. He tried the first two or three days to do something but did not make much headway. Nobody seemed to pay much attention to anything but the clock and the whistle, and he concludes that he is doing well enough and settles down to that pace. An inventory of his stock at the end of the day discloses the remarkable fact that he has rough-turned 50 bolts of 1-in. diameter and 12 ins. long.

To turn 200 bolts at this rate would require four days at 50 cents per day or $2 cost. Now, figuring that the machine is worth $1 a day to the company, we would get the use of it three days more by the first method, which would amount to $3, making the total cost of 200 bolts by the day-work standard, $5, or $2.50 per 100, as against 50 cents per hundred under the piece-rate plan. In the first instance, the boy increased his day rate 200 per cent. and the company saved even more, while in the last example both lost in the end.

The above illustrations are not visionary, but will be recognized as plain, common sense facts by all who have had an opportunity to study the practical effect of both methods. Many other similar cases might be cited, but these two are sufficient to show the general trend of the apprentice who is given little or no attention, and the consequent loss to the company.

To the young man serving his time who, perchance, may read this article, I beg to add a parting word. *Don't be afraid of earning a dollar more than you get!* If you are paid $1 per day, and earn no more, you are a dead weight on the company's hands. Business institutions are not run for amusement, but for profit; and the man who does not add his mite to the sum total of the profits is in the wrong business. Remember, too, you are in business for yourself and cannot afford to waste a minute.

If you do not receive such attention as you may wish for, work out your own salvation. Think! investigate! experiment! If you don't succeed by one means, try another. There is no such thing as failure before the man with an iron will. Once in the service of the company on your time, with your name on the pay-roll, no matter what kind of a shop, you have the advantage of a thousand less fortunate boys and you ought to succeed. But no matter where you go, nor in what shop you work, if you are quick, active, earnest and energetic, you will find men eager to advise you: not to hurry, to take lots of time, that the world wasn't built in a day, not to spoil the job by doing so much, that the company will cut the price, that the next man will have to do more than you, etc., etc., and this from genuine "knockers" full of whimsical inconsistency and perverse unreason—"knockers" who were born wrong, and are "knockers" because they were born wrong. They seem to have wheels in their head that are continually running in the wrong direction. But let me insist for your own good, that you:

"Go ahead and make your play,
Never mind the knocker.
He's in every worker's way,
Never mind the knocker."

"He strikes only those who climb;
Never mind the knocker.
'Tis success he deems a crime,
Never mind the knocker."

"When the knocker's course is run,
When his jeers and scoffs are done,
He'll be cursed by every one;
Never mind the knocker."

(The above lines are quoted from the *Machinists' Journal.*)

A little while ago a motive power superintendent sat up nights preparing a lecture to be delivered to the apprentices of one of his shops. The shop men heard of this and asked to be allowed to come in. When the apprentices assembled, two hundred shop men came with them, and all listened with interested attention to a most admirable address from a man who had worn overalls for years and knew what he was talking about when he revealed to his audience a view of the ground upon which the mechanic of to-day stands, as they could not possibly have seen it before. He traced the development of machine tools and the men who created them, and showed the effect of the progress of the times upon the demand for highly skillful workmen. The shops of this country are full of men who are ready with instant and generous response to official superiors who fully understand the relations between those who direct and those who do the work—next day the life of the tool dresser in that shop was made miserable and he quit to give place to a better one who could give the men the tools they wanted.

Mr. George W. Wildin has resigned as mechanical engineer of the Central Railroad of New Jersey, to accept the appointment of assistant mechanical superintendent of the Erie Railroad, with headquarters at Meadville, Pa.

CONVERSION OF LOCOMOTIVES.

BY G. R. HENDERSON.

Most large railroads of the present day are composed of an aggregation of small roads, having a heterogeneous assortment of equipment of various ages and capabilities. The selection of these engines may not in all cases have been wisely made, and the changing conditions of traffic will in a few years sometimes demand an entirely different class of power.

The principal weakness of the older engines lies in their meager heating surface, as this feature has been given the greatest attention in recent years; and the strenuous manner in which engines are operated at the present time calls for all the heating surface which can be provided, even in modern locomotives. Under these conditions the superintendent of motive power is at times put to his wits' end in an effort to obtain some kind of satisfactory service from the old power. As switch engines seldom are required to generate large quantities of steam continuously, if the size of the drivers and other parts permit, the engines may be used in switching service. Generally, however, the wheel base is excessive and changes are desirable in order to make a satisfactory locomotive for this purpose.

One of our large Western roads owns a number of consolidation locomotives with 17 x 26-in. cylinders, drivers from 45 to 48 ins. over the tire, and boilers carrying from 130 to 150 lbs. steam. The adhesive weight is only about 70,000 lbs. and the heating surface from 1,000 to 1,100 sq. ft., the engines being over twenty years old. It is evident that these are not fit for economical road service, but will answer fairly well for switching. Unfortunately, the cylinders of these engines have so much overhang and the back of the engines so little that it is hardly practicable to remove the truck, and besides the limited tractive force of these engines, about 18,000 lbs., renders them inadequate to handle trains brought in by the new heavy road engines. The great need for switch engines of suitable power was partly met by changing some much larger consolidation engines, as explained below. These were originally tandem compounds, having 15 and 25 x 28-in. cylinders, 57-in. wheels, and carrying 180 lbs. boiler pressure, with 150,000 lbs. adhesive weight. The heating surface, 1,900 sq. ft., was rather small for road service, but ample for yard use. In converting these engines, the front truck was removed, as were also the high-pressure cylinders, and the smokebox and front frames were shortened, the low-pressure cylinders being bushed to 22 ins., thereby converting them to simple engines. The removal of the truck reduced the wheel base from 23 ft. 9½ ins. to 15 ft. 2 ins., the distribution of weight showing 42,500, 42,800, 35,800 and 33,800 on the first, second, third and rear pair of drivers respectively, the tractive force amounting to 31,100 lbs. When fitted with the Westinghouse straight-air cock in connection with the ordinary automatic fixtures, these engines gave the best of service, as they were able to handle complete trains brought in by the road locomotives, and the boiler was amply large for this service. As the engines are only four years old, they will be useful for many years to come.

The same road owned in its equipment ten passenger locomotives of the ten-wheel type. These engines have 20 x 26-in. cylinders, 73-in. drivers, 180 lbs. steam pressure, with 123,000 lbs. adhesive weight. The heating surface, however, amounted to but 2,150 sq. ft. and the grate area to 28½ sq. ft. These engines were only three years old, but, as may be imagined from the grate and heating surface quoted, they were always regarded as poor steamers. Modern locomotives of this size would have at least 45 sq. ft. of grate and 3,000 sq. ft. of heating surface. As these machines were comparatively new, it would not be wise to retire them, and a study was made to determine what could best be done with them. The tractive force being only about 20,000 lbs. and the adhesive weight more than six times as much, it was decided that the engines could best be converted into the Atlantic or 4—4—2 type, which would permit the use of wide firebox boilers. A boiler of 68 ins. diameter was therefore designed in place of the old 60-in. shell. It had 49 sq. ft. of grate and 3,100 sq. ft. of heating surface, the working pressure being 200 lbs., as after examination it was believed that the machinery would safely stand this 20-lb. increase and that the larger and heavier boiler would still prevent slipping with two pairs of drivers instead of three pairs. The main frames were cut back of the main pedestals and a low trailing pedestal welded on, the trailers being 42 ins. in diameter. The rear section of the side rods were omitted and the knuckle-pin ends cut from the front sections. No changes were made in the cylinders or valve motion, the front of the engine remaining as originally constructed, except the smokebox, which was enlarged to suit the boiler. The expected weight on drivers after this change was figured at 93,000 lbs. and the tractive force at 22,000 lbs. The old boilers, being comparatively new, were to be used in stationary work and were to be credited to the engines. It was thought that the cost of making the change would amount to $4,000 per engine. None of these engines has yet been put into service after being altered, but the work on the first one is well under way.

Of course, it does not follow that every ten-wheel engine could be so converted, but in the case quoted the engine was under-cylindered for the adhesive weight, and "under-boilered" for the cylinders. Ordinarily the removal of one pair of drivers would produce too slippery an engine; but in the present case there was an excess of adhesive weight. This machine as changed will be a very close counterpart of the Class D engines of the Chicago & Northwestern, which have a tractive force of 20,800 lbs., with 91,000 lbs. on drivers, 20 x 26-in. cylinders, 80-in. wheels and 46 sq. ft. grate area, with 3,015 sq. ft. of heating surface. (See American Engineer, August, 1900.)

The welfare of the ordinary shop apprentice is engaging the attention of an increasing number of able mechanical railroad officers. They see the necessity for returning to the degree of care with which boys used to be educated in shops years ago and are insisting that the foremen interest themselves in the boys and see that they have an opportunity to properly learn shop work. They are personally supervising apprenticeship, by meeting the boys occasionally and questioning them to find out what they have learned. In every way these officers are endeavoring to be honest with the apprentices and secure for them that for which they enter apprenticeship. Four of these officers brought up the subject, on a recent trip of one of our staff, and spoke of apprenticeship as the only means for securing high grade men for shop forces in the future. They all mentioned the desirability of providing night schools or encouraging the boys to attend schools already available, in order to start them in elementary mechanics and mechanical drawing. Two of them are actually supporting night drawing schools out of their own pockets and are enthusiastic as to the results. They are somewhat discouraged by the fact that they are educating boys for service on other roads and are hopeful that such efforts will soon become sufficiently general to overcome this difficulty. This journal heartily commends such efforts and would exert its influence in every possible way to show the vital need of uplifting apprenticeship against all indifference and opposition on the part of those who do not appreciate it and selfishly desire to continue, as at present. Labor organizations are, as a rule, not helpful in their attitude toward apprenticeship or toward the boy who has completed his term and is ready to enter the ranks of journeymen. This, however, is believed to be but a temporary obstacle. On a large railroad system it ought to be easy to send a young journeyman to another shop—starting him in new surroundings, not those in which he lived as a student—and thus retain his services.

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Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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CONTENTS.

After a most profitable and thoroughly enjoyable trip to Great Britain and Continental Europe, I return greatly improved in health and with a heart full of gratitude for the friends who made the journey possible. Observations and impressions resulting from meeting many men who are carrying the burden of transportation problems abroad are being presented in a series of letters, appearing in these pages, in the hope of suggesting some new ways of viewing our own problems which may perhaps prove helpful in their solution.

I wish that all of the friends could have been with me to share the universally cordial receptions, enjoy the pleasures of the journey and to aid in drawing conclusions from it. My conclusions are matters of individual opinion, but they are carefully presented. Of one thing I am more than ever sure: That of all problems vitally touching human interests, there are none more important than those concerning transportation. What I have seen and learned abroad increases my respect and admiration for the accomplishments of American railroad motive power men, who are confronted by difficulties which are unknown elsewhere.

I take this occasion to express my hearty thanks to the European railroad officials for the courteous, cordial and kind reception which they gave me everywhere on this trip. To my friends who sent me abroad, I add another word of heartfelt gratitude for their kindness to me. G. M. BASFORD.

"Engine failures" are the bane of transportation as well as mechanical departments. They are increasing rather than decreasing. This is because of the heavy work locomotives are called upon to do which they never faced before "large train tonnage" became a watchword. Operating officers complain that they cannot get the service from locomotives which they used to get, and they are likely to criticise modern tendencies in design, thinking that these are responsible for failures and for the delays in turning engines at terminals. They forget that locomotives cannot be forced without paying the price, particularly with respect to firebox repairs. An "engine failure" is nowadays usually a firebox failure, from leaky tubes or seams, caused by the forcing of the fire. The fires should and must be forced, but there is a point where it becomes more economical to lighten the load rather than put the locomotive in the hands of the boilermaker after every trip in order that it may be put in shape for the next one.

The writer recently took a photograph of a gang of thirteen men engaged, with the help of a rope tackle, in moving a plate of firebox steel from the storehouse to the boiler shop of a well-known railroad. Now, "13" is an unlucky number, and therefore the picture will not be printed. It is also an unlucky number for that railroad. Even if facilities for handling such material are not provided, there are ways of moving it which are quicker and less expensive than this. It is strange that the value of investments in appliances for handling material is so often overlooked. Overhead trolleys and air hoists are cheap and may be made at home. In the absence of power cranes they may be made exceedingly useful.

Nowhere are hoisting facilities more needed than in roundhouses, where large or small engines are cared for. In a certain trip of over 7,000 miles, recently made by the writer, not one roundhouse was found which had anything of this kind.

Draft gear of passenger equipment needs immediate attention. The construction of 10 or 15 years ago, when locomotives and cars were light, and trains had comparatively few cars, will not answer now, when passenger locomotives of 30,000 lbs. tractive effort and Pullman cars weighing 125,000 lbs are in common use. When they start heavy trains these big locomotives "bottom" the present draft gears, and a sudden pull of moderate severity may, and often does, pull out the draft gear, break a coupler or a knuckle. The draft springs should have a greater capacity than from 12,000 to 16,000 lbs., and the attachments should be made correspondingly stronger. It is claimed that many of the break-in-twos of the present time are in the couplers and knuckles, and that these should not be laid to the draft gear itself. This is not fair to the coupler, because when a spring "bottoms" something must yield, and the weakest part gives way. Passenger draft gear needs to be brought up to the capacity of present big locomotives, and the best way to accomplish this seems to be the adoption of the friction principle. This is now being applied to a number of officers' cars. A better test would be had on baggage cars, which are always at the head end of a train.

Ash-pit work is the slowest process about most roundhouses. Boiler washing causes considerable delay, but it does not stand out as prominently as work which must be done at each end of every run. It is evident that more ash-pit tracks should be provided, and many complaints are heard because of the failure to provide more than one pit track for terminals where from 25 to 75 locomotives per day must be dealt with. In one instance eight locomotives were found, by a representative of this journal, awaiting their turn for attention from the fire cleaners. Passenger and freight engines were mixed as they came, and in the midst of the rush the ash pit was found to be full from the accumulation of the morning, and all progress stopped until it was cleaned out enough to provide for these engines. The superintendent of motive power expressed the serious need of two things: three or four ash-pit tracks with pits long enough to take a full day's accumulation, and improved locomotive grate construction which would permit of cleaning fires quickly. These would greatly facilitate movement of locomotives, and they would also aid in reducing the troubles with leaky tubes. This is found to be a more serious and general difficulty than ever before.

ECONOMY IN RAILROAD OPERATION.

Railroads operate over wide expanses of territory, are directly administered by men who have no personal interest in the question of economies and who have all they can do to keep things moving. One great reason why no personal interest is felt, is, that the official in charge has no financial interests at stake, and being on a salary, may be looking for another position to-morrow. A change of management nearly always makes more or less changes in minor officials, and often a complete one in heads of departments. Such changes are occurring monthly, and but a few days ago I overheard a remark to the effect that "if Mr. X. gets to be general manager of a certain road Mr. A. would not last fifteen minutes." So it is not reasonable to expect men, under such circumstances, to lay awake nights or work overtime, trying to save dollars. If one can make a record as an active man and a hustler he is doing all that he feels is necessary, both for himself and the company."

This paragraph, quoted from a paper read by Mr. W. B. Waggoner before the Western Railway Club, represents a situation which exists too generally in the United States. Very few railroads in this country appreciate the necessity for a definite policy of operation and a steadiness of such a policy which will permit the most important officials to devote their time to the real interests of their employers. Men who are most deeply concerned in efforts to hold their jobs cannot do good work, and cannot frame long term policies with a view of attaining true economy of operation. What can be expected of an official who by frequent changes in management is kept in a continual fever of excitement for fear of losing his position? With all due respect to the advantages of occasional "new blood," the cases of taking officers from other roads to fill vacancies is becoming a serious menace, and it is time for managements to begin to think this over. One thing stands out prominently in European practice—the officials are free from these wild-eyed anxieties and are therefore in position to do their best work.

MOTOR DRIVEN MACHINE TOOLS.

PLANER DRIVING BY ELECTRIC MOTORS.—II.

Continuing the subject of planer driving by electric motors, we are enabled to show herewith a number of interesting arrangements of motor-application. In the previous article (pages 69 to 72 of the February issue), reference was made to an arrangement for varying the cutting speed of the machine while the return speed remained constant. The question may be asked: Why is this a desirable feature? Why cannot the return speed be varied as well as the cutting speed?

The answer is that most planers are so designed as to give a fixed cutting speed which is supposed to be suitable to about the slowest rate needed under average conditions. This minimum cutting speed is usually fixed at about 20 or 24 ft. per minute, and is accompanied by a corresponding reverse speed of from three, to three and a half times this speed, or, say, from 60 to 84 ft. per minute. These speeds will vary somewhat with the size of the planer, but they represent average practice for the majority of planers. In some cases, it has been found desirable and possible to run roughing cuts on cast iron at 30 to 40 ft., and finishing cuts at from 50 to 60 ft. per minute; also, with the use of improved steel for cutting tools, these higher cutting speeds can be used for steel as well.

Assuming a possible cutting speed of 60 ft. per minute, and a return speed of 80 or 90 ft. per minute as the limit which can be placed upon the driving mechanism, it will be evidently impracticable, if not impossible, to further increase the return speed, with the usual planer design. The variation of work upon some planers will require a range of cutting speed of from 20 to 60 ft. per minute, but it will now be seen to be quite out of the question to have a return-speed range with the same ratio; hence, the usual practice is to vary the speed only on the cutting stroke, and to make the return speed constant at as high a rate as the mechanism will stand. This is not so much due to the fact that the platen cannot be moved at a high rate of speed, if once started, but owing to the severe work at the moment of reversal and the time required to bring up the speed from the reversal point, causing a heavy strain to be thrown upon the belts and driving mechanism; there is a limit to speed, commercially as well as mechanically.

As relating to this phase of the subject of speed changing, we beg to call attention to the illustration, Fig. 9, which shows a special method of planer driving, as built by the Cincinnati Planer Company, Cincinnati, O. This machine is driven by a Northern Electric constant-speed motor, which is connected to the constant speed shaft by a chain; driving by means of a chain seems to be preferred to gears by some users. This constant speed shaft, upon which is mounted the return driving pulley, is connected through a gear box to the variable speed shaft which carries the pulley for the cutting stroke. The change gears of this mechanism are so proportioned as to give the desired rates of cutting speeds, and the changes from one speed to another is effected by means of the shaft and hand wheel shown alongside the housing of the machine.

Another method of obtaining a variable cutting speed, with constant-speed table return, is illustrated by Fig. 10, which shows a planer built by the Betts Machine Company, Wilmington, Del., with a motor drive using a Crocker-Wheeler motor. It will be seen that in this case the motor is set low, partially below the floor line. The countershaft for this machine is carried upon brackets which are attached to the housings of the planer. Upon this countershaft are placed three pulleys. The inner pulley, or the one next to the machine housing, is a cone, and has three steps; this pulley is attached to the countershaft and is driven from a similar three stepped pulley on the motor shaft.

By means of these stepped pulleys, the cutting speed can be varied to suit the work in hand. The outside pulley is also attached to the countershaft and drives the platen in the forward or cutting stroke in the usual manner. To obtain the constant return speed of the platen, a two step pulley is

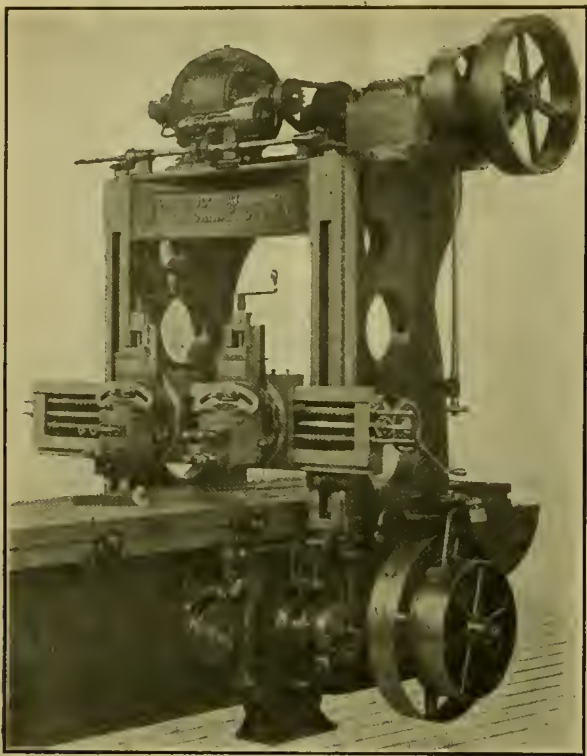


FIG. 9.—A SPECIAL DESIGN OF FLYWHEEL DRIVE UPON A PLANER, WITH MECHANICAL VARIABLE-SPEED DEVICE; BUILT BY THE CINCINNATI PLANER COMPANY.—NORTHERN ELECTRIC MOTOR.

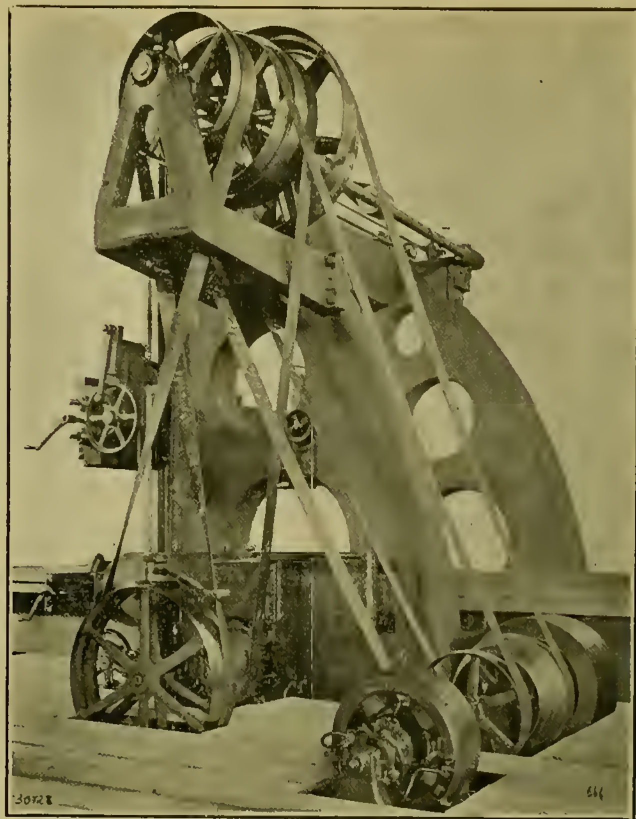


FIG. 10.—AN INTERESTING MOTOR DRIVE UPON A HEAVY BETTS PLANER, USING AN UNUSUALLY HEAVY FLYWHEEL. CROCKER-WHEELER MOTOR.

mounted on the countershaft and runs loosely upon it; this pulley is driven by belt from another pulley on the motor shaft. By this means the return speed is kept constant and the same as the motor speed. One face of the two stepped pulley is of double width to allow for the shifting of the belt which drives the platen in return direction. This device forms quite a unique arrangement.

An interesting self-contained drive is illustrated in Fig. 11. This shows a large open-side planer, built by the Detrick & Harvey Machine Company, Baltimore, Md., which is equipped for motor-driving, using the belt-drive. The countershaft of this machine is specially mounted upon standards, secured to the tops of the housings of the planer, and of such a height as to give sufficient length to the operating belts, the belts operating the raising and lowering of the cross-rail being the ones that determined this height. This makes necessary the seemingly high arrangement of shaft supports, but with this arrangement the motor can be placed in any convenient position, as is shown. In Fig. 12, which is a view of the style of

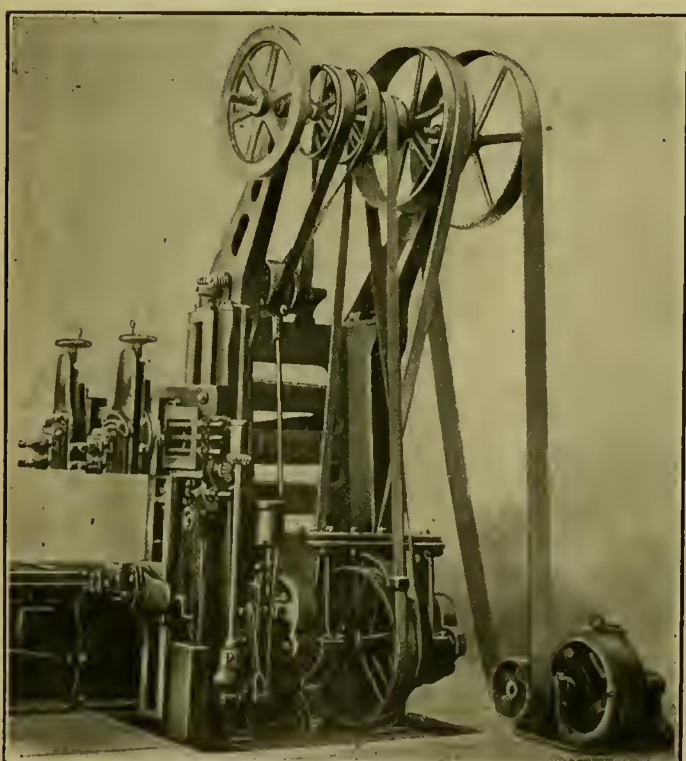


FIG. 11.—VIEW OF THE BELTED INDIVIDUAL DRIVE USED UPON LARGE SIZES OF THE OPEN-SIDE PLANERS, BUILT BY THE DETRICK & HARVEY MACHINE COMPANY, SHOWING USE OF FLYWHEEL.

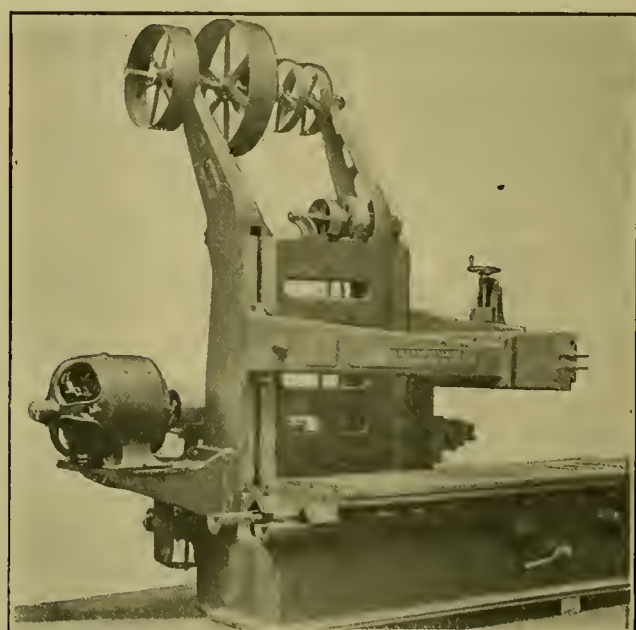


FIG. 12.—THE TYPE OF INDIVIDUAL DRIVE (BELTED) USED UPON THE SMALLER SIZES OF OPEN-SIDE PLANERS BY THE DETRICK & HARVEY MACHINE COMPANY.—GENERAL ELECTRIC MOTOR.

motor application used by the Detrick & Harvey Machine Company upon their smaller sizes of open side planers, the flexibility of this arrangement may be seen; here the motor, a General Electric constant-sped motor, is mounted upon a small bracket on the end of the frame of the tool. Upon the larger tool a very heavy flywheel is shown on the countershaft; the flywheel is used on the smaller size of the Detrick & Harvey planers, but this tool is shown without the same in place.

So far, the machines described above have been examples of motor drive wherein the necessary changes from the standard form of belt drive have been made at the works where the machines were built. When such changes can be thus made upon new machines, the whole design can be made to present a more or less harmonious design as to appearance and utility. When, however, an existing machine must be changed from belt to motor drive, the conditions are different, and call for different treatment.

Fig. 14 is an illustration of such a case. The cut shows a planer built by the Putnam Machine Company, Fitchburg, Mass. The arrangement here used for carrying the motor is built up of structural shapes; the construction of which will be readily understood by reference to the view. A pair of brackets are bolted to the housings which support the I beams upon which the motor rests. The motor shaft is extended and

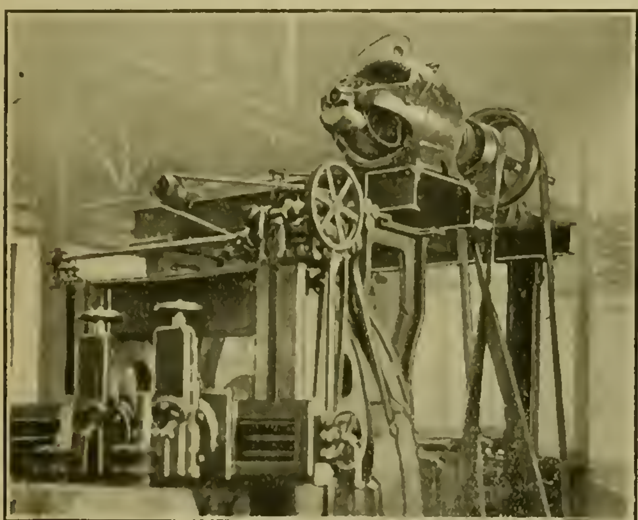


FIG. 13.—AN INTERESTING APPLICATION OF INDIVIDUAL MOTOR DRIVING, WITH FLYWHEEL, TO A PUTNAM PLANER.

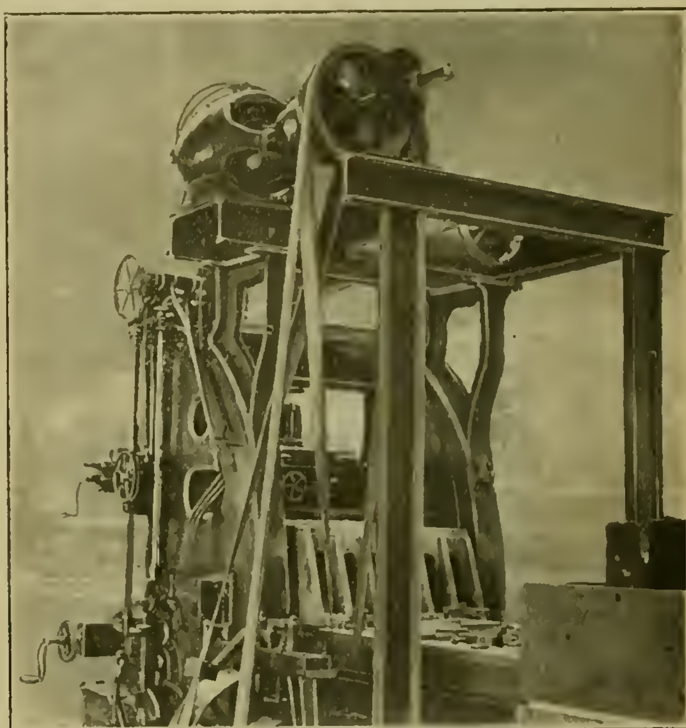


FIG. 14.—REAR VIEW OF THE MOTOR-DRIVEN PUTNAM PLANER, SHOWING STRUCTURAL SUPPORT FOR DRIVE.—MILWAUKEE MOTOR.

MOTOR-DRIVEN PLANERS.—WEST MILWAUKEE SHOPS, C. M. & ST. P. RY.

carries the pulleys for operating the machine. The bearing for the outer end of the motor shaft is carried also by an I beam which is supported by similar construction extending to the floor. This arrangement, while not as pleasing in appearance as some others perhaps, is well adapted to the existing conditions. The fact that the machine had a right angle drive, also, made it difficult to design a more compact arrangement.

In our previous article upon this subject, mention was made of some of the conditions of planer operation which required at certain times an accession of power for a brief period, and that this additional power was usually furnished by a balance wheel placed upon the motor shaft, or upon the countershaft of the machine. While there seems to be an opinion held by some that a balance wheel is superfluous, and while it may be conceded that in some cases, where the driving mechanism is of the slow-moving type, that a sufficient amount of energy is furnished by heavy countershaft pulleys, there are, however, many cases where this demand for extra power is quite urgent. A comparison of observations from a machine without a balance wheel, and one with it, will convince any one of this fact.

An examination of the illustrations of the machines described in these articles will show that the various builders have made provision for this stored energy either by extra heavy pulleys, or by separate balance wheels, as seemed most advisable. The testimony of the Betts Machine Company is to the effect that upon motor driven planers it has been their practice to provide stored energy by means of flywheels to an amount equal to about one-half of the work required by the machine, allowing the balance to come upon the motor. Experimentally, they had gone through the problem, beginning with a very heavy wheel and cutting down until the right result was reached. It was found that a too heavy wheel caused undue slippage of the belts between the countershaft and the machine. When the proper porportion was found the operation became satisfactory and vexatious troubles disappeared.

The experience of another builder is given to show the opposite method of procedure. Their first motor driven machine was sent out with a balance wheel that proved to be too light. The operation of the machine was not at all satisfactory, and the light wheel was replaced with a heavier one, and later by a still heavier one, which proved to be about what was needed. In many cases a motor driven planer, if equipped with a properly proportioned balance wheel, will require a somewhat smaller motor than one not so equipped, and will do more work —this is the testimony of a successful builder.

In the large majority of cases a balance wheel in connection with a planer driving mechanism, is a benefit and especially so when the machine is motor driven. Just what amount of extra power is required, and the best way of applying it must be determined by existing conditions. So much difference in details of design exists between different builders, that what would apply to one will not apply to another. Numerous schemes and devices have been suggested, to improve the action of a planer as to its driving mechanism, but as yet no arrangement has been sufficiently successful to replace the ordinary countershaft, with shifting belts, with a properly arranged balance wheel effect.

Because of a rather large number of cracked cylinders in large locomotives recently built, a great hue and cry is raised on several railroads against large engines. Of course cylinders should be designed and made so that they will not break, but the very large number of old and small engines with their cylinders banded seem to have been forgotten. The trouble may be remedied without going backward as to the size of locomotives.

THE 42,000-GALLON PLANTS AT (1) STOBO, PA.; (2) NEW CASTLE JUNCTION, PA.; (3) HAZLETON, O.; (4) ROCK POINT, PA., AND (5) GROVETON, PA.
THE 21,000-GALLON PLANTS AT (6) WILLIAMSBURG, PA.; (7) WHITSETT JUNCTION, PA., AND (8) BUENA VISTA, PA.
IEWS OF REPRESENTATIVE INSTALLATIONS OF THE WATER-SOFTENING SYSTEM.—PITTSBURG & LAKE ERIE RAILROAD.

AN EXTENSIVE WATER-SOFTENING INSTALLATION.

TOTAL CAPACITY, 348,000 GALS. PER HOUR.

PITTSBURGH & LAKE ERIE RAILROAD.

V.

As stated in the first article of this series, ten water-softening plants were provided for upon the Pittsburgh & Lake Erie, all of which are now completed and have been placed in operation. We are fortunate in being able to secure photographs of several of the other more important installations, which are herewith presented.

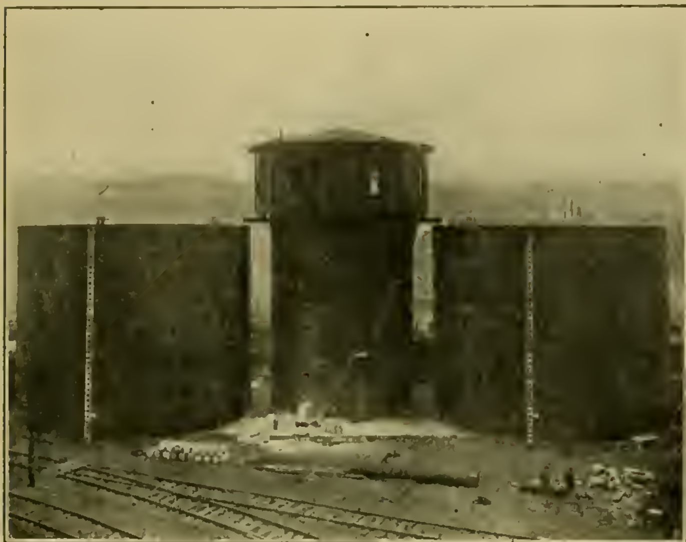


FIG. 9.—RECENT VIEW OF THE M'KEES ROCKS SOFTENER, SHOWING PROTECTING HOUSING IN PLACE.

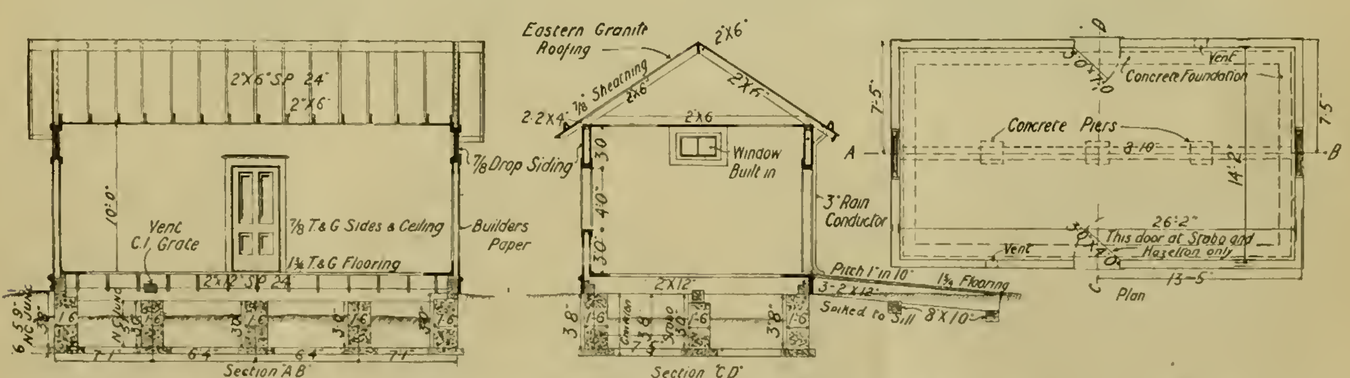
The accompanying views present representative types of the Kennicott water-softener which are in use upon this road. The softeners here shown are of smaller sizes than the McKees Rocks softener, which was described in the previous article; the capacities embraced in these installations are 21,000 and 42,000 gals. per hour. These softeners are located at the important water supply stations along the road where water is taken in sufficient quantities to warrant their installation.

All of the softeners illustrated in the accompanying engravings are of the same design, differing only from that used at McKees Rocks in size. Reference was made in the last article to the smaller sizes of softeners, which are referred to in this article. In some instances mechanical details of construction will be found to differ slightly, but the principle of operation is identical in all of the softeners in use upon this road.

The storage tanks for the treated water, however, differ widely in construction at different points. At some stations the elevated wooden tanks, of the usual type, have been continued in use, although in several other places steel storage tanks are to be found. The different types of storage tanks which are used may be seen by reference to the accompanying views. In Figs. 1, 2, 3 and 4 steel tanks will be noticed, while in Figs. 5 to 8 wooden tanks are to be found.

In the installation shown in Fig. 1, which is the one at Stobo, Pa., both the softener and the storage tank are located on the hill side, which brings their foundations at 21 ft. above the rail level. This gives an ample head for the delivery of water into the locomotive tenders, and no water is uselessly pocketed in the bottom of the storage tank, as is the case when the storage tank extends down to the rail level. The above arrangement is practically duplicated at the Rock Point (Pa.) installation, which is illustrated in Fig. 4. In the latter case also the tank foundations are located at a height of 21 ft. above the rail level. Both of the softeners above referred to have capacities of 42,000 gals. per hour, and are provided with storage tanks of 250,000 gals. capacity. Each receives its water supply from pumps driven by gasoline engines, thus minimizing the amount of attendance required; at each of these plants, one man does all the work of pumping and attending to the water purifying process, and no extra help is required on account of purifying the water.

The softener illustrated in Fig. 2, which is located at New Castle Junction, Pa., is interesting on account of its unusual height. The tops of the tanks are 77 ft. above the foundations. This was occasioned by the fact that the softener and storage tank are located at a much lower level than the track, it being necessary, of course, to have the storage tank of sufficient height to produce ample head for delivery of water into the locomotive tenders; the softener was, necessarily, made of similar height in order to deliver into the storage tank. It is obvious that all of the water in this storage tank below the level of the water plug is unavailable for delivery by gravity into tenders; but piping connections are arranged so that, for cases of emergency, all of this water, otherwise uselessly locked up, may be delivered by the supply pump through the stand-pipe into the tenders, thus making this large quantity of treated water a reserve for use in emergency. This storage tank has a capacity of 250,000 gals. above the height of 21 ft. above rail level. The softener at this point, as well as that shown in Fig. 3, which is at Hazleton, Ohio, is of a capacity of 42,000 gals. per hour. It will be noticed in the latter installation (Fig. 3) that special types of elevated storage tanks are used; these tanks, however, were in use at this point before the water-softener was installed.



DETAILS OF THE SPECIAL DESIGN OF FRAME STORE HOUSE USED AT THE WATER-SOFTENING PLANTS OF 42,000 GALLONS PER HOUR CAPACITY FOR PROTECTION OF THE CHEMICALS.

The remaining four illustrations, on page 104, illustrate the use of the more usual form of elevated wooden storage tanks. In these cases it was not thought advisable to replace the old storage tanks with new ones of steel. The installation shown in Fig. 5 is that in use at Groveton, Pa., this softener being of a capacity of 42,000 gals. per hour. The remaining three softeners are each of a capacity of 21,000 gals. per hour, that shown in Fig. 6 being located at Williamsburg, Pa.; that in

Fig. 7 at Whitsett Junction, Pa., and that in Fig. 8 at Buena Vista, Pa.

As may be noted, several of these softeners are provided with housings at the top for protection to the working parts and to the attendants. All of the softeners are, however, now provided with similar housings, which were erected before cold weather last fall. In Fig. 9 is presented another view of the McKees Rocks softener, which shows it with the housing applied. These housings are built so as to provide plenty of room for convenience of access, and are very comfortably arranged.

CHEMICAL STOREHOUSES.

It is interesting to note also that careful provision has been made at each water softening plant for the proper storage of the chemicals. Storehouses have been installed at each point, of a special design, designed to protect the chemicals from the deterioration that would be inevitable under more unfavorable conditions. An accompanying drawing shows the essential features of the building that has been installed at the purifying plants of 42,000-gals.-per-hour-capacity; it is of frame construction, of the sizes and type shown, but is remarkable for the care taken to make it both air-tight and dry. The exterior appearance of one of these buildings is shown alongside of the water-softener at New Castle Junction, at the right, in Fig. 2, page 104.

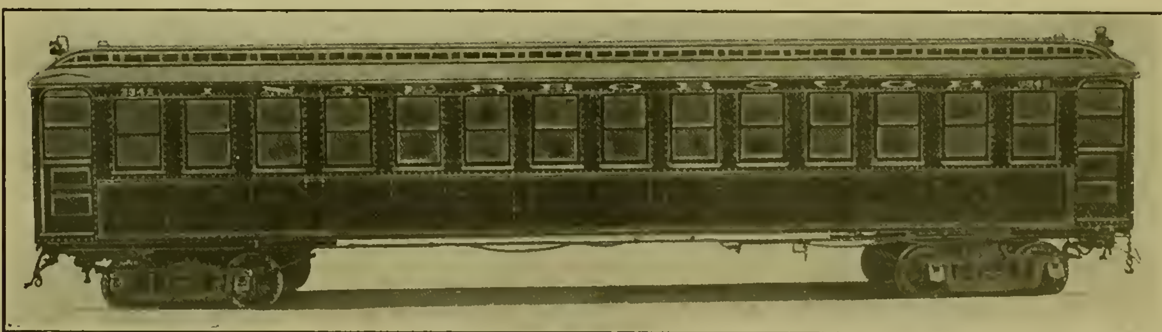
In all cases it has been designed to have the "chemical houses" large enough to hold a month's supply of chemicals—the lime in barrels, and the soda ash in bags. The storehouses used at the smaller softening plants (of 21,000-gals.-capacity per hour) are, of course, somewhat smaller than the one shown in the accompanying drawing, while that used at the McKees Rocks plant is much larger and of heavy brick construction. The important feature of the designs of these buildings has been to make them as nearly air-tight as possible to prevent the lime from "air-slacking," and also to provide against dampness; this purpose has been successfully fulfilled.

These houses are placed conveniently to the purifying plants, and where possible, conveniently to the tracks also; but the former has been given the preference. In most cases the chemicals can be handled directly from car to house; in some cases, however, it is necessary to haul the supplies by team from the car, but in all cases the pumper can handle the chemicals from the house to the purifying plant alone.

FIREPROOF CARS FOR NEW YORK SUBWAY.

The officers of the Interborough Rapid Transit Company of New York City have the credit of the first fireproof passenger car and of inaugurating a new principle which is sure to effect radical changes and introduce important improvements into the construction of passenger equipment.

Mr. George Gibbs, consulting engineer of the Interborough Rapid Transit Railway, began the designs of the new equipment of this road in 1902, and in this journal for March, 1903, the construction of the first installment of the cars was illustrated. These cars were of wood, with steel platforms and steel members incorporated in the frames, for additional strength. At the outset the necessity for perfectly fireproof construction was appreciated, but there was no precedent in the matter of design, and furthermore the market conditions rendered it impossible to place orders for steel construction at that time, even if the design had been ready. Therefore, as a large amount of equipment was needed in a short time, the wooden cars were built, and are now ready for the opening of the road. It should be recorded for the benefit of the officials of the Interborough, that the steel car design was put in hand before the lamentable accident on the Paris underground railroad. The reason for this action was an appreciation of the necessity of protecting passengers from the danger arising from the possibility of the parts of wooden cars becoming ignited by electric conductors with which the wood might come into contact in case of accident to the cars themselves or to the electrical apparatus.



SAMPLE STEEL FIREPROOF PASSENGER CAR.
INTERBOROUGH SUBWAY, NEW YORK.

The first installment of cars are undoubtedly stronger and better protected against fire risks than any equipment of any electric road at this time, as our engravings already referred to will indicate. The claims made for fireproofed wood were carefully considered and were believed to be insufficient and unsatisfactory.

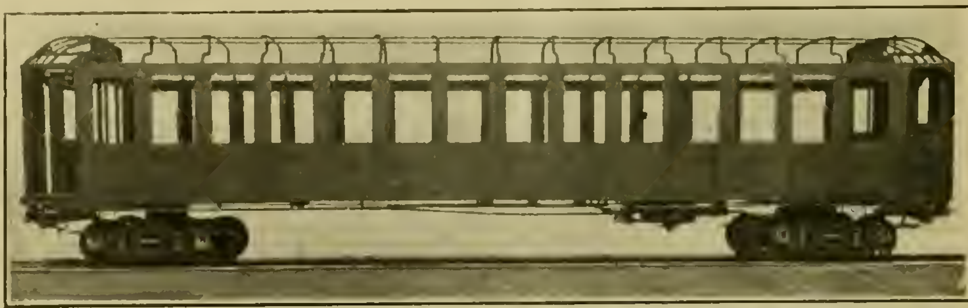
The all-metal car problem was then attacked. This involved radical departures from existing practice and presented many questions, such as weight, strength, insulation from extreme heat and cold, the prevention of noise in operation, and other difficulties. The co-operation of Mr. A. J. Cassatt, president of the Pennsylvania Railroad, was obtained, and the assistance of the mechanical department of that road at Altoona, was offered. The Pennsylvania people were interested in the problem because of the necessity for fireproof equipment for the new tunnel across New York City. The design for a sample steel car was developed, and the car was completed at Altoona in about 14 months after beginning the design. It is now in service on the Second Avenue line of the elevated system in New York, and is apparently satisfactory in every respect, except as to weight, this car being about two tons heavier than the wooden ones. A new design has been prepared after this experience, and 200 cars have just been ordered from the new drawings. These will weigh the same as the first design (wooden cars) and they promise to be completely successful. The drawings of the new design are not yet available, but the photographs of the sample steel car are presented in order to record this important step in car development. Details of the framing will be presented in a subsequent issue of this journal. The leading dimensions of the sample steel car are as follows:

Length over corner posts	41 ft. ½ in.
Length over platforms	51 ft. 2 ins.
Width over sheathing	8 ft. 7 ins.
Width, maximum, at window sills	9 ft. ½ in.
Width at eaves	8 ft. 8 ins.
Height, sill to plate	7 ft. 1 in.
Height, rail to top of roof	12 ft. 0 ins.

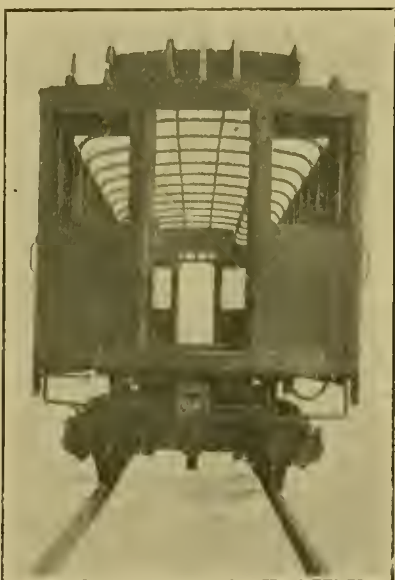
Beams are used for the center sills and plate girders reaching up to the window sills supplement the side sills. The window posts are built up and are unusually wide, because of the use of standard shapes. These posts extend down to the bottom of the car sides. Other details of the frame construction will be reserved for the description of the standard car. The floor is of corrugated steel, laid transversely and covered with monolithic composition. The interior finish will be of aluminum. The head lining is of pressed steel over asbestos composition and wherever possible, this composition manufactured for this road and called "Transite Board," is employed in order to deaden the noise.

The seating plan, end door and vestibules are the same as in the wooden cars. The only wood about its entire construction is in the window frames, the doors and the cross seats. In the new design the cross seats will have metal frames, leaving only the doors and window sash of wood. Even these may be made of metal if thought desirable.

This car is perfectly safe from fire and, as the entire structure will be "grounded" in case of accident, there can be no danger from contact with anything carrying heavy currents. If a collision should occur and the car rests on the conducting rail, it is sure to also come into contact with the traffic rails or the ground, and the circuit breakers at the power house will cut off the current. In the matter of fireproofing, this is the most important advance step ever taken, and it seems likely to exert a powerful influence over the construction of passenger equipment for other than electric railroad service. This is one of several features which go to make this one of the most interesting of railroads.



SIDE VIEW OF FIREPROOF CAR SHOWING PLATING AND ROOF FRAMING.



END VIEW SHOWING ROOF FRAMING.

We are indebted to Mr. George Gibbs for these photographs.

In the modern industrial railway equipment where turntables are used for outdoor work there is always a temptation to set the turntables upon too shallow a foundation, the result being that they are thrown out of line by the influence of the frost. In the new plant of the B. F. Sturtevant Company at Hyde Park, Mass., where special turntables of their own manufacture have been very successfully introduced in connection with their industrial system, each turntable rests at the top of a brick circular well with 8-in. walls extending to a depth of 4 ft. or below the frost line. These walls are set upon hard-pan and the center filled with loose stones providing perfect drainage. The first winter's experience has shown them to be absolutely unaffected by frost.

CORRESPONDENCE.

IMPROVED LOCOMOTIVE FRAMES.

Opinion of Mr. A. G. de Glehn.

To the Editor:

It is always with great interest that I examine the illustrations and descriptions of modern American locomotives in your most useful journal. If engineers on this side of the water have with advantages adopted principles from American practice, it would certainly seem to me that there are points in ours to which it might be worth while for American engineers to turn their attention.

One of the most characteristic features in American practice is the so-called "bar frame." It is to me especially interesting to watch its evolution from what really once was a bar frame to one which can no longer be called so with any exactness.

I should like to refer to the frame illustrated in detail in your January number, page 12. I find what I should certainly call a plate frame at the rear and at the front end; what lies in between might be called a bar frame on its way to become a plate frame, except just where it could perhaps be really most needful, that is, just over the axle boxes.

Would it not really be better, cheaper and lighter to make a real plate frame straightaway all through? The bar frame was supposed, though I could never understand on what grounds, to require less bracing. It would seem that American engineers are finding out that vertical and horizontal diagonal bracing is really necessary, and the drawings referred to show the way this bracing is carried out. We over here, of course, cannot understand how you have done without this bracing for so long, and have with interest watched for its appearance. It has certainly come to stay. But in all seriousness may one not ask: Would not such a pair of frames with their bracings, except, perhaps, at the drawbar end and where a steel casting has advantages, be better, cheaper and lighter if made, as is the universal practice over here, of plates and angle iron?

A. G. de Glehn.

[Editor's Note.—In the matter of frame construction, and particularly frame bracing, foreign practice offers a good field for study for American locomotive designers. In England, Germany and France locomotive frames are substantially braced against twisting, and the frame structure of engines in these countries, with the admirable bracing, is a feature to be admired. We undoubtedly need such bracing for bar frames. It is, then, a question whether locomotives in the United States have not outgrown the bar frame. We shall go more fully into this question in a forthcoming issue.—Editor.]

THE RECORD-BREAKING TIRE-BORING OPERATION.

To the Editor:

On page 61 of the February issue of the American Engineer, Mr. Albert N. Reese of the West Albany shops, N. Y. C. & H. R. R. R., makes reply to my article on boring driving wheel tires which appeared in the preceding number of your paper, as follows:

"He (Mr. Pattison) has charged up the time of four helpers at West Albany and for but one at Roanoke. I think he has forgotten to charge the time of the two men which he states are required to roll tires for him, which should be accounted for. * * * Since sending you the article published in your November issue, we have done very much better, but do not think it necessary to publish it. * * * Taking the same figures which Mr. Pattison has used, we have the following results, proving that Mr. Pattison has made a slight mistake. * * * Charging him with three helpers as should be done, we have the following:

Time of one mechanic, 4 2-3 hours, at 50 cents per hour	$2.33
Time of three helpers, 4 2-3 hours, at 12½ cents per hour	1.74
Total time to bore 10 tires	4.07
Average cost for boring one tire	.41

Then Mr. Reese quotes the same figures used by him in his first article showing the average cost per tire to be 33 cents.

Mr. Reese is very much mistaken in his interpretation of my statements. After presenting in tabular form the details of the actual machine operations, and showing that the time of the mechanic amounted to 4 2-3 hours to bore 10 tires, I continued as follows:

"As our tires are unloaded from the cars at some distance from the shop, it requires about five minutes per tire on an average, for each of two men to bring them into the shop, and about two minutes per tire to take them out. It requires but one helper to assist in setting and removing tires on the two machines referred to above, his time being about equally divided between the two, as all lifting is done by pneumatic hoist and walking crane."

Now this certainly seems plain enough, but in order to make it clearer still, I will say that it requires five minutes per tire for each of two men to roll them into the shop, which is a total time of ten minutes per tire for one man, or 100 minutes for 10 tires; it requires two minutes for each of two men to roll them out of the shop, which is a total of four minutes per tire for one man, or 40 minutes for 10 tires. Now as "it requires but one helper in our shop to assist in setting and removing tires on the two machines," it requires but *one-half the time* of one helper to wait on each machine; and as 4 2-3 hours, or 280 minutes, were required by the mechanic on one machine to bore the 10 tires, the one-half of this time which was required of one helper to assist in placing and removing these tires from the machine, is 140 minutes. Then the *total* time required of all helpers, employed in boring these ten tires, would be 100 plus 40 plus 140 minutes, or 280 minutes, equal to 4 2-3 hours, as stated in the preceding article. The figures presented in the article referred to are, therefore, correct, making the tires cost in this shop 29 cents each as against 37 cents each in the West Albany shops.

As Mr. Reese claimed in his first article that it required four or five helpers to keep him going, we would have been justified in charging the time of five helpers against his shop, which would make the cost per tire 41 cents in the West Albany shops, as against 29 cents in this shop. We do not doubt, however, that he would be able to get along with four helpers even with no crane facilities at all.

J. H. Pattison, Foreman Machine Shop,
Roanoke Shops, Norfolk & Western Railway, Roanoke, Va.

NUMBERING SHOP MEN.

To the Editor:

I wish to register a protest and I hope you will put your foot of disapproval down on any system of numbering of men as recommended in article on "Railroad Shop Management," on page 56, in your last issue. I believe this to be the most detestable thing in any shop, and will antagonize any intelligent man. Let these people who are studying this question try and devise something to help to elevate the men instead of lowering them like animals at a county fair.

Foreman.

In the use of purified water sometimes trouble is experienced through foaming. A number of motive power officers are of the opinion that this cannot be altogether avoided and believe that the maximum possible amount of water space over the crown sheet should be provided. Steam never becomes dryer after it leaves the boiler and the water and steam space should be made as great as possible wherever foaming is likely to be troublesome. This is an argument in favor of the wagon top boiler.

Six foot doors on box cars have introduced new difficulties which have thus far failed to bring out construction which will prevent the doors from bulging and jamming, so that they can not be opened. Either a trussed construction or a very strong door is needed. The cost of lumber will probably prevent the latter method of overcoming the trouble and some method of trussing must be resorted to. Light channels or angles on the outside of the door will undoubtedly accomplish the purpose better than truss rods which are never satisfactory with wooden construction of any kind.

THE NEW ILLINOIS CENTRAL SUBURBAN CARS.

The new suburban cars of the Illinois Central which were described in this journal in October, 1903, page 358, have attracted considerable attention abroad and have been the subject of criticism by *The Railway Engineer* without a proper study of the problem. At the request of the editor of this journal, Mr. A. W. Sullivan, assistant second vice-president of the road, presents the following rejoinder which should be studied by all who are interested in heavy short distance passenger traffic. The Illinois Central has attacked a new problem in transportation as well as one in car design, and the report of 46 passengers leaving a train in two seconds at an intermediate station is sufficient proof of this. The subject is too important for superficial critics to treat.

"In the comments upon the car, which are made at some length, *The Railway Engineer* evinces a disposition to disparage the ultility of the design as a whole, and to convey the idea that the new features it contains have been in common use in England for many years. As a matter of fact there has never been in use in England, nor anywhere else for that matter, a car like this, nor one containing so many entirely new ideas both of design and construction. The characteristic feature of this car is the completeness with which provision is made for every essential requirement in the rapid transportation of a dense passenger traffic, with a far greater degree of security and comfort for the passengers than has ever been provided.

"To prove this statement, mention need only be made of the following points: Steel construction throughout of the underframe and upperframe, giving greater protection to the passengers against accidents and from fire. A floor plan combining with transverse seats an aisle on both sides of the car, affording access to every part of the car from either side. Side-doors which slide within the walls of the car, and end-doors with vestibules connecting all the cars, affording access from within to every part of the train. Carrying capacity far in excess of any other car, with seats for the greatest number of passengers. Perfect system of lighting, heating and ventilation. Electric connection between the side-doors of the entire train and the locomotive, giving signal automatically to the engine man of the opening and the closing of the doors. Absolute control by the train men of the opening and closing of the side-doors. Inability of passengers to expose themselves to danger. Rapidity of loading and unloading passengers without disturbance of those who remain in the cars. Distribution of passengers throughout the car or the entire train after it has resumed motion. Distribution of passengers evenly on station platforms with assurance that the train can be entered at any point. Short stops at stations, with consequent improved train schedules.

"No one of these features can be found in any carriage ever used on an English railway, nor can such results in working be obtained with any equipment now used in England.

"These cars have now been in service continuously for four months, during which time they have been tested by every extremity of weather likely to occur. The location of the Illinois Central Railroad in Chicago is one peculiarly exposed to the effects of storms, running as it does for nearly seven miles on the shore of Lake Michigan, its trains must withstand the full effects of the blizzards which sweep over the lake in winter. Since the cars went into service the temperature has ranged from 96 above to 16 degrees below zero, Fahrenheit, and during the months of December and January, heavy snow storms, accompanied by winds having a velocity of 40 to 50 miles per hour, have prevailed; yet notwithstanding these conditions, the side-doors have worked perfectly, and no trouble was experienced during the coldest weather in keeping the cars warm. The absence of opposite openings preventing draughts through the cars, there is no loss of warm air when the doors are opened.

"With reference to the carrying capacity, while there are seats for 100 passengers, there is standing room for 200 more, making a total of 300 passengers that can be carried in each car. During the rush hours of the morning and evening the usual load is from 210 to 225 passengers per car, and it has gone as high as 260 per car with room enough to spare to admit of the conductor passing through the car to collect the tickets, and in addition to operate the car doors at stations averaging one-half mile apart.

"The width of the cars, 10½ ft., is designed to utilize the space available on tracks which are constructed 12 ft. from center to center. The average weight of the cars first built, 84,600 lbs., is somewhat heavier than of those now under construction, but is not excessive when measured by carrying capacity; the tare weight per passenger for its ultimate load being but 282 lbs., which is much less than can be obtained with any form of wooden construction. One of the new cars takes the place of two of the old, and with no increase in the weight of the train there is a greatly increased carrying capacity.

"It is, however, in the rapidity with which passengers can be received and discharged, with consequent short train stops, that a most important advantage exists in conducting the transportation service. In the ordinary operation of these trains as many as 46 passengers have been discharged from one car at an intermediate station in two seconds, and 115 passengers have left one car at a terminal station in four seconds. The service is yet too novel and the weather conditions too severe to obtain the highest results that this system of handling passengers is capable of developing, but it is even now of not infrequent occurrence that stops of 8 and 10 seconds are made in which a large number of passengers enter and leave the train, and an average of 12 to 14 seconds for all the stops of a schedule is often made with trains running full. There is comparatively little difference in the time consumed by trains at stations as between a light and heavy business, a large number of passengers being received and discharged as quickly as a few. It is in this capacity for handling a heavy business as quickly as a light business that the new cars display the advantages of the system.

"Referring directly to the comments of the *Railway Engineer*, it may be said that the Illinois Central in common with other railroads has but limited space available for the conduct of its suburban business, and because of the restrictions imposed by its environment it has been forced to adopt the improved methods made possible by the use of the new type of car, whereby its capacity for suburban transportation can be doubled without increasing its terminal facilities, its tracks, or its station and platform accommodations. This is made possible simply by the superior character and capacity of its new equipment, which utilizes to the highest degree the space between the tracks and avoids the waste of space and time incident to the use of small cars and slow methods of handling passengers. The principle of large transportation units and facility for quick dispatch holds good for passenger business equally with freight, with the same certainty of result that the higher efficiency of the new methods will be productive of larger revenues. While to the English eye the new cars look huge and magnificent, they are less expensive to construct than cars of the same capacity built to the ordinary dimensions of wooden car construction, and possess the further important advantage of greatly increased security from casualty incident to steel construction.

"The statement of the *Railway Engineer* that the wide suburban carriages of the Great Eastern Railway, designed by Mr. James Holden, are 28 ft. 2½ ins. long over the buffers and 9 ft. wide at the waist; that they have five compartments, each seating 12 passengers, and that they tare on the average 10 tons, 6 cwt., which is equal to 387.53 lbs. per seat, is true for the second and third class carriages; but is not true for the first class, which for the same dimensions have four compartments, each seating 10 passengers, or a total of 40 passengers against 60 for the second and third class carriages, a difference which will require some revision of the tare weight per seat."

A. W. Sullivan.

H. H. VAUGHAN.

It is a pleasant task to announce to our readers the appointment of Mr. Vaughan as superintendent of motive power of the Canadian Pacific Railway. It is a remarkable accomplishment for a young man to come to this country a perfect stranger, as Mr. Vaughan did twelve years ago, and in these years advance from the operation of a lathe in the shop to the position of assistant superintendent of motive power of the Lake Shore, and from this to be called to take charge of the motive power responsibilities of such a road as the Canadian Pacific. It is a source of satisfaction to see one's opinions verified and to find that predictions have become facts. This appointment indicates the appreciation of an experience which includes an education begun at a technical school, supplemented by shop experience which enabled the man to hold his own as a workman among strangers, this being followed by some years in test work and drafting rooms, and then by valuable commercial experience which included the designing and construction of machinery and the management of a successful manufacturing enterprise. He was called to return to railroad work, for which he is eminently well fitted, and it is to be hoped that his abilities are to be directed for many years in this work, where many men like him are so greatly needed. There are no railroad positions so difficult to fill as those of the motive power department. Here are concentrated the problems of the engineering of the locomotive, the management of large works and shops, the operation of a large number of locomotives on the road, and the organization having more possibilities for economy through efficiency than any other. This requires a combination of mechanical engineer, business man, organizer and executive in a man who will not allow himself to be swamped by details. The railroads will do well to encourage to the utmost the men who are acquiring experience to fit them for such work, and it is good to see such a wise and promising appointment.

Mr. Vaughan was born in England, graduated from Kings College, London, served an apprenticeship at the works of Naysmith, Wilson & Co. at Patricroft, England, and after that worked as a machinist for a short time at the Gorton shops of the Manchester, Sheffield & Lincolnshire Railway, and at the Nine Elms shops of the London & South Western Railway. In 1891 he came to the United States and entered the shops of the Great Northern as a machinist, and soon became mechanical engineer of that road under Mr. J. O. Pattee. In this position he developed marked ability in designing many devices, such as the present engineer's valve of the New York Air Brake Company. In 1897 he went to the Philadelphia & Reading as mechanical engineer, and two years later took charge of the management of the shops and mechanical engineering development of a manufacturing establishment in Chicago. Here he acquired a valuable commercial and manufacturing experience and the management of men. In March, 1902, he was called to the Lake Shore & Michigan Southern Railway as assistant superintendent of motive power under Mr. H. F. Ball. In two years, by his ability and his pleasing personality, he accomplished important work in a way which won enduring friendship all through the department. His keen intellect, clear observation and direct thinking have given him a broad outlook, which compasses the needs of the times in a way which promises success in the great motive power problem. It is encouraging to know that the railroads appreciate such men, and the Canadian Pacific is to be congratulated upon securing so valuable a man.

Overhead traveling cranes should not be used to place work in machines. Jib cranes for such large machines are better. They are always available for the attendant and may be used individually without causing others to wait. The traveling crane should be considered as an overhead railroad for transportation purposes only. Several times mistakes have been pointed out to the writer, indicating the importance of this question.

REAMERS FOR ROD PACKING CUPS.

At the Albuquerque shops of the Atchison, Topeka & Santa Fe Railway, Mr. W. L. Essex, general foreman, showed the representative of this journal a business-like contrivance for reaming piston rod packing cups to standard sizes and to exact interior contours. In the engraving the whole set of parts and a pile of reamers of different sizes are shown. One of the reamers is keyed in place in the bar, ready for the work, which is done in a lathe. The cups are held in chucks and the

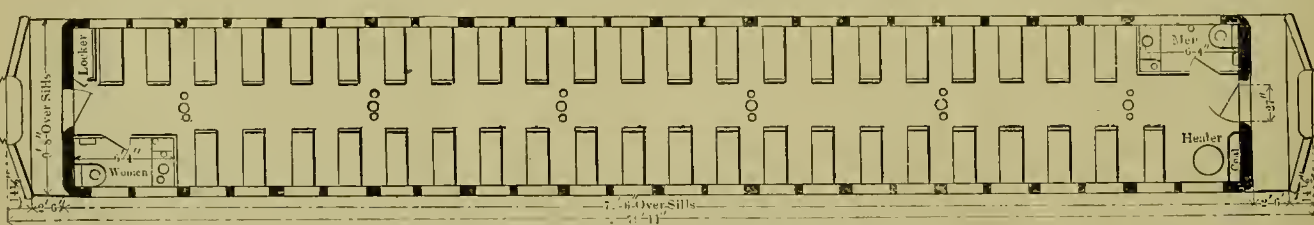
STANDARD RECEIVER FOR ROD PACKING CUPS.

boring bar is held by the centers. The rod at the left in the engraving passes through a hole in the boring bar to prevent it from turning. This process insures accurate fitting of all cups and is very rapid and inexpensive. The sizes of rods to be fitted are kept standard in 1-16-in. variations and cups are kept in stock for all sizes. It will pay every railroad to fit up devices for insuring accuracy in the important matter of maintenance of rod packing.

80-FOOT FIRST-CLASS COACH.

Great Northern Railway.

Twenty coaches, 80 ft. in length, have been built for the Great Northern by the Barney & Smith Company. They provide seating capacity for 86 passengers and weigh 111,250 lbs. The chief dimensions are as follows: Length over buffers, 81 ft.; length over platforms, 79 ft. 11 ins.; length over sills, 72 ft. 6 ins.; width over sills, 9 ft. 8 ins.; width over crown molding, 10 ft. ½ in.; transom centers, 55 ft. 10½ ins.; total wheel base, 66 ft. 10½ ins.; wheel base of 6-wheel trucks, 11 ft.; diameter of wheels, 42 ins.; size of journals, 4¼ x 8½ ins.; journals, collarless.



80-FOOT, FIRST-CLASS COACH.—GREAT NORTHERN RAILWAY.

The cars are finished in mahogany inside, with painted canvas headlining. The lighting is by acetylene gas. The heating system is that of the Safety Car Heating and Lighting Company, with 579 ft. of 1¼-in. pipe. The cars have wide vestibules and 6 ft. 4 in.-toilet-rooms. They are reported to be very satisfactory in riding qualities. We are indebted to Mr. G. A. Emerson, superintendent motive power, for the drawing.

MACHINISTS AS TEACHERS.

So far as we are concerned, the business use of our lives is to take material of a low value and convert it into things of a higher value, and that, too, is the business of the teacher, and there is no reason why the teacher should occupy any higher place than the machinist, except that they are dealing with more valuable material. The best mechanics are those who make the selection of material best suited to the purpose. The teacher is at present restricted to working all sorts of material through the same mill, whereas if the trades were added to the possessions instead of teachers' duties being those of turning the mill to grind out two-legged animals to fit the Board of Regents' standard gauge, their most successful members would be those who could best guide their material into its most useful channel.—Prof. J. E. Sweet, in a paper on the Apprentice Question, read before the Metal Trades Association.

One thing that motive-power officers are not thinking enough about is the design of their locomotives. In visiting a large number of railroads one is struck with the fact that the locomotives generally have the appearance of being "manufactured," rather than built to conform to the ideas of the railroad officers with respect to local conditions. It is easy to tell from which of the locomotive builders' shops a new locomotive has come. The general appearance of locomotives indicates a degree of indifference to the arrangement of detail which goes to make up a handsome result, of which the locomotive is thoroughly worthy. Exceptions only prove the rule. Upon inspecting a locomotive which bears evidence of careful consideration of its appearance one is sure to discover evidences of thoughtful and careful design in the whole or in details, which inspires confidence that the engine will give a good account of itself. Motive-power men cannot afford to ignore this matter or to leave to the builders too much responsibility for results. They should take advantage of all of the ability and experience of the builders, and then be sure that the details are worked out to suit the local conditions, which no one but those who operate and maintain the equipment can thoroughly understand. This can be done without additional expense, and those who do it will be likely to obtain a higher degree of success in their calling than those who do not. The specialization of locomotives becomes more necessary every year, and a transcontinental trip will convince anyone of the great variety of local conditions which must be met by thorough knowledge and experience in operation and maintenance. The pursuit of symmetry and handsome appearance can easily be carried too far, but efforts in this direction reflect that which is to be desired—more careful design. A handsome engine is generally a very good engine.

A rather general movement is on foot to increase the size of hand holds on freight cars. It is however one thing to increase the size of the iron used and quite another thing to gain the full value of such increase. This cannot be done unless the method of fastening the hand holds to the cars is improved. These parts are now secured exclusively by bolts on one large system, no lag screws being used for this purpose. This is an important improvement which will undoubtedly be introduced generally for ladders as well as hand holds.

The Consolidated Railway Electric Lighting & Equipment Company announce the removal of their general offices in New York City, from 100 Broadway, to the Hanover Bank Building, corner of Nassau and Pine streets.

PERSONALS.

Mr. C. A. V. Axen has been appointed general foreman of the shops of the Chicago & Northwestern at Kaukauna, Wis., to succeed Mr. R. Whittier.

Mr. D. J. Malone has been transferred as master mechanic of the Oregon Short Line at Salt Lake City. He has been master mechanic at Pocatello, Idaho. Mr. W. J. Tollerton succeeds Mr. Malone at Pocatello.

Mr. H. W. Ridgeway has been appointed master mechanic of the Mexican Central at the City of Mexico. He was formerly superintendent of motive power of the El Paso & Northwestern and succeeds Mr. C. W. Wincheck, resigned.

Mr. J. A. Pfeiffer heretofore erecting shop foreman of the Atchison, Topeka & Santa Fe at the Topeka shops, has been appointed general foreman of the shops of that road at Winslow, Ariz.

Mr. J. N. Barr, assistant to the president of the Chicago, Milwaukee & St. Paul, has been granted leave of absence for six months on account of ill health. It is understood that he will spend this time in California.

Mr. William Cross, engineer of tests of the Canadian Pacific, has been appointed assistant to the second vice-president of that road. He will have charge of motive power west of Fort William, Ontario, with headquarters at Winnipeg, Man.

Mr. Thomas Paxton has accepted the appointment of master mechanic of the St. Louis, Iron Mountain & Southern, with headquarters at Baring Cross, Ark., to succeed Mr. George Dickson.

Mr. J. N. Sanborn has been appointed superintendent of motive power of the Texas Southern, with headquarters at Marshall, Texas. He has been promoted from the position of master mechanic of this road at Marshall.

A dynamometer car is being built by the American Car & Foundry Company, for the International Correspondence Schools. It will be modeled after the dynamometer car of the Chicago, Burlington & Quincy, and it is stated that a number of roads have already expressed a desire to use the car.

Mr. T. U. Cutler, master mechanic of the Northern Pacific at Fargo, N. D., has been transferred to the same position on the Rocky Mountain division at Missoula, Mont., to succeed Mr. W. F. Buck, and Mr. Cutler is succeed at Fargo by Mr. J. E. O'Brien.

Mr. H. C. Shields has been appointed master mechanic of the Lehigh & New England, with headquarters at Pen Argyl, Pa. He has been division foreman of the motive power department of the Delaware, Lackawanna & Western at Bangor, Pa.

Mr. James Connors has been appointed district master mechanic of the Chicago, Milwaukee & St. Paul, with headquarters at Dubuque, Iowa, to succeed Mr. George H. Brown, who has been assigned other duties. Mr. David Patterson succeeds Mr. Connors as general foreman at Dubuque.

Mr. J. J. Reid has resigned as mechanical inspector of the Northern Pacific Railway to accept the appointment of general master mechanic of the Louisville & Nashville Railroad with headquarters at Louisville, Ky. Mr. Reid will have general charge of all the shops of the line as well as other responsibilities.

Mr. A. W. Wheatley has been appointed assistant superintendent of motive power of the Northern Pacific with headquarters at St. Paul, Minn. He has been superintendent of shops of that road at Brainerd, Minn., where he is succeeded by Mr. U. N. Anderson, formerly general foreman.

Mr. U. L. Driscoll heretofore master mechanic of the Cincinnati, New Orleans & Texas Pacific at Chattanooga, Tenn., has been appointed master mechanic of the Alabama Great Southern at Birmingham, Ala., to succeed Mr. V. B. Lang, resigned. Mr. Driscoll is succeeded at Chattanooga by Mr. W. H. Dooley, heretofore master mechanic at Somerset, Ky. Mr. Dooley is succeeded by Mr. D. Brown, heretofore general foreman at Somerset.

Mr. James C. Cassell, general superintendent of the Norfolk & Western Railway, has been appointed assistant to the president. Mr. Cassell began railroad services in 1871 as a telegraph operator on the Pennsylvania and has steadily advanced to his present position. He has been connected with the Norfolk & Western for twenty-five years and has occupied every position in the operating department, from dispatcher to general superintendent.

Mr. C. F. Giles, master mechanic of the Louisville & Nashville, at Louisville, Ky., has been promoted to the position of assistant superintendent of machinery, with headquarters at the same place, to succeed Mr. H. Swoyer, who recently resigned. Mr. W. L. Tracey, assistant master mechanic, succeeds Mr. Giles, and Mr. J. G. Clifford, master mechanic at South Louisville, succeeds Mr. Tracey. Mr. J. J. Sullivan, master mechanic at New Decatur, Ala., succeeds Mr. A. Beckert, recently resigned.

The Master Mechanics' Association Committee on Cost of Shops has prepared blank forms for distribution to members for the purpose of securing data concerning the cost of recently constructed shop plants. The blanks are very well arranged, and it is to be hoped that they will receive the best possible attention from those who have these important figures at hand. This committee will be enabled to do a valuable work, if they are placed in possession of information which will enable them to state the cost of buildings of various types and of equipment of the various departments of locomotive shops and power houses. Those who have recently been called upon to estimate the probable cost of new shops, will appreciate the value of general information of this kind, and the report, if complete, will be one of the most useful undertakings which the association can take up at this time.

The United States Government has placed the first exhibit at the World's Fair in St. Louis. It consists of a postal car, built in the Altoona shops of the Pennsylvania Railroad. The United States Government's extensive display includes the inner works of the postoffice department, of which the railway postoffice service is an important part. To properly demonstrate that feature a postal car similar to those operated on the Pennsylvania-Vandalia system was selected by the government as representing the most advanced ideas in devices for the expeditious handling of United States mail. The car placed in the United States Government building at the World's Fair is No. 6542. When the new postal car was recently placed in the Government building at St. Louis, it was photographed under the immense arches of steel, which compose the framework of that exhibit palace, the only steel-framed structure on the ground. The handsomely finished sides of the car are covered with heavy canvass to protect it until the opening of the Exposition, April 30, when visitors to the World's Fair will be privileged to witness postal clerks at work in the car, showing how the mails are distributed and handled on fast trains of the Pennsylvania-Vandalia system in eleven States.

A 1,000 TON DRAWBRIDGE MOVED AND LOWERED BY SAND JACKS.

DELAWARE, LACKAWANNA & WESTERN.

The lifting of a thousand ton steel drawbridge through a height of 20 ins. so that it will clear its old supports; its transfer upstream a distance of thirty-five feet and its final lowering to a new pivot pier ten and a half feet lower than that on which it originally rested, is an engineering feat of more than ordinary importance. And when it is accomplished in a space of twelve hours with unfavorable tides, winds and river currents, it becomes all the more remarkable. Yet this is what was performed by Chief Engineer Bush of the Lackawanna Railroad recently in transferring a new steel double-deck draw span from old to new piers across the Passaic River, at Newark, New Jersey.

DRAW-BRIDGE OVER THE PASSAIC RIVER, AT NEWARK, N. J.—DELAWARE, LACKAWANNA & WESTERN RAILROAD. VIEW FROM PIER ON NEWARK SIDE AS DRAW SPAN WAS BEING LOWERED ONTO THE NEW PIVOT PIER. OLD PIVOT PIER AT RIGHT; SAND JACKS COVERED WITH CANVAS.

The Lackawanna have for some time past been engaged in developing great improvements in elevating their tracks through Newark and eliminating a large number of grade crossings, to accommodate their greatly increasing suburban traffic. On December 20 the elevated structure was put into commission by the moving of the enlarged draw span from the original location to the new right of way. In March, 1901, a new double-deck draw span, 220 ft. long, had been erected at this point to replace an old bridge not sufficiently strong for the steadily increasing traffic. The new bridge was suitably designed for the elevation work through Newark and Harrison that was to come later, the lower deck being used for carrying the main line traffic. The lower deck will now be used for a single track approach to the new freight yard at Broad street, Newark, at the street level, while the upper deck, heretofore unused, is now occupied by the two main line tracks. The new grade and location of elevation work were such as to require the bridge to be moved 35 ft. north of and parallel to the old location and placed 10½ ft. below the old elevation. The bridge weighed, ready for removal, 1,017 tons.

It is a simple matter to move a bridge and raise and lower it through a small difference in elevation but to drop it ten to twelve feet exactly on top of a pivot pier located in a strong tideway, is a more troublesome operation. The secret of its successful accomplishment dates back to the early Egyptians, who, in spite of their lack of machinery, were accustomed to seal the tombs of their dead with enormous stone slabs. For many years scientists have wondered how these stones of such size were lower into a sarcophagus, until it was discovered that the idea of the sand-jack was made use of, in that a column of fine sand upon which they rested, was allowed to run out from underneath, allowing the slab to settle firmly into place.

Probably nothing like the huge sand bins used in this modern work has ever been seen before. Four immense boxes, 11 ft. high, 5 ft. wide and 54 ft. long, were built on scows, and carried the sand which in turn supported the plungers which held the bridge. The sand boxes and plungers were so constructed that the difference between the elevation of grade line of the bridge on the old location and the grade line of the bridge on the new location, amounting to ten and a half feet, was taken care of by letting out the sand in the cylinders. A set of slides controlled the orifices through which the sand was allowed to run out, and so perfectly was the work performed that the bridge settled into place without so much as a scratch. The variation in the height of the tides and the lifting of the bridge from its old location onto the scows, as well as the releasing of the scows from underneath the bridge in its new location, were controlled by means of water ballast, which was pumped in and out of the four scows by four centrifugal pumps each having a capacity of 1,600 gals. per minute.

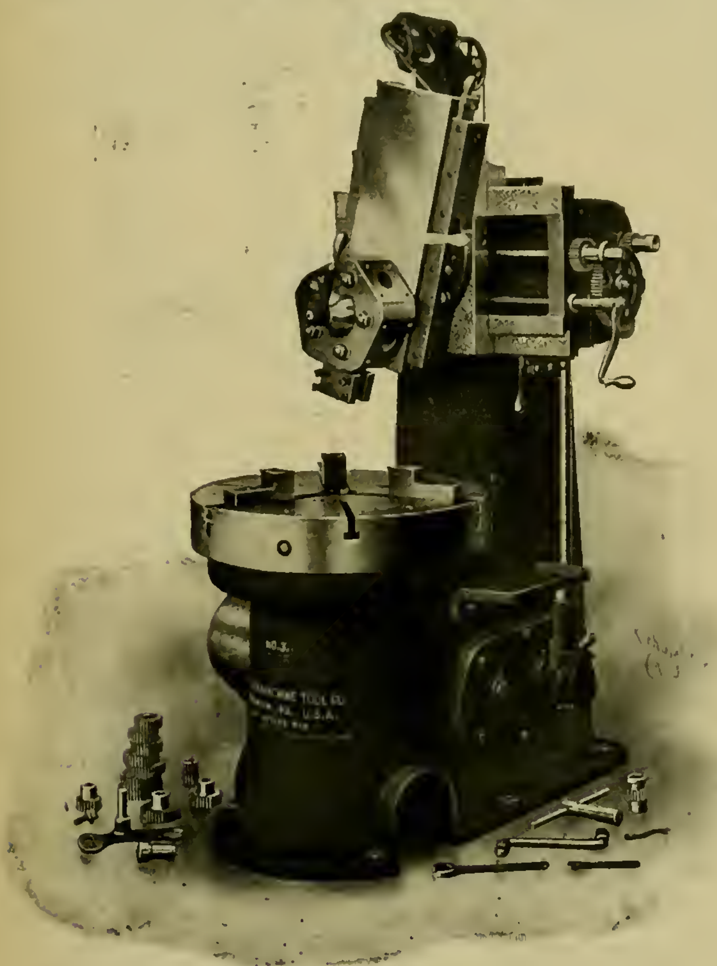
The four scows were secured under the bridge at low tide, and elevated by removing the water ballast to within a few inches of the bottom of the bridge. When the tide began to rise the immense drawbridge was lifted from its pivot of granite in the middle of the river and the floats were then drawn up stream with their burden until the bridge was poised above the new pier and between the newly laid elevated tracks. Then the sand in the boxes was permitted to run out from the holes and the plungers carrying the weight of the bridge sank steadily and evenly into place. The work was started at 4 a. m. and the bridge touched the new pivot pier at 5 p. m., completing a connection that renders possible the handling of the road's immense suburban traffic in a most satisfactory way.

A MODERN BORING MILL.

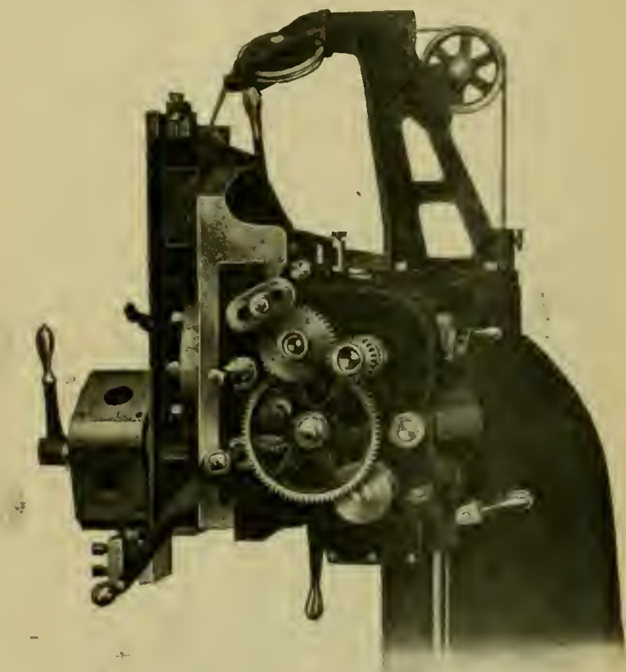
COLBURN MACHINE TOOL COMPANY.

The important part which the boring mill is coming to take in modern machine shop practice and in rapid duplicate manufacturing is fully recognized by railroad shop managers, and its use in this direction is rapidly extending. Nothing has done more to develop modern methods of manufacturing than the boring mill and its easy methods of chucking and control.

One of the most modern and efficient tools, at present upon the market, is the boring mill manufactured by the Colburn Machine Tool Company, Franklin, Pa. A line of these tools ranging in size from 34 to 78 ins. is manufactured by them. Of these the 34-in. size is illustrated herewith. A characteristic strength and solidity of design is easily recognized in this machine, especially as regards the heavy chuck or table.



THE 34-INCH VERTICAL BORING AND TURNING MILL, WITH TURRET HEAD AND SCREW CUTTING ATTACHMENT.—COLBURN MACHINE TOOL COMPANY.



SIDE VIEW OF HEAD OF THE 34-INCH COLBURN BORING MILL, SHOWING DETAILS OF THE SCREW CUTTING ATTACHMENT.

Some of the more important features of this tool may be of interest. It is supplied with either a plain table or 3 or 4 jaw chuck. The turret is five sided, and the turret slide swivels 30 degrees either side of the perpendicular; the counterweight for the slide is carried inside the column, doing away with the overhanging arms and chains which are usually employed on mills of this size. The drive on these mills is what is called a parallel drive, enabling the machine to be set on a crane floor and belted up to a line shafting running lengthwise along the crane columns of a shop.

A scale and pointer is furnished on the vertical slide to enable duplicate work to be done to exact depth; this is not shown on the cut, but it is a very desirable feature. The gearing is powerful, with 16 changes of speed; there are 10 changes of feed. Practically all parts of the machine are jig drilled, making them interchangeable—a very important feature when repair parts happen to be needed. Further information will be gladly supplied regarding any of these tools by the Colburn Machine Tool Company.

THE PHOSPHOR-BRONZE SMELTING COMPANY.—A revised price list, No. 22, of "Elephant Brand" phosphor-bronze has been issued by these manufacturers to take the place of all previous lists and quotations. The new rolling mill is now in successful operation, and, with greatly improved facilities and a well-assorted stock, this company is ready to supply all requirements. Correspondence should be addressed to 2200 Washington avenue, Philadelphia, Pa.

FAIRBANKS, MORSE & CO.—A new catalogue of hoists and mining machinery operated by gas, gasoline, crude oil or producer gas has been issued by Fairbanks, Morse & Co., Franklin and Monroe streets, Chicago. In addition to this line of machinery, in which they have established a valuable reputation, this company manufactures a complete line of hoisting machinery operated by steam, including both flat friction and geared hoists.

THE DAKE SQUARE PISTON ENGINE.—The Holland Company, 77 Jackson boulevard, Chicago, in their circular No. 41 describe and illustrate their motor for air or steam power for operating blowers, fans, pumps and generators, or any service requiring a compact motor. The pamphlet gives the sizes of the machines and all information necessary for ordering.

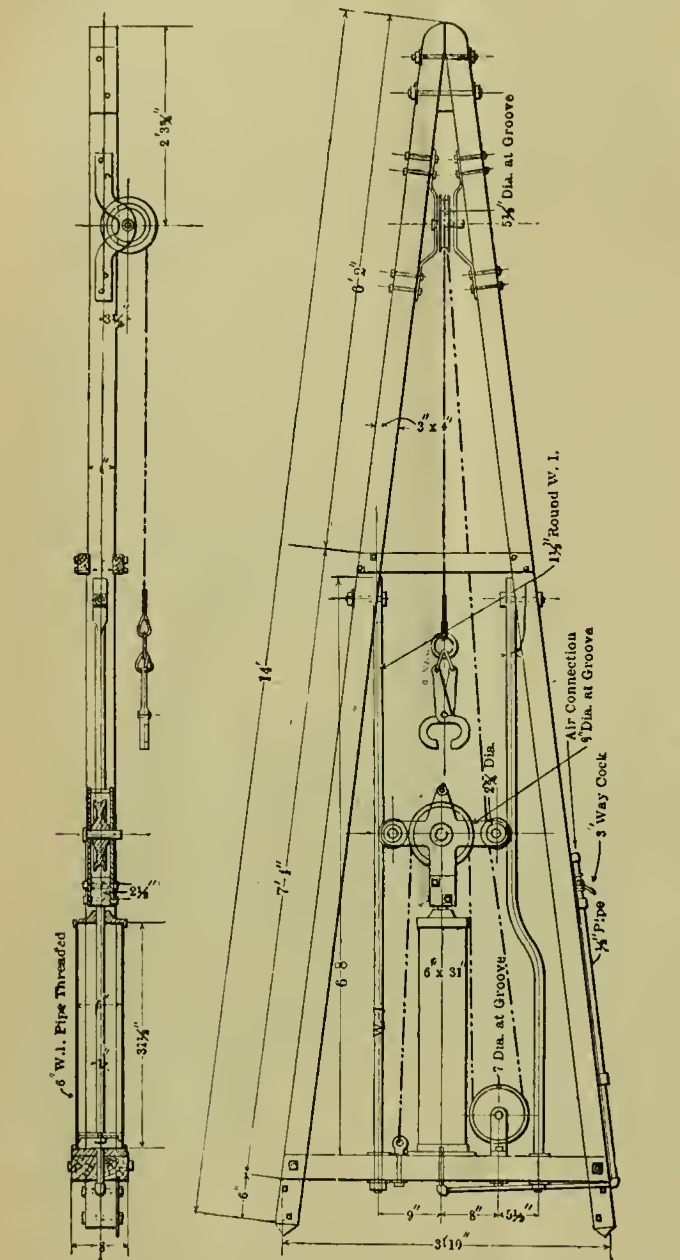
Mr. David Hunt, Jr., has resigned as treasurer of the Baush Machine Tool Company, of Springfield, Mass., to accept the appointment of general sales manager of the Warner & Swasey Company of Cleveland. Mr. Hunt was formerly, for several years, connected with the sales department of Messrs. Manning, Maxwell & Moore, and has a wide acquaintance among railroad men and other users of machine tools.

THE STAR BRASS MANUFACTURING COMPANY has moved its Chicago office from the Monadnock building to 303 Fisher building. Mr. W. T. Johnson is in charge.

Colonel John T. Dickinson, vice-president of the Consolidated Railway Electric Lighting & Equipment Company, general offices, Hanover Bank Building, New York, is authority for the statement "that the Consolidated company has more of its 'Axle Light' equipments of electric car lighting in use on the best cars constituting the finest trains of leading railway lines than all other systems of electric car lighting combined. Also, that the chief mechanical officials of several of the great railway systems in the country, where a large number of 'Axle Light' equipments have been in service for the past few years, have concluded that Consolidated 'Axle Light' is the cheapest to install and maintain, and the most efficient system of electric car lighting ever yet devised. Each car carries its own independent electric car lighting apparatus, ready for immediate and constant use, no matter in what service the car may be placed."

PORTABLE AIR HOIST FOR LOADING CAR WHEELS.

This engraving illustrates a convenient air hoist for handling car wheels into or out of box cars. It is leaned against the roof of the car and an air hose is connected to the yard supply. The air cylinder is 6 x 31 ins., and uses air at 100 lbs. per sq. in. It is in use on the Lake Shore & Michigan Southern Railway. We are indebted to Mr. L. G. Parish, master car builder at Englewood, Ill., for the drawing.

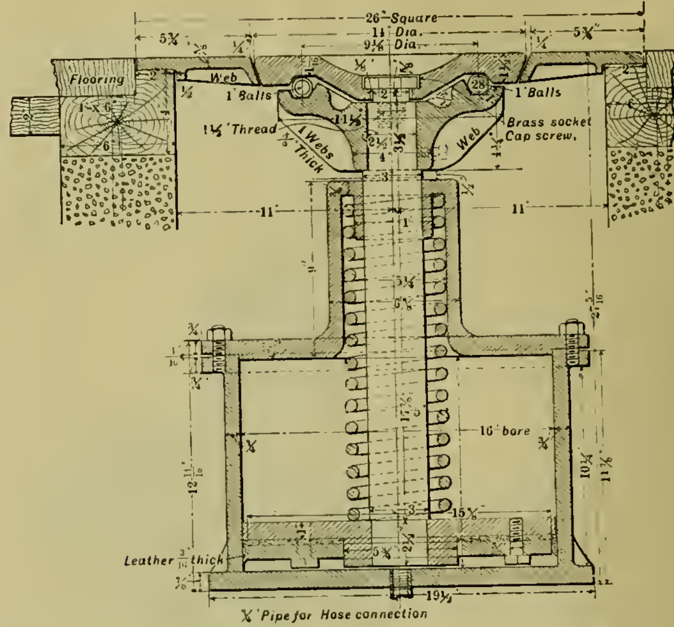


DETAILS OF THE PORTABLE HOIST FOR LOADING WHEELS.—L. S. & M. S. RAILWAY.

PNEUMATIC CROSSING JACKS FOR PUSH CARS.

For a number of years jacks of this general character have been used at the Topeka shops of the Atchison, Topeka & Santa Fe. They cost very much less than turntables and are specially convenient in tracks which must be used for locomotives, where small turntables could not be employed.

This jack is operated by a conveniently located air valve. The plate on the top of the piston rod is brought up under the push car, which lifts the car off the rails. The car may then be easily turned on the ball bearing and let down upon the other track. Water-tight pits of concrete are built for these jacks, and when in the normal position the top plate lies flush with the floor plate, as shown in the drawing. The pits are 22 ins. square, with 9-in. walls and 9-in. floors. To return the piston to its normal position, the piston rod is surrounded by a coil spring of 5-16-in. wire in 15 coils, the free height of which is 2 ft. and the outside diameter of the coil 5 ins.



DETAILS OF AIR CYLINDER AND BALL BEARING SWIVEL JOINT UNDER THE PLATE.

A NEW DESIGN OF STEEL-FRAME MOTORS AND GENERATORS.

TRIUMPH ELECTRIC COMPANY.

Recognizing the modern demand for electric motors and generators to be extremely compact and strong, to be efficient and durable, and to be capable of withstanding fluctuating loads and heavy overloads, the Triumph Electric Company, Cincinnati, Ohio, have recently placed on the market a new series of designs of bipolar machines, with steel frames, for use as motors or generators, in the sizes of ½ to 5-h.p. In this new design it was sought to produce a machine that is simple in construction, does not easily get out of order and requires but little attention; and, moreover, one that can be placed under the care of an inexperienced attendant and be always ready for service.

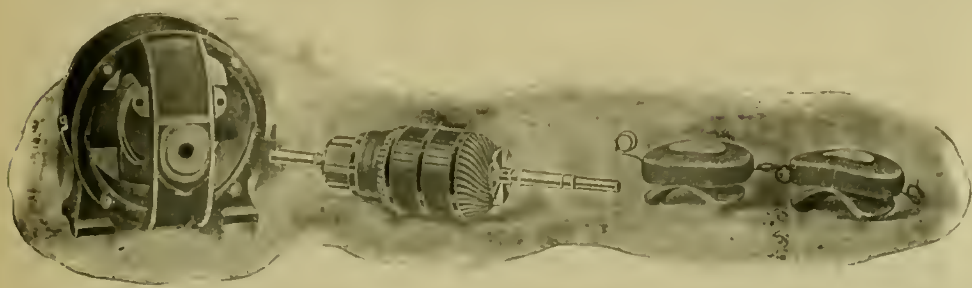
The accompanying engravings illustrate, in one case, a 1-kw. machine, arranged for use as a slow-speed generator, and the other, the unassembled parts of a ½-h.p. motor of the new type. An important feature of the general design is its compactness. The arrangement of the yokes serves also to make the machine perfectly iron-clad.

The frame and pole pieces are of soft close-grained steel, the pole pieces being accurately fitted within the crown and bolted in for ease of removal if necessary. The yokes may be removed by loosening 4 bolts each, and can be mounted in any position, thus making the machine easily available for floor, wall or ceiling use without change.

The field coils are form wound and thoroughly insulated. Every coil is soaked in a varnish bath, then baked, after which it is covered with two layers of friction tape, finally receiving two coats of insulating paint. This construction makes the field coil practically indestructible. Each coil on completion is tested with alternating current.

The armatures are of the usual laminated construction, but on these machines notched discs are used and they are annealed after punching and varnished before assembling—the most approved construction. The armature coils are embedded in the notchings, with most thorough insulation, thus reducing the air gap and making most efficient machines. The commutator shell is of a new design, making it impossible for a segment to get loose and cause trouble. The brush holders are simple, light and effective, and are so set as not to require adjusting under any condition of load or overload.

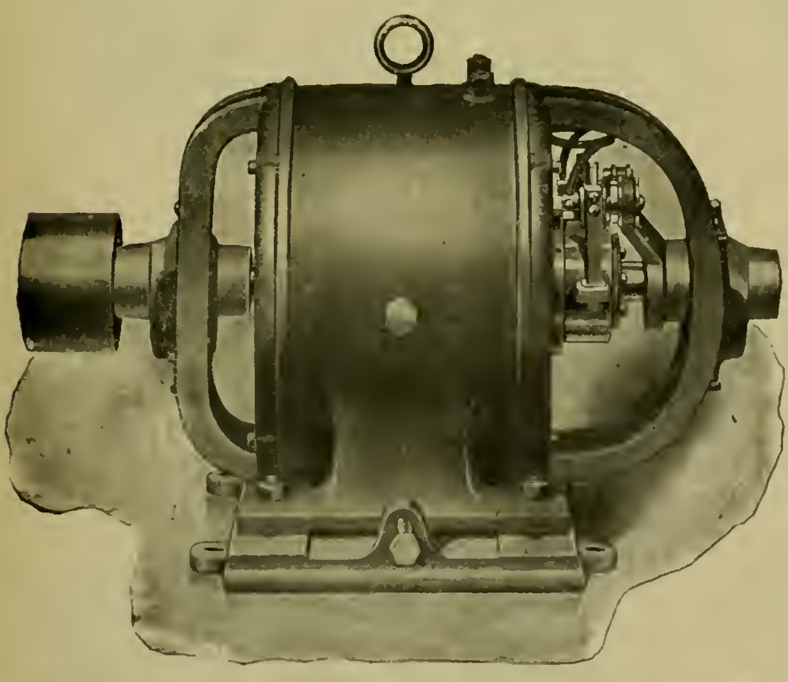
These machines are rated well within their limits of capacity,



DETAIL VIEWS OF THE FRAME, ARMATURE, POLEPIECES AND FIELD COILS OF THE ½-H.P. STEEL FRAME MOTOR.

and, as open machines, no part will heat more than 40 degs. Cent. over the surrounding air, when operated for 10 hours under full load. They will withstand an overload of 50 per cent. for a period of one hour, and a momentary overload of 100 per cent. without injury. As entirely enclosed machines the ratings will be somewhat less, to meet these requirements.

No expense, either in quality of materials, workmanship or



GENERAL VIEW OF THE 1-KW. SLOW-SPEED STEEL-FRAME GENERATOR.—TRIUMPH ELECTRIC CO.

in care of testing, has been spared to make these machines as nearly perfect as possible. They are built, as motors, in sizes from ½ to 5-h.p., and as generators, from ½ to 5-kw., inclusive. The Triumph Electric Company also builds larger machines, for belt-drive and direct connection, the particulars regarding which may be had upon application.

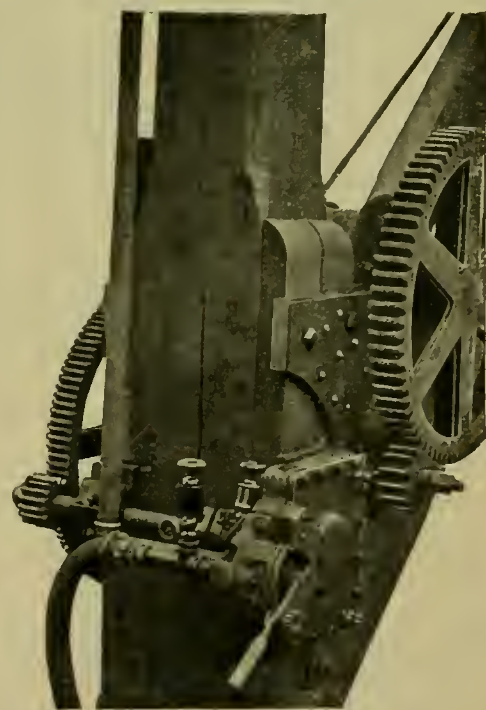
THE DAKE SQUARE-PISTON ENGINE.

Probably there can be no simpler way in applied mechanics, to obtain a rotary motion from the force and expansion of steam than that employed in the construction of the Dake engine. Reduced to its simplest elements it consists of nothing but two movable pieces, one sliding inside the other, and both floating in a square, steam-tight box or cylinder, and being guided in their movements by the crank on the end of the driven shaft.

The Dake motor provides a cheap and very effective means of changing jib cranes from hand to power cranes, as shown in the accompanying illustration. In nearly all railroad yards, foundries, machine shops, boiler works and structural steel plants, where compressed air power is used, this motor can be very profitably applied for driving jib cranes. The accompanying illustration shows an unloading jib crane in a railroad yard, formerly operated by two men on either side with cranks; the cranks were removed and the motor bolted to the side of the mast without changing the gearing.

This machine can be bolted to the mast of any jib crane and will raise and lower the load at any desired speed and in a reliable manner. If it is desired to rack the load on the boom or raise and lower the boom, as the case may be, in addition to raising and lowering the load, a double drum hoist is furnished, by which the load can be raised and lowered independently of racking it, or otherwise operating the boom.

The Holland Company, who supply this motor to the trade,



DAKE MOTOR AS APPLIED TO A JIB CRANE FOR HOISTING. FOR USE WITH COMPRESSED AIR.

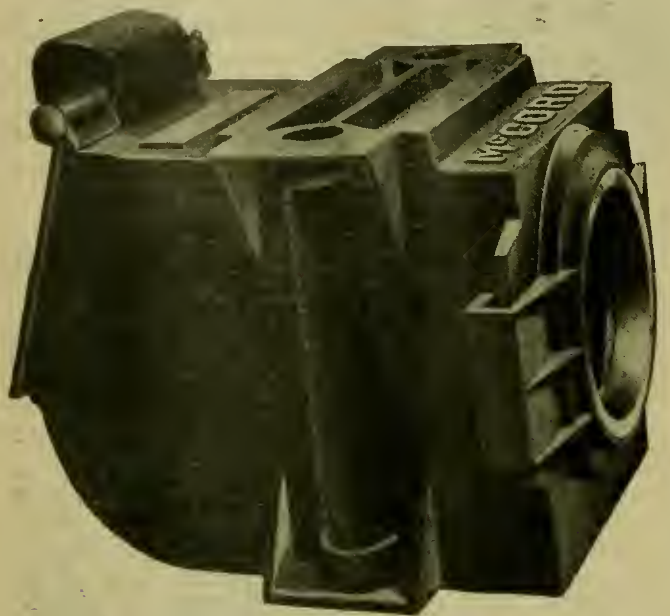
have recently issued a new circular (No. 41) devoted to the Dake square-piston engine, for use with compressed air or steam. The motor is illustrated in detail, and this circular will be of interest to all who are interested in motors of small sizes. The Dake motor operates upon a very interesting principle and, as a prime mover, is one that requires very little attention and is very durable. It is carefully provided with all necessary adjustments and the wearing surfaces are of phosphor bronze and can easily be renewed.

This motor is built in sizes ranging from 1 to 30-h.p., and can be supplied for direct-connection to machines, as reversible engines, or with throttling governor for use as a constant-speed stationary engine. Further particulars will be gladly supplied by the Holland Company, No. 77-83 Jackson Boulevard, Chicago, Ill.

McCORD JOURNAL BOX WITH OUTSIDE DUST GUARD.

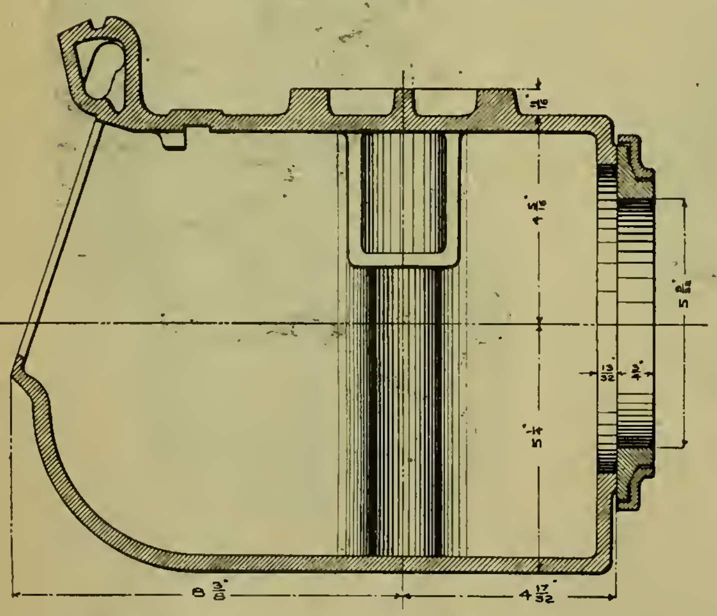
A special feature of the McCord journal box has been the construction which has made the lid tight, preventing the entrance of dust. The usual form of dust guards, however, was depended upon to keep dust from entering at the other end, and both ends must be dust tight in order to meet the journal box problem. The dust guard difficulty has usually been attacked by attempts to make tight joints upon rough and uneven surfaces. The new McCord box has no dust guard slot. This portion of the standard box has been cut off and the back end of the box carries a boss surrounding the axle and terminating in a ground surface. The dust guard is in the form of a cast iron ring turned to fit the dust guard portion of the axle. The box has lugs upon its inner face and these serve to hold in place a malleable iron shell which encloses the dust guard ring and this shell is urged toward the box lugs by springs enclosed in cavities in the outer faces of the lugs, as indicated in the engraving. The dust guard ring is ground on its inner face to make a joint with the boss on the box. The springs hold the shell against the dust guard ring and are sufficiently strong to take the weight of the ring off the axle and the ring is free to move with the axle. The sectional drawing shows the form of the joint between the dust guard and the box, and also that between the dust guard and the shell. If desired the dust guard ring may be made in segments, which will be always urged toward the center by the shell, so as to take up wear. This, however, will probably not be necessary, as a wear of less than 1-64-in. has been found in a mileage of over 100,000 miles on a locomotive tender. This leads to the conclusion that without sectional rings the guard will outlast the usual life of a freight car.

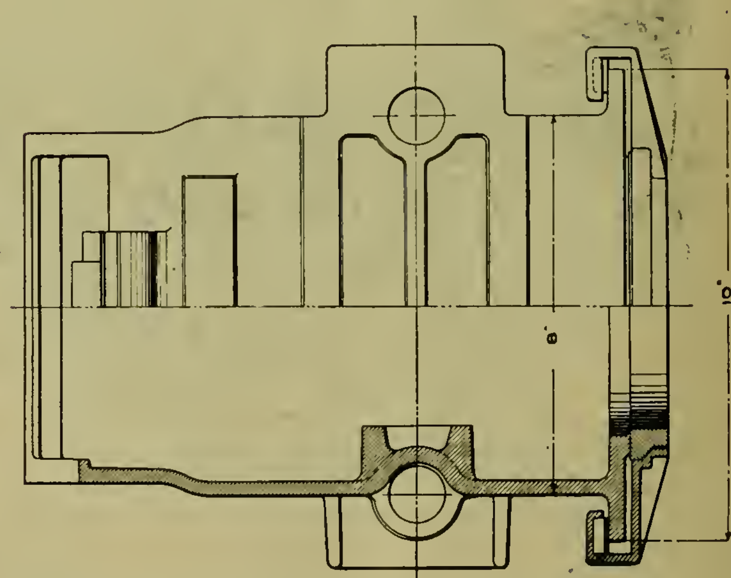
This guard has four parts. It is made entirely of metal and will not be injured by a hot box. It is claimed that it will raise the oil level at the back of the box to the center of the journal, that there is no possible way for dirt to obstruct it or interfere with its effectiveness. This construction allows 3-8 in. more clearance between the guard and the wheel than is to be had with the usual construction of journal boxes with dust guard slots. This new box has already been specified upon about 5,000 cars, and it is stated that because of the saving of weight, its cost is but little more than the ordinary box with wooden dust guards. Further information may be had from McCord & Company, Old Colony Building, Chicago, Ill.



MCCORD JOURNAL BOX WITH OUTSIDE DUST GUARD.

DUST GUARD RINGS AND SHELL.





SECTIONS THROUGH NEW MCCORD JOURNAL BOX AND DUST GUARD.

Compressed Air, A Treatise on the Theory and Practice of Pneumatic Power Transmission. By W. C. Popplewill. Published by the Scientific Publishing Company, 53 New Bailey Street, Manchester, England, 1903. Price 7s. 6d.

This book is not exhaustive and not entirely original. It presents the principles of compressed air transmission with a chapter on calculations, one on tests of compressed air machinery, while the major part of the space is occupied by descriptions of air compressors, air motors and tools and transmission pipings. An unusually large number of compressors are described, including several operated by the hydraulic principle. The author has drawn a balance between theory and practice and gives some of each. This book ought properly to be one of several volumes on the subject. It is not sufficiently complete for present needs in the literature of compressed air. Perhaps the author will be encouraged to keep on and write the encyclopedia, which is needed on this subject.

A LARGE INSTALLATION OF WATER-SOFTENING APPARATUS FOR THE ROCK ISLAND.

For the Locomotive Supply of an Entire Division.

The Chicago, Rock Island & Pacific Railway are preparing to equip an entire division with a system of water purifiers and softeners for the locomotive water supply. In common with most of the other roads in the West, this System has experienced a great deal of trouble from bad water, and now proposes to give water-softening a fair and impartial trial by equipping their entire Kansas division, with seventeen installations, located at the locomotive water supply stations. The waters throughout their Kansas division have always been a source of trouble and expense, and that division was naturally selected as the most favorable for this installation. As was recently stated in this journal, the only way to give water purification a fair trial is to equip an entire division, so that certain

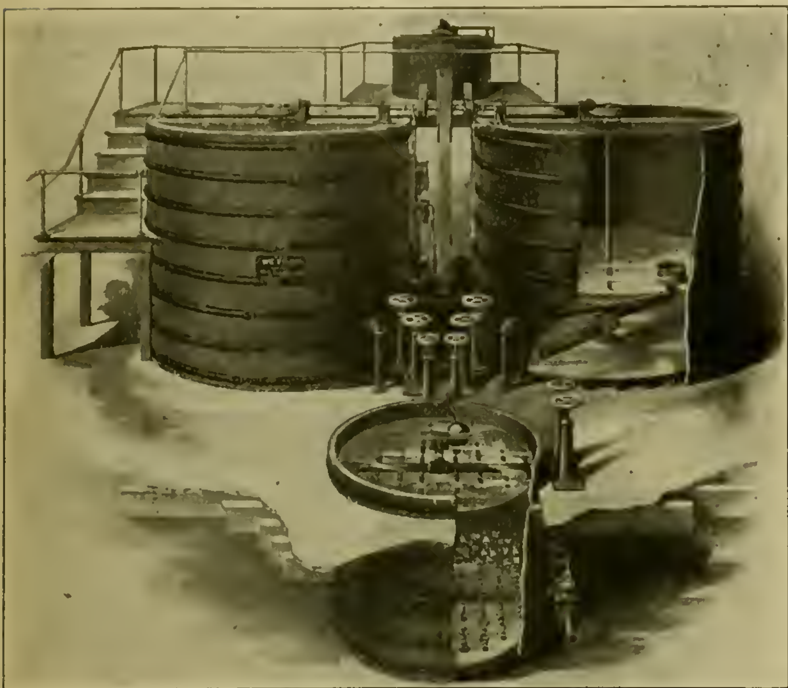


Fig. 1.—View of Apparatus used in the We-Fu-Go System of Water Softening and Purification, Showing Diagrammatically the Mode of Operation.

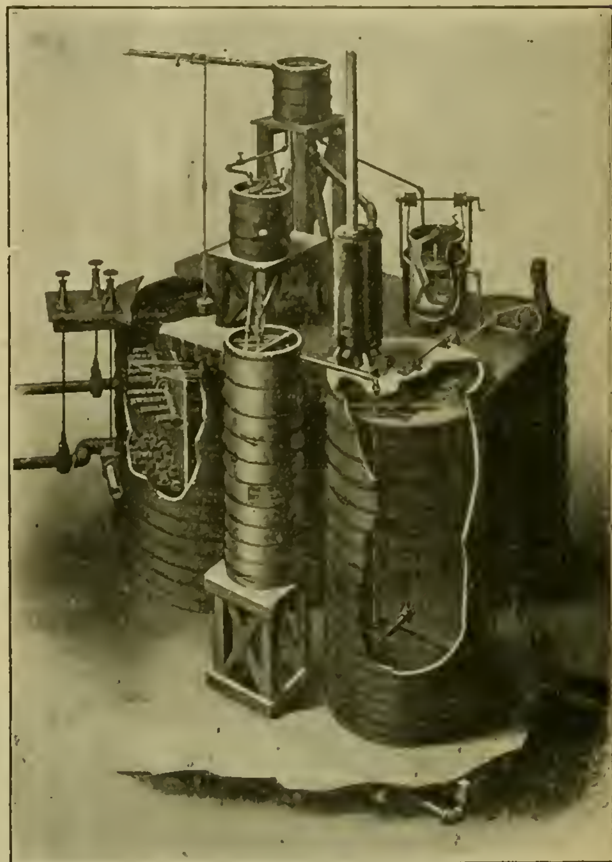


Fig. 2.—Diagrammatic View of the We-Fu-Go Continuous System of Water Softening and Purification.

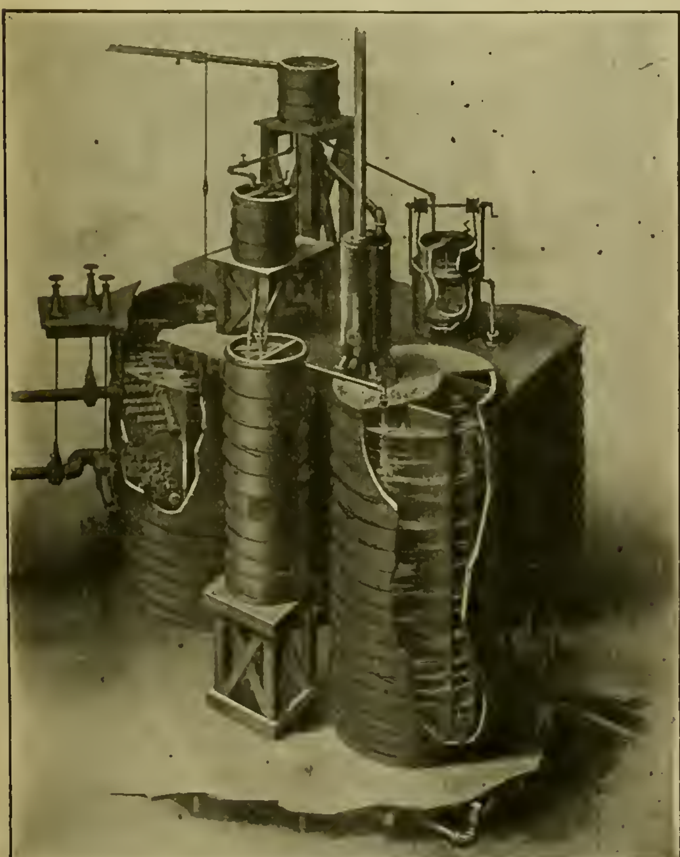


Fig. 3.—Diagrammatic View of Apparatus used in the Scaife Automatic System of Water Purification.

engines may always use the treated water and not mix the good with the bad, and it is important that the necessity of this should be appreciated. In several cases engines which, with bad water, required retubing as often as every six months, are now using only treated water, and the expectation of more than doubling the life of the flues is warranted. This is an excellent test. The best comparison can only be made when entire divisions are thus equipped, which, although expensive, will unquestionably pay.

After a thorough investigation of the various systems of water-purifying on the market, the contract for this equipment was let to William B. Scaife & Sons Co., of Pittsburgh, Pa., the manufacturers of the Scaife and We-Fu-Go softening and purifying systems. Both of these systems are now well known and perfected; plants operating under them, in every part of the country, and for every purpose, are daily purifying over 300,000,000 gallons of water. Some of these plants have been in operation for eight and nine years. A brief description of these systems may be of interest:

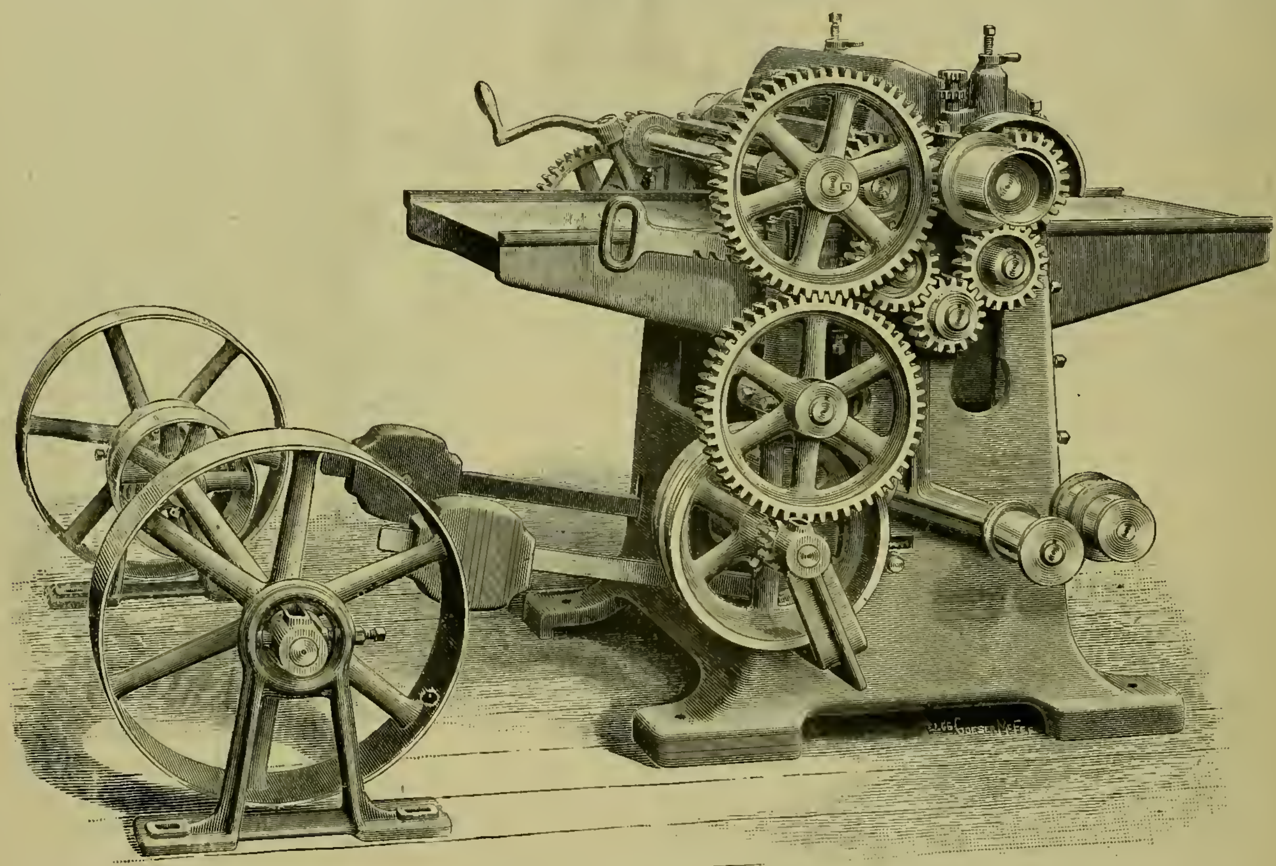
The We-Fu-Go system (which was formerly manufactured by the We-Fu-Go Company, of Cincinnati, Ohio, until purchased by William B. Scaife & Sons Co.) is shown in the first cut (Fig. 1). It consists essentially of two settling tanks and a small chemical tank, with, first, the necessary pipe connections to admit the raw water to either one of the settling tanks or to the chemical tank; second, the pipe connections necessary to draw off the purified water from either settling tank at the top, by means of a hinged floating take-off pipe; and, third, waste or wash pipes through which to get rid of the sludge collected in the bottom of either settling tank. Mixing of the chemicals and the raw water is accomplished by mechanical stirring devices which are driven by a small engine; the stirring devices are designed to give the water a rolling motion, which materially assists chemical action and hastens precipitation. The treated water, after being drawn off through the floating take-off pipe, is conducted to a gravity filter, which removes any matter carried in suspension, thus causing the water to leave the plant soft and clear.

The operation of this system is as follows, in detail: While filling the left-hand settling tank with raw water, the exact amount required of the first chemical reagent is weighed and put into the small elevated chemical tank, dissolved, and then washed into the settling tank; when this settling tank is full the second chemical is added and the water stirred for a few minutes longer. It is then allowed to settle several hours, so as to permit the greater portion of the precipitates and suspended matter which the water will then contain, to deposit. After this the water is drawn off through the filter below, and is ready for use. It can be drawn off as desired, using the settling tanks as storage tanks. This system has the advantage that, inasmuch as definite quantities of water are treated each time, it can always be correctly treated, no matter how variable the water or amount used may be.

Another system controlled by the Scaife Company is the We-Fu-Go continuous system, which is illustrated by Fig. 2. This system involves a continuous process, and consists essentially of three tanks—a reaction tank for the lime, a reaction tank for the soda, and a large settling tank equipped with a regular gravity filter. The chemicals are introduced in proportion to the flow of water through the tanks, and thorough mixing is brought about by the use of a small engine which drives mechanical stirring devices, as shown in the illustration. The saturating tank, for making the saturated solution of lime, is said to be an especially efficient device; in a series of tests the quantity of lime water introduced into the system varied from 1 gal. to 100 gals. per minute, but the solution did not vary 4-10 of a grain to the gallon. This shows the efficiency of this portion of the apparatus, as the results obtained from a continuous system are almost entirely dependent on the successful making of a continuous supply of uniformly-saturated lime water. This system is so designed that the water has from four to six hours to pass through the tanks, so as to allow ample time for the chemical action and settling. A heater is shown in the cut, but it is only employed when the water is of such a nature as to make it desirable to slightly heat it, or to prevent its freezing in cold weather.

The third system of this company is the Scaife automatic system of water purification. This system is especially adaptable to locations so isolated that little attention can be given it, and where steam for driving a small engine is not available. One of these plants is illustrated in Fig. 3. The mixing and precipitation is brought about by the water passing over and under vertical partitions in the lime reaction and soda reaction tanks, as shown. This system is also provided with a mechanical gravity filter in the settling tank, in the same manner as the system described above. The same lime-saturating and soda-introducing devices are employed in this system as in the We-Fu-Go continuous system.

These systems have been in use, mainly in stationary plants, for a number of years, with great success. Seventeen of these plants will be installed for the Rock Island at the various water stations on the Kansas division. The conditions were carefully gone into in considering these installations, and the system best adapted to meet the conditions at each particular point was adopted. Thus, with the variety of the systems manufactured by William B. Scaife & Sons Co., every possible condition will be met, each system being designed especially for each particular water, and for the particular location and requirements at each point—these are features which will be readily appreciated by all railroad men.



THE NEW DESIGN OF 24-IN. SURFACE PLANER, WITH GEAR-DRIVEN UPPER AND LOWER FEED ROLLS.—GREAVES, KLUSMAN & CO.

A speed of a mile in 39 seconds is reported in an automobile contest in Ormond, Fla , on a rate of 92.3 miles per hour. This was done by Mr. W. H. Vanderbilt, Jr., with a 90-h.p. Mercedes machine. Mr. Vanderbilt believes that he can make much faster time with the same machine.

A HEAVY NEW DESIGN OF SURFACE PLANING MACHINE.

Greaves, Klusman & Co.

In the accompanying engraving is shown an important new design of 24-in. surface planer that has recently been developed and placed upon the market by Greavea, Klusman & Co., Cincinnati, Ohio. It is designed for very heavy service in planing in hard and soft wood, and for smooth planing, strong and fast feeding, and general excellence of workmanship and design, it is claimed to be unexcelled by any machine of this type.

The illustration well shows the general design of this tool. But some of its important points should be referred to. The frame is cast in one piece, wide at the base, and is very heavy, and of great strength. The table or bed is also cast in one piece, planed true, and is dovetailed into the frame, with extra long bearings, as wide apart as the width of frame will allow; this makes the table as steady as if it and the frame were cast in one piece. Any wear can be taken up by means of gibs and set screws. The table is raised and lowered by means of the large crank shown, an indicator on side of the frame showing the exact thickness the machine is set to plane.

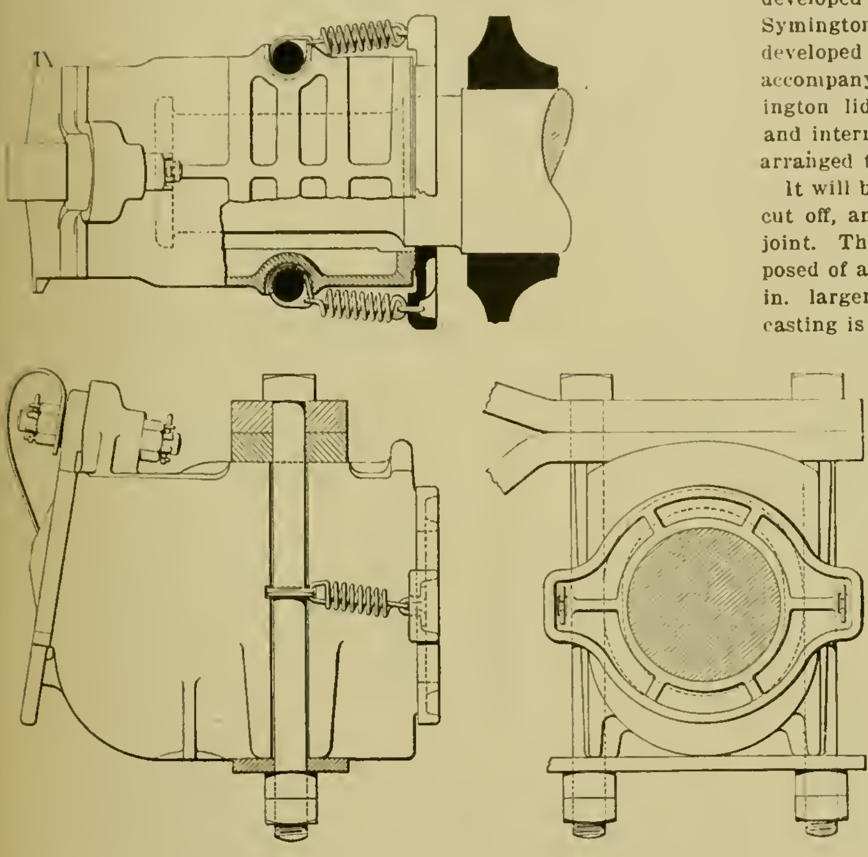
The cylinder is double belted, having a pulley at both ends. It is made of the best forged steel, with 1 13-16-in. journals, which run in self-oiling boxes, 9 ins. long, lined with the best babbitt and provided with improved oil wells and oil cups. The feed consists of 4 large steel rolls, all of which are very powerfully geared. They are driven from the cylinder, there being two changes, fast and slow, controlled by a belt tightener. The lower rolls extend the full width of the bed, having their bearings in planed ways in the frame; these bearings or boxes are milled to fit the frame.

Both pressure bars work very close to the knives, and are adjustable to the timber independently of each other and the feed rolls, thus insuring steadiness, even when planing very short and thin stuff, and the most perfect work with either hard or soft lumber. The pressure bars are self-adjusting, always regulating themselves to the various sizes of thick and thin lumber being planed.

This machine will plane stock from 1/8 in. and less, in thickness, up to 8 ins., and any width up to 24¼ ins. It is to be noted that it can be belted in any direction. It is claimed that this planer will compare favorably, in quantity and quality of output, with any of the larger and more elaborate machines of this class.

THE SYMINGTON JOURNAL BOX WITH OUTSIDE DUST GUARD.

The Symington M. C. B. dust guard was developed to supply the demand for a dust guard which would go into the slot of the Master Car Builders' box. To meet the demand that has developed on some railroads that have not as yet used the Symington M. C. B. dust guard, the Symington Company has developed during the past year the journal box shown in the accompanying engravings. This box has the well-known Symington lid with machined joint and central spring pressure and internal ribs for supporting the packing. The rear end is arranged to take the new dust guard.



THE SYMINGTON JOURNAL BOX WITH OUTSIDE DUST GUARD.

It will be noted that the entire rear end of the journal box is cut off, and the back of the box is machined off to a perfect joint. The dust guard, consisting of only three parts, is composed of a single grey iron casting, faced off and bored out 1-32 in. larger than the dust guard seat of the axle. This casting is held to the box by means of two helical springs fastened at one end to the dust guard, and at the other end to the journal box bolts with a ring which is inserted in small annular grooves in the box behind the arch bar bolts. It is well known that this form of spring has great durability and efficiency for this kind of service. The Symington company uses only one size spring for all sizes of journal boxes, and agree to replace, free of cost, any spring that fails in two or three years' service. It will be noted that there is no possibility for thia dust guard or these springs to become clogged in any way with dirt so as to lose their efficiency. These springs have an upward inclination which relieves the axle entirely of the weight of the dust guard. The dust guard is free to move up or down or to either side, while the projections on the ears of the guard prevent it from turning with the axle. Eighteen months' experience has demonstrated that an enormous mileage can be obtained with a very slight wear on the dust guard, and an imperceptible wear on the axle.

One great advantage claimed for this construction over others of this type is that the dust guard is first put on the axle and then on the box. The side springs are then pulled out and the arch bar bolts dropped through the clevices on the ends of the springs. This dust guard provides from ⅜ to ½ inch more clearance between the hub of the wheel and the face of the box than the Master Car Builders' design, which is very desirable.

The Symington company are so convinced of the merits and durability of this dust guard that they guarantee it for the life of the wheel. It is stated that the saving in the weight of the box proper permits this new design to be sold complete, with dust guard, at the same cost as the regular Symington M. C. B. box, with any patented dust guard. New dust guard castings can always be secured for the cost of any special dust guard. Further information may be obtained from the T. H. Symington Company, No. 706 Paul street, Baltimore, Md.

A recent study of coupler failures on a large railroad, covering 16,000 breakages of couplers, revealed the fact that 32 per cent of the total number were due to broken knuckle pins. While this is due to some extent to poor fitting of the pins in the couplers and kunckles, the facts which were ascertained point to the necessity for using better material for these pins.

BOOKS AND PAMPHLETS.

A Treatise on Friction and Lost Work in Machinery and Mill Work. By Robert H. Thurston, M. A., LL. D., Dr. Eng'g. Past President of American Society of Mechanical Engineers and late Director of Sibley College, Cornell University. 8vo, 430 pages, 77 figures, illustrated. Seventh edition. Published by John Wiley & Sons, 43 East Nineteenth St., New York. Price, $3.

This work of Professor Thurston's is well known for the thoroughness with which it treats this important subject, and its popularity is attested by this seventh revision and enlargement of the work. This seventh edition brings the contents well up to date and adds a considerable amount of new matter, which appears in the form of a summary at the end of the volume. Many new problems in friction and lubrication, which have arisen with the high speeds of electric motors and steam turbines, receive proper attention in this edition, as new and extensive studies of the subject have been completed. Most of the important later researches on the subject of lubrication and friction have been abstracted and are here published. Much new information has also become available in relation to the classes of lubricants, old and new, which have been found suitable to special uses, and the adaptation of its special lubricant to every rubbing part, its load and its velocity of rubbing being considered, has come to be an acknowledged essential art, and great progress has been made in its development; much is added along this line. The work is the most complete treatise on the theory of friction to be found in the English language, and the important work which Professor Thurston has done in this volume is to show that it is the sum of the cost of wasted power and of lubrication, not simply the lubricant, that has to be minimized, and this is the real problem of the engineer in dealing with this branch of his work.

Rotary Planers.—Catalogue No. 37 has recently been issued by the Newton Machine Tool Works, Philadelphia, Pa., descriptive of their extensive lines of Rotary Planing Machinery. Various types of their rotary planers are illustrated and described, including their portable rotary planers, vertical rotary planers, duplex rotary planers and planers mounted on circular bases. Illustrations are also presented of other machine tools of the large line built by this company.

Gorton Disc Grinders.—An interesting catalogue has recently been received from the Diamond Machine Company, Providence, R. I., descriptive of the large line of Gorton universal and plain Disc Grinding Machines, which are now being manufactured by them. The latest refinements in disc grinding are referred to in this book. Universal disc grinders, with single and double-head arrangements, are illustrated in detail; also a large line of motor-driven grinders are shown, adapted to all classes of service. An interesting tool is that shown for use in grinding the ends of tubes, rods, shafting, etc. The vertical floor disc grinders, which are also made by this company are very important for a wide range of grinding service. This is an invaluable catalogue and should be in the hands of all interested in modern machine shop practice.

Electrical Machinery.—A most beautiful catalogue has recently been issued, descriptive of the large line of dynamo-electrical machinery, which is built by the Triumph Electric Company, Cincinnati, Ohio. In addition to illustrating their standard types of multipolar generators, for belt-driven and direct-connected work, and their steel motors for all classes of service, a large number of illustrations are presented, showing important installations which they have made in various industrial plants and elsewhere. This company has made a specialty of direct-connected generators for marine work, as well as for stationary work. In the line of motor-driving for direct application to machinery this company has had a wide and extensive experience. Their enclosed type of motor is especially adapted for use under the trying conditions usually met in machine-tool driving. A large number of illustrations are presented to show actually applications that have been made of Triumph steel motors to planers, drills, boring-mills, lathes, punches, cranes and other types of machinery. Altogether, this is one of the most complete and comprehensive catalogues of its kind that we have seen. It is beautifully and artistically gotten up and is printed on the finest quality of paper. The engravings are exquisite, and the cover is a work of art. This catalogue should be in the hands of all interested in electrical machinery.

The Jeffrey Manufacturing Company.—Circular No. 77 has just been received, descriptive of The Jeffrey Grab Buckets. These grab buckets are most efficient and economical in operation, as indicated in the pamphlet. They will work in ore, run-of-mine coal, broken limestone, gravel and sand; they are also useful in excavating in clay, gravel, and in soft earth of any nature, and when teeth are added to the scoops, this device may be made to answer the purpose of a steam shovel in many kinds of work. Reference is also made in this pamphlet to the large number of catalogues, which are issued by The Jeffrey Manufacturing Company, Columbus, Ohio, descriptive of their many other lines of automatic machinery; any of these catalogues may be had upon request.

The second edition of catalogue No. 115, the general condensed catalogue of the B. F. Sturtevant Company, Boston, Mass., is now ready for distribution. This catalogue describes and illustrates new apparatus manufactured by this enterprising company, among which are a new type of hand-blower; several new types and sizes of forges; new sizes of vertical single and double engines; a new type of enclosed vertical compound engines; new type of semi-enclosed bi-polar and four-pole motors; new sizes of generating sets with vertical compound engines; factory equipments, such as bench-legs, pattern storage shelf brackets, electric hoists, cast iron sinks, trench cover-plates, etc.; industrial railway equipments, such as cars, truck ladles, turn-tables, T-rails, etc. It also contains a description of the various Sturtevant systems, such as heating and ventilating, special ventilating, drying, conveying and mechanical draft systems.

EQUIPMENT AND MANUFACTURING NOTES.

The Jeffrey Manufacturing Company, of Columbus, Ohio, through its connection with the Ohio Malleable Iron Company, located in the same city, are now in the field soliciting orders for high-grade malleable castings. They are now prepared to turn out malleable castings in large quantities and the quality is insured.

The T. H. Symington Company and the Baltimore Railway Specialty Company were burnt out in the recent disastrous conflagration in Baltimore. They ask the indulgence of their railroad friends and their characteristic energy may be counted upon to place them in the near future in position to meet all requirements. The foundries were not involved, and they are prepared to take care of all business. The new office is at 706 Paul street, Baltimore, Md.

Contradicting the suggestion of a slacking of business activities comes the report from the Imperial Pneumatic Tool Department of the Rand Drill Company telling of the large increase of sales since the first of the year. That the worth of their products is universally appreciated is proven by the orders received for piston air drills, wood boring machines and hammers, and the installation of a number of complete pneumatic tool plants in the railroad shops, ship yards, boiler works, foundries and bridge and iron works, both in this and foreign countries.

Mr. P. H. Wilhelm, formerly representing the New York Car Coupler Company, the Washburn Car Coupler Company, the Buckeye Malleable Iron and Coupler Company, the Railroad Supply Company, of Chicago, with headquarters at Atlanta, Ga., has accepted a position as railroad representative of the American Steam Gauge and Valve Manufacturing Company, Boston, Mass., with branch offices at New York, Chicago, Philadelphia and Atlanta, Ga. Mr. Wilhelm has spent the greater portion of his life in actual railroad service and it will be remembered that, in 1893, he was, on the recommendation of the majority of the railroads, appointed superintendent of transportation at the World's Fair in Chicago. After the close of the exposition, he took up the active business of railroad supplies, which he has followed up to the present time. Mr. Wilhelm has been very prominently mentioned for the position of superintendent of transportation at the St. Louis Exposition, but he prefers to remain in the railroad supply business. The American Steam Gauge and Valve Manufacturing Company now have the largest plant in the country devoted to the manufacture of steam and other gauges, safety valves, steam engine indicators, whistles and steam supplies in general, and, being the oldest house in this country in their particular line, Mr. Wilhelm will certainly be able to keep up his reputation of representing one of the best concerns.

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL.

APRIL, 1904.

CONTENTS

RAILWAY SHOPS.

BY R. H. SOULE.

XII

THE ROUNDHOUSE.

At the annual convention of the Master Mechanics' Association in 1900 it was decided to appoint a special committee to report on the question, "What should be the arrangement and accessories of an up-to-date roundhouse;" the committee reported in 1901, was continued and enlarged, and reported finally in 1902, since which time the conclusions then reached have been reflected in many cases of modern practice. The systematic and thorough inquiry into and discussion of this important subject was the logical result of events; the gradual increase in the size and weight of engines, and the increased mileage required of them (both on account of press of business and more critical operating supervision) had emphasized the fact that promptness, thoroughness, and efficiency at roundhouses was the keynote of the situation, if improved results were to be expected. The result of this agitation was salutary, as it is evident that the present temper of operating officers is to provide roundhouse facilities which are fully up-to-date.

The roundhouse plan is always mapped out with reference to its possible ultimate completion to a full circle, even though but a few stalls are built at the outset; it is therefore necessary to assume the number of stall segments corresponding to the full circle, and, further, it is desirable to simplify the engineering work of laying out the structure on the ground by adopting such a total number of stalls (in the full circle), that the central angle subtended by each may be expressed in degrees and integral minutes (without the use of seconds of arc). Assuming a minimum of 30 stalls and a maximum of 60 stalls as limits within which practice is likely to be confined, it is found, by resolving 21,600 (minutes of arc corresponding to 360 degrees) into its prime factors, and making combinations of the same, that the total number of stalls in the full circle must be either 30, 32, 36, 40, 45, 48, 50, 54, or 60.

Again, it is necessary to assume the center to center distance between door posts on the inner circle; this will usually be from 13 ft. to 14 ft.; there are so very few cases, in practice, outside of these limits that it is unnecessary to consider them; the 13 ft. spread is practicable with structural steel posts, and the 14 ft. spread may be necessary with timber posts; in any case it is well to make the working clearances through these track pit doors as liberal as possible, as doors warp, tracks settle, and engines lean, and combinations of these factors may wreck doors or cabs; on the other hand, the greater this door post spread, the greater the diameter (both inside and outside) of the roundhouse, and therefore it must be judiciously chosen.

The Master Mechanics' report of 1902 advised that the span should be 80 ft. and several roundhouses of that span were subsequently built in various parts of the country; the Lambert's Point house of the Norfolk and Western, although built in 1891, had a span of 84 ft., and there has been a marked tendency to increase the span over the 80 ft. standard recommended in 1902; for instance the houses at Mason City, Ia. (C. & N. W.) and Chicago, Ill. (C. & N. W.), are of 84 ft. span, while those at Fairmont, Va. (B. & O.), Glenwood, Pa. (B. & O.), and Holloway, O. (B. & O.), are of 91 ft. span, or approximately 90 ft. from center to center of roof truss bearings, which appears to be the maximum so far attained.

The cross section adopted will be influenced largely by the conception of economy which prevails in the minds of the officers having the deciding voice; if first cost is the prime consideration, a flat (or nearly flat) roof supported by posts, and with minimum head room, will probably be used; if operating efficiency, and economy in handling and maintaining engines are the principal objects in view, posts will be eliminated and head room increased.

Fig. 7 gives six cross sections from actual practice; it will be noticed that Moline has three posts, Collinwood and Rensselear two, and Lambert's Point one, while Fairmont and McKees' Rocks have none; in all these designs the engines head out which may be accepted as standard practice; this gives maximum space at the machinery end of the engine where most of the repair and maintenance work is to be done; good light being very necessary, and good height contributing to good ventilation, it is logical to aim at construction which makes the outer circle wall higher than the inner circle wall, and which brings the peak of the roof over the general region of the smoke stack and the steam dome; this is accomplished at Lambert's Point, Fairmont, and McKees' Rocks. Compromise sections are found at Glenwood, Pa., and Holloway, O. (B. & O. points), where a section similar to Moline is used with the left hand post omitted, a deep truss being introduced between the outer wall and middle post, thus eliminating that particular post which would be most in the way of the repair men. In some Russian and French roundhouses the house and turntables are covered by a roof supported on arched trusses but this of course implies a full circle, and there are few such houses in this country. The Central Railway Club recommended, through a committee report in 1900, that roundhouse roof trusses should always be made of timber, as metallic trusses cause moisture to condense and drip, but this recommendation is seldom followed.

Overhead electric traveling cranes are being introduced in roundhouses; at Wilmington, Del. (P. R. R.) a new house has been put up with provisions for a crane runway to carry a crane covering the outer portion of the span (the crane has not yet been installed, however); in this case smoke jacks can not be used, and some form of roof ventilator must be depended on to carry off the smoke; it is understood that at another Pennsylvania roundhouse there will be a traveling crane over the inner segment, which arrangement will permit of the use of smoke jacks as usual. The Baldwin Locomotive works have a new roundhouse at 27th st., Philadelphia, with a traveling crane in actual use.

The length of the engine pits varies, but it will be noticed from Fig. 7 that 60 ft. is common practice. Ventilation can best be considered in connection with the cross section, and different arrangements will be seen in Fig. 7. Lambert's Point is without smoke jacks, but has a continuous slatted peak ventilator which has been found to be very effective, and is well adapted to the mild climate of Virginia; Fairmont and McKees' Rocks have both smoke jacks and peak ventilators on the same axis; Collinwood has smoke jacks with auxiliary ventilations through collars around them, and other places have various combinations of smoke jacks and special ventilators of various types.

and in their final report of 1902 made no mention of it whatever.

Tables 19 and 20 give the essential engineering data for laying out roundhouses of from 30 to 60 stalls (in the full circle) having inner door posts, either 13 ft. or 14 ft. centers, and having a span of either 80 ft., 85 ft., or 90 ft.; the diameters of the outer circles and the lengths of the outer chords for spans intermediate between 80 ft. and 85 ft., or between 85 ft. and 90 ft. may be interpolated in either table. The extreme case would be a 60 stall house of 90 ft. span with door posts 14 ft. center to center, in which case the diameters would be, inner circle 267.5 ft., and outer circle 447.5 ft. It will be noticed that all the values in the tables progressively increase, excepting only the lengths of the outer chord, which decrease, and cause a corresponding reduction of working space at and near the front ends of the engines; this fact should be borne in mind in selecting a standard roundhouse, and may account for the fact that full circles of 45, 48, and 50 are popular, although other considerations (such as the amount of land available) of course, have a large influence.

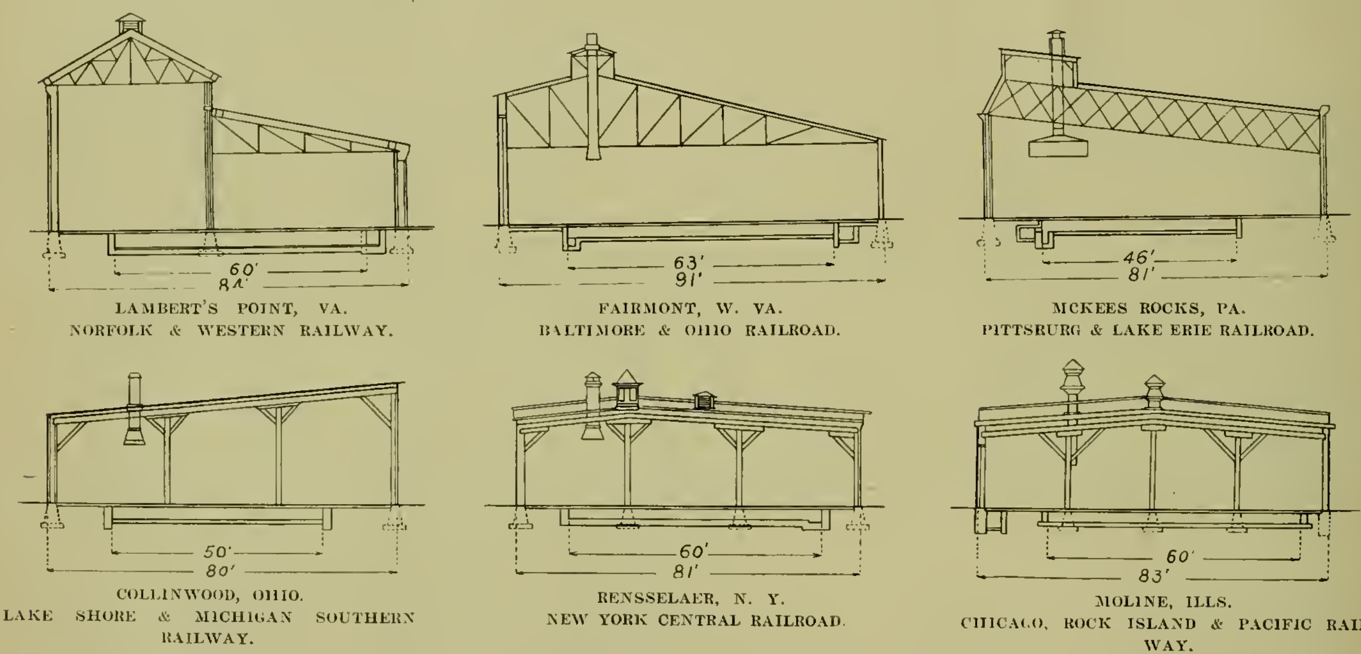


FIG. 7.—SECTIONS OF SIX REPRESENTATIVE ROUNDHOUSES.

Smoke jacks are made in various forms; either metal or wood, and, if metal, either of sheet iron or cast iron, either fixed or telescopic, and, latterly sometimes swinging, so that when dropped over the stack of the engine they may be withdrawn without damage to the smoke jack; wooden smoke jacks are usually given at least three coats of fire proof paint, and are put together with copper nails and brass screws; at Glenwood, Pa. (B. & O.), and McKees' Rocks, Pa. (P. & L. E.) the cone bottom is replaced by a pyramidal part which, while only a little wider than the head of the stack, is elongated in the direction of the track (at McKees' Rocks to about 14 ft.) so that the engine does not have to be placed with its stack on the axial line of the smoke jack, but may stand several feet either way from a central position. In some cases smoke jacks are provided with dampers, to prevent down drafts of cold air, when the stall below is not occupied, but they are something extra to handle and of doubtful value. At the new roundhouse of the Baldwin Locomotive Works, where regular smoke jacks can not be used on account of overhead cranes, a special curved siphon pipe is dropped into position by the crane when it is desired to fire up an engine; the upper end of the pipe covers the top of the smoke jack and the lower end connects with an underground flue which leads off to a brick stack. The difficulty of the smoke jack problem is illustrated by the fact that the Master Mechanics' Committee in their preliminary report of 1901 said that on this detail they were "unable to agree,"

In many roundhouses fire walls are introduced dividing the house up into segments, and in one case at least (Sault Ste Marie, Canada) the entire structure is fire proof, the walls being of stone, the posts and beams of steel, and the roof of concrete on expanded metal. A most essential point from an operating standpoint is that tracks on opposite sides of the turntable shall be absolutely in line with the turntable track when the turntable is in either of its two reversed positions. The actual number of stalls to be erected at a given roundhouse point is dependent on many operating conditions, and need not be considered here. At West Albany, N. Y. (N. Y. C.) there are two half roundhouses instead of a single full circle house; although this arrangement may have been necessitated by land limitations, yet it possesses several advantages from an operating standpoint; the breakdown of a turntable can block in only half the engines, the engines in both houses are very accessible to and at minimum distance from the machine shop annex, which is in an intermediate T shape building, and finally additional tracks for standing engines on can be provided, radiating from the two turntables, so that the combination has the housing capacity of one full house, but the standing capacity of two full houses.

Turntable diameters range from 70 ft. up, only one recorded installation since 1902 having the smaller diameter of 65 ft.; on the other hand, at Moline, Ill. (C. R. I. & P.), the diameter is 75 ft. and at Fairmont, Va., Glenwood, Pa., and

Holloway, O. (B. & O. points), it is 80 ft. The larger tables are revolved more easily on account of the longer leverage, give more latitude in balancing engines of different types and with different loads of water and coal in their tenders, and enable hostlers to move engines more freely and make better time in handling them. As frogs at the turntable pit edge are to be avoided where conditions permit, a column has been introduced in tables 19 and 20 to indicate the minimum possible diameters which can be used; the values are based on the use of 80-lb. rails (Am. Soc., C. E. section), with a minimum distance of ¾ in. from base to base at edge of pit; it will be seen that frogs may be avoided by using a 70-ft. turntable with 40 or less stalls in the full circle, or an 80-ft. turntable with 45 or less. Sometimes the number of stalls (in the full circle) and the turntable diameter are so chosen as to permit of "nose" frogs, or frog points, which are not as objectionable as tail frogs; such is the case at Moline, Ill. (C. R. I. & P.), where a 48 stall (in the full circle) house has a 75-ft. turntable.

Drop pits are absolutly essential in every large roundhouse, and are very convenient and useful even in a small one; in the latter case the minimum requirement is a drop pit for engine truck wheels, but a still better arrangement is a combination pit which will permit of dropping and withdrawing a pair of truck wheels, and will also permit of dropping, without withdrawing, a pair of driving wheels, so that a journal or a driving box may be examined; in larger houses separate drop pits for truck wheels and driving wheels are justified. The St. Louis & San Francisco have a form of continuous ring pit in some of their roundhouses so that a pair of truck wheels may be removed from any engine standing in the house; in many places there are examples of drop-pit installations on a liberal scale, as, for instance, at Fairmont, Va. (B. & O.), where, in a 24 stall house there are drop pits for drivers under five tracks, and for truck wheels under two. Drop pits are usually rectilinear, in which case the pit can be at right angles to not more than one track, but at Elizabethport, N. J. (C. R. R. of N. J.), and Dubois, Pa. (B. R. & P.), they are built to an arc of a circle, and therefore cross all tracks at right angles. Drop pits have hitherto been usually equipped with hydraulic hand-power lifts, but it is understood that the new Blair Furnace, Pa., house of the P. R. R. is to have drop pits of novel construction and fitted with electric lifts.

TABLES 19 AND 20.—DATA FOR ROUNDHOUSES.

Number of Stalls in Full Circle.	Central Angle per Stall.	Diameters (in Feet.) Turntable, Min., Without Frogs.	Inner Circle.	Outer Circle. 80-Ft. Span.	Outer Circle. 85-Ft. Span.	Outer Circle. 90-Ft. Span.	Outer Chord (in Feet). 80-Ft. Span.	85-Ft. Span.	90-Ft. Span.
		Table 19—With Door-Posts 13-Ft. Centers.							
30	12—0	51.81	124.40	284.40	294.40	304.40	29.73	30.77	31.82
32	11—15	55.26	132.70	292.70	302.70	312.70	28.69	29.67	30.65
36	10—0	62.14	149.20	309.20	319.20	329.20	26.95	27.82	28.69
40	9—0	69.03	165.70	325.70	335.70	345.70	25.56	26.34	27.12
45	8—0	77.65	186.40	346.40	356.40	366.40	24.17	24.86	25.56
48	7—30	82.82	198.80	358.80	368.80	378.80	23.47	24.12	24.78
50	7—12	86.26	207.10	367.10	377.10	387.10	23.05	23.68	24.31
54	6—40	93.16	223.60	383.60	393.60	403.60	22.30	22.89	23.47
60	6—0	103.50	248.40	408.40	418.40	428.40	21.37	21.91	22.42
		Table 20—With Door-Posts 14-Ft. Centers.							
30	12—0	51.81	134.00	294.00	304.00	314.00	30.73	31.78	32.82
32	11—15	55.26	142.80	302.80	312.80	322.80	29.68	30.66	31.64
36	10—0	62.14	160.60	320.60	330.60	340.60	27.94	28.81	29.68
40	9—0	69.03	178.40	338.40	348.40	358.40	26.55	27.34	28.12
45	8—0	77.65	200.70	360.70	370.70	380.70	25.16	25.86	26.56
48	7—30	82.82	214.10	374.10	384.10	394.10	24.47	25.12	25.78
50	7—12	86.26	223.00	383.00	393.00	403.00	24.05	24.68	25.30
54	6—40	93.16	240.80	400.80	410.80	420.80	23.30	23.89	24.47
60	6—0	103.50	267.50	427.50	437.50	447.50	22.37	22.90	23.42

The roundhouse floor should be hard and firm and non-absorbent; a wooden floor is comfortable to work on, but if properly maintained is very expensive in the long run; for a thoroughly satisfactory floor a concrete base seems to be necessary, but the wearing surface may be either cement or vitrified brick, and if the latter either simply bedded in sand or flushed with tar. Between end of pit and entrance doors a flangeway through the concrete can be nicely formed by putting a rail on its side with its head against the web of the track rail.

Day lighting has been touched upon when considering the best form of cross section; night lighting is best accomplished by incandescent electric lights inside the house, and arc lights outside; a good arrangement of the inside lights is a ring of lights in the outer gangway always burning, and rows of lights down each bay to be turned on or off as needed; there should be plenty of sockets for portable lights either on posts or in pits or both. Heating by hot air from a fan is most satisfactory, especially if the dampers are so arranged that a large volume of hot air can be delivered under an engine in one pit and quickly thaw it out.

In an up-to-date roundhouse complete piping systems are provided for steam, air, cold water, hot water (for washing), and blow off; the Master Mechanics' committee recommended that the steam and air lines should be overhead, and all others in an annular pit. Duplex pumps yielding not less than 100-lb. hose-nozzle pressure should be installed for washout purposes.

Every large roundhouse should have, and most recent ones do have, an annex in which are usually housed a machine shop, smith shop, engineer's room, store house, oil house and power plant; the annex at Clinton, Ia. (C. & N. W.), for instance, is 60 ft. by 140 ft., and at Glenwood, Pa. (B. & O.), is 70 ft. by 131 ft. The oil house is, of course, often isolated. The outfit of tools generally considered essential for an active roundhouse should include one small lathe (12 to 16 ins.), one large lathe (24 to 30 ins.), one good strong drill press (30 to 36 ins.), one bolt cutter, one shaper (stroke 24 ins. and up), possibly a planer (30 by 30 ins. at smallest), and a blacksmith forge; this list may be enlarged at very active points.

The track approaches to a roundhouse are often a point of congestion, and their arrangement has been given much study in recent years; the essentials are separate tracks for incoming and outgoing engines, convenient facilities for supplying coal, sand, and water, and for removing ashes; the coal, sand and ash facilities should be on the incoming tracks, and the water facilities accessible from both incoming and outgoing tracks. The Pennsylvania is introducing inspection pits on roundhouse approach tracks, the idea being that if repairs are found necessary, material can be assembled, arrangements made in advance (while engine is still on the ash pit) and time saved.

At the Union Station, St. Louis, owing to space restrictions, 62 stalls are provided in three rectangular houses which are served by five transfer tables working in three pits; in such an arrangement there are no waste corners, but on the other hand the plant must be supplemented by a turntable or a Y on which to turn engines.

(To be continued.)

The Railroad Y. M. C. A.—The outlook for 1904 includes prospective buildings at two points in Ontario, one in Alabama, two in Arkansas, two in Indian Territory, one in Kansas, one in Maine, two in Massachusetts, two in Michigan, one in Missouri, one in New York, two in Utah, one in West Virginia. These buildings are to be erected with the co-operation of the railroad men and twenty railroad systems. In most cases the railroad appropriations have been made conditional upon a portion of the cost being secured in subscriptions from the men and their friends. At several of these points the buildings are now being erected. The growth of the Young Men's Christian Association is due, not only to the fact, that it has the hearty support and co-operation of the railroad corporations and their employees, but also very largely to the fact that the associations have always had the influence and practical co-operation of far-sighted, broad-minded and liberal Christian men. The work as organized and conducted, adapts itself to railroad men of every branch of service, and permits all of whatever belief to enjoy the benefits of membership.

An international engineering congress will be organized by the American Society of Civil Engineers in connection with the World's Fair at St. Louis. Information as to the membership and papers to be presented may be obtained from Mr. C. W. Hunt, secretary of the American Society of Civil Engineers, New York City.

AN IMPORTANT NEW TERMINAL-YARD LIGHTING AND POWER PLANT.

WEEHAWKEN, N. J.

WEST SHORE RAILROAD.

III.

(*Continued from page 92.*)

BOILER FEED AND BLOW-OFF PIPING.

The care taken in the design at the Weehawken power plant, of these two very important features of the boiler equipment, the boiler feed and blow-off piping, makes them very interesting and worthy of note. The troublesome leakage at blow-off valves is carefully provided against and the possibility of shut down of any boiler due to lack of feed water supply will be eliminated by a duplicate system of feed piping. The arrangements of both the feed and the blow-off systems of piping are clearly shown in the two basement plans which are presented in this article.

The boiler feed piping system is carried entirely in the basement just below the boiler room floor, extending above at points to connect with boiler feed pumps, economizers, feed water heater and boilers. The duplicate sources of water supply for the boiler feed pumps are shown at the southwest corner of the boiler room basement, where connections are made with the high and low pressure water mains of the city of Weehawken, N. J.; the duplicate suction connections, each of which is of 6 inch pipe, lead through Worthington water meters to the feed pumps. The pumps deliver through the feed water heater, in the boiler room, to the economizers, and from thence on to the duplicate 4 inch feed mains in the basement, from which the feed connections are made to the boilers. The feed connections to the boilers, which are made at the base of each of the three steam drums of each boiler, are clearly shown, together with other important connections in the boiler feed system, in the inset supplement illustrating this power plant, which appeared in the preceding issue.

The connections provided in the feed system are very flexibly arranged. Either the feed water heaters, or the economizer, may be by-passed, or both may be by-passed at once; in this way either one, or both of the feed pumps, may deliver either cold or heated water to the boilers through either leg of the duplicate system of feed piping. The necessary valves are conveniently arranged so as to make these changes possible with the least amount of trouble. The entire feed system is piped with the "special full weight" grade of galvanized mild steel pipe and is tested with the "high pressure" test of 400 lbs. hydrostatic for 48 hours. Excessive pressure in the feed system, due to a delivery pipe from the pump becoming clogged, is prevented by a relief valve located in the delivery of each pump.

Two boiler feed pumps are provided in duplicate, each of which is capable of feeding the entire equipment of boilers. The pumps are Worthington outside-packed-plunger pressure pumps with "pot" valves fitted to handle cold water; each has steam cylinders 12 ins. in diameter and water cylinders 7½ ins. in diameter, with a common stroke of 10 ins. The capacity of each pump is 22,000 gallons of water per hour delivered against a pressure of 300 lbs., with a piston speed of not over 100 ft. per min. They are located conveniently for access in the open space on the boiler room floor adjacent to the base of the stack. The feed water neater is located directly above the feed pumps upon a special steel platform, as shown in the boiler room view in the inset. It is a vertical Wainwright, closed tube type heater, having 300 sq. ft. of heating surface; the guarantee accompanying this heater is that it is capable of raising the temperature of 70,000 lbs. of feed water per hour from 40 deg. F., to 100 deg. F., with 7,000 lbs. of exhaust steam at atmospheric pressure.

The blow-off piping system includes not only the three blow-off connections from each boiler, but also one from each economizer and one from the feed water heater. All these deliver to a 4 inch blow-off main in the basement which leads to a special blow-off tank, of interesting design, which is for the purpose of allowing the vapor to collect and escape into the atmosphere. From this tank a 6 inch overflow line leads to the sewer. The blow-off connections from each boiler consist of three 2½ inch asbestos-packed blow-off cocks at the mud drum, each of which is connected to the blow-off main through a 2½ inch Cadman angle blow-off valve. Thus each of the three separate connections are provided with two special valves, in series and located as close to each other as possible—the most approved practice for preventing destructive and annoying leakages. The entire piping for the blow-off system is flange connected, and tested for high pressure service. An important feature of this piping system is that tees and crosses are used in place of elbow fittings at all points possible, blank flanges being applied on the vacant sides to permit ready access for cleaning out pipes.

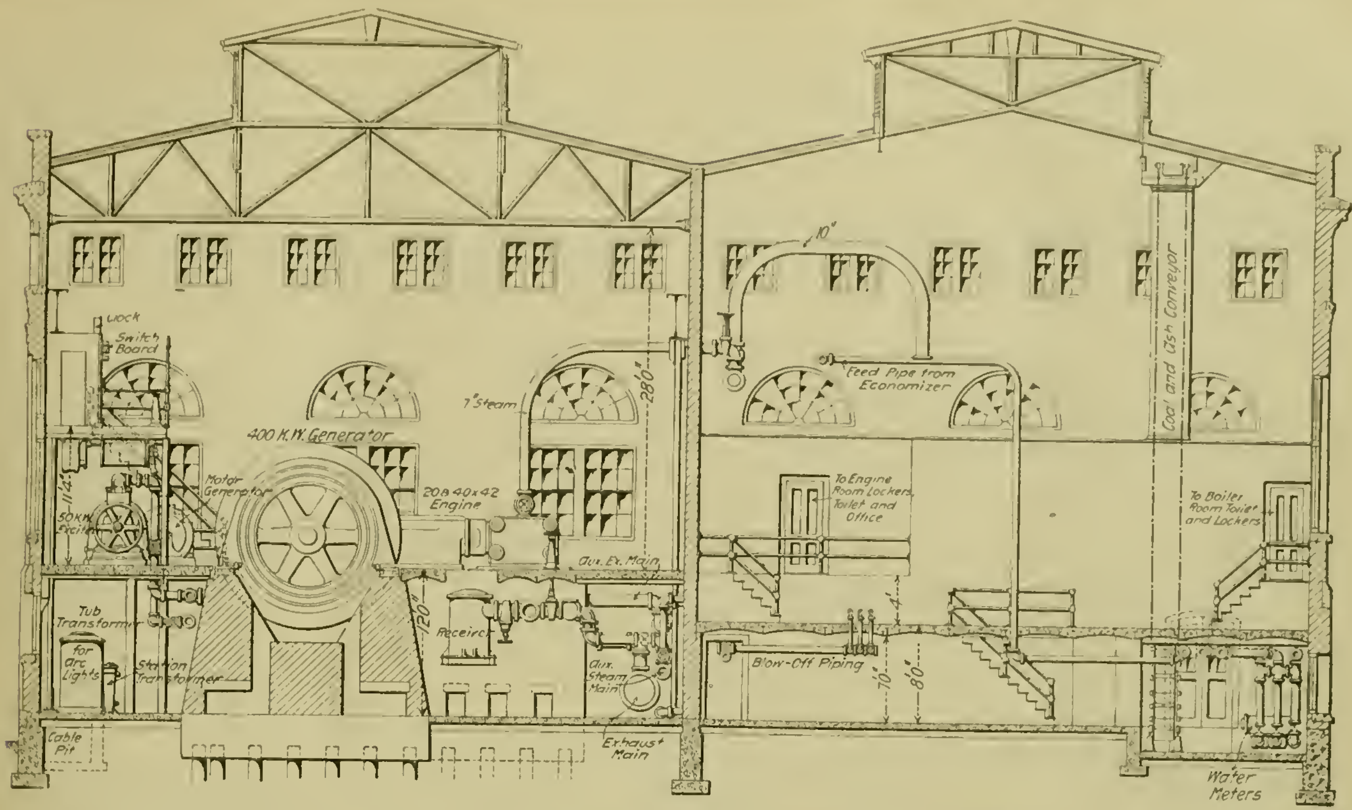
The blow-off tank, which is located in the basement immediately beneath the feed pumps, is a horizontal cylindrical tank, 4 ft. in diameter and 11 ft. long, with convex heads in one piece, the test pressure designed for being 200 lbs. per sq. in. Two inlets on the top receive the blow-off connections from the boilers, etc., while a third connection, of 6-in. pipe, leads from the top of the tank out through the roof to discharge the vapors of the hot blow-off to the atmosphere. The overflow connection, of 6-in. pipe leading to the sewer, is taken from the side of the tank so that the tank always remains about half full.

STEAM PIPING.

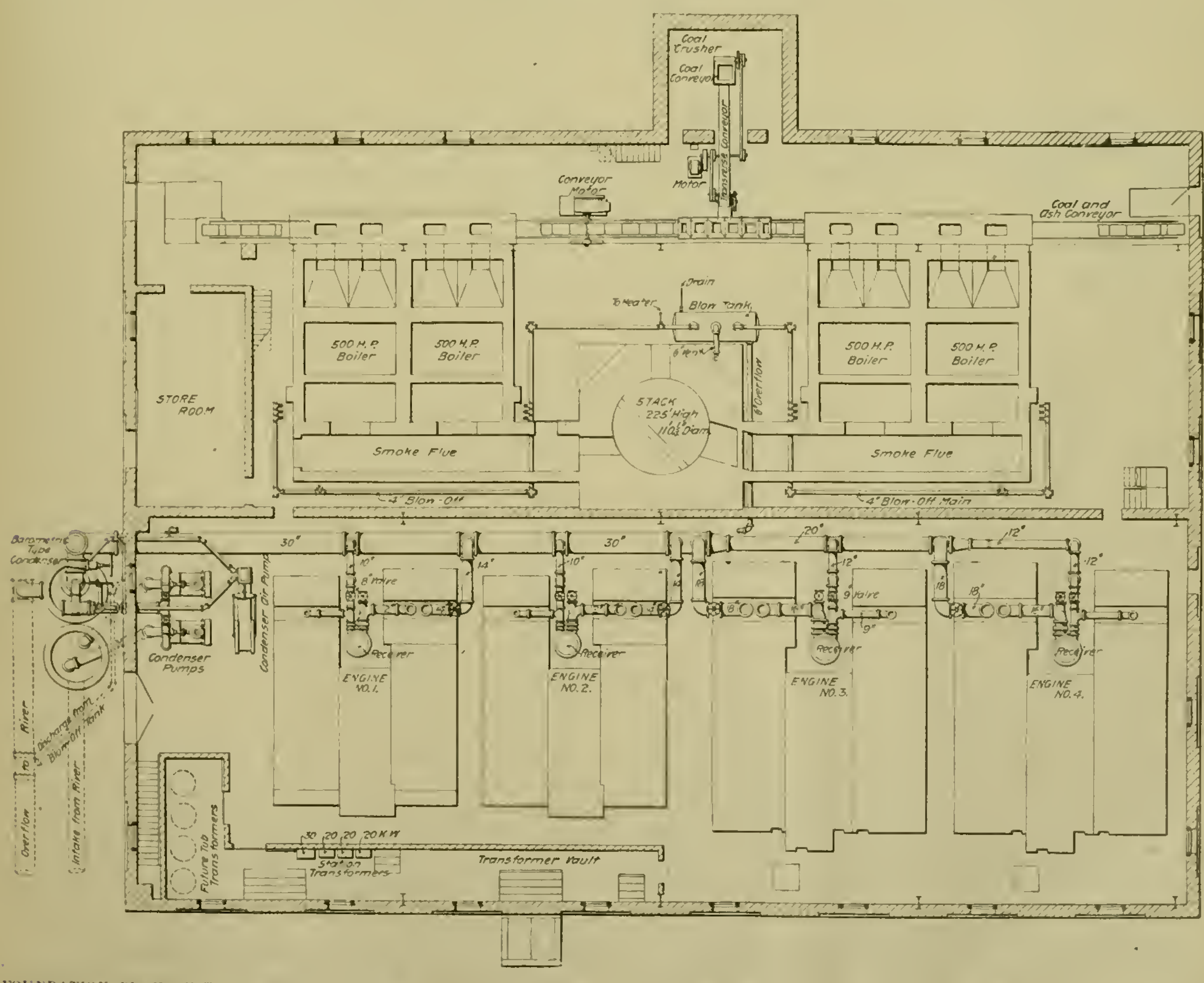
The arrangement of the main steam piping system is well shown in the plan and elevation views of the power house which were presented in the inset supplement to the preceeding issue. The system begins at the 10-in. automatic non-return, emergency and hand-stop valves on the manifold connections from the three superheaters of each boiler, and from these 10-in. pipes lead through easy bends to the 12-in. longitudinal steam header, on the boiler room side of the division wall, from which the delivery connections are made to the engines and to the auxiliary steam piping system. The entire system is laid out with great care to provide for expansion, by bends and angles. The pipe used is the "special full weight" grade of lap-welded, mild-steel pipe, and the entire system was tested throughout with the high pressure test of 400 lbs. hydrostatic for 48 hours continuously.

The interesting feature of this steam piping is the arrangement of the main header and the provision for expansion. As shown in the plan and cross section views in the inset, the steam header is carried on a pipe gallery at the rear of the economizer setting, at a height of 19 ft. 6 ins. above the boiler room floor; where the gallery is interrupted by the base of the stack, the header is carried around it by a loop with double-elbow vertical off-set connections at each end, which make excellent provision for expansion—this is best shown in section D-D in the inset. The header is arranged in sections, not on the loop system, but so as to permit individual connections between adjacent boilers and engines; the entire header is broken up by stop valves into four sections, each of which sections connects with one boiler and one engine. This is a very flexible and convenient arrangement of the piping system, as in this way the equipment may be sectionalized into four practically separate and individual power plants.

The gallery supports for the header are carried partly by the division wall and partly by rods from the roof trusses. The header rests upon two 6-in 12¼-lb. I-beams running along the outer edge, being fastened rigidly at the middle point of each portion of the gallery and allowed to expand in either direction. The provision for expansion at the intermediate points of sup port are shown in the detail of the roller bearing saddle, each of which permits of about 6 ins. of free and easy movement. The pipe saddle is arranged to move upon three pipe rollers, and these in turn roll upon a smooth plate clamped to the I-beam base; the three pipe rolls are held together by a novel side-



CROSS SECTION D-D THROUGH ENGINE ROOM, SHOWING ARRANGEMENT OF EXCITER UNITS, SWITCHBOARD GALLERY AND TRANSFORMER VAULT IN BASEMENT.—CROSS SECTION C-C THROUGH BOILER ROOM, SHOWING BLOW-OFF AND FEED PIPING.

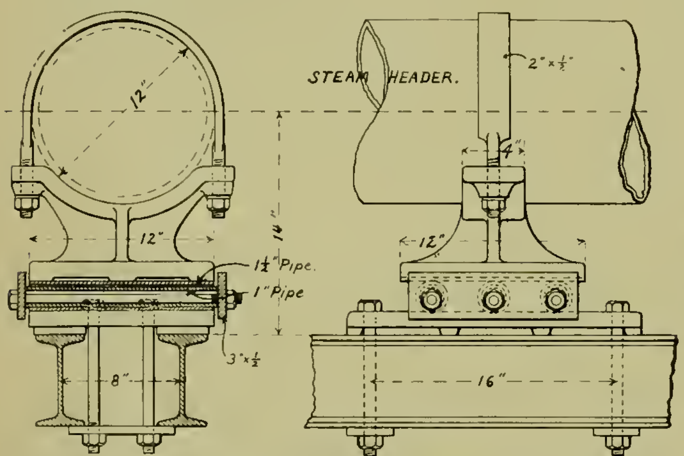


FOUNDATION PLAN OF THE BASEMENT, SHOWING EXHAUST PIPING AND CONDENSING SYSTEM, AND ALSO BLOW-OFF TANK AND PIPING.

plate distance piece arrangement, as shown, which keeps them in place relative to each other.

Each boiler connection has a 10-in. stop valve, not only at the boiler outlet, but also close to the header. The engine connections are each also provided with two valves, one the engine throttle and the other the angle valve just above the header. This is an important provision to protect idle boilers or engines in case of leaky valves. The outer ends of the header are closed with blank flanges. As will be noted, all connections are made to the header at the top side, there being no openings from the lower side except the drain connections. The connecting pipes are all arranged with long radius bends to provide for expansion; the sharpest bends are those of 4-ft. radius, which lead from each section of the header to the auxiliary steam header in the basement near the exhaust header.

Drainage is carefully provided for in the entire system of steam piping, as well as at the engines. Each section of the header has a "drop leg" of 12-in. pipe, with gauge glass, for condensation to collect in, which is connected to a steam trap for automatic drainage. The other steam pipes, including the auxiliary header, have at all points where water may collect drop legs, formed by tees opening downward and a section of the full size pipe extending down from it. In all cases the drop leg pockets extend down a distance of 24 ins. or more, in order to form a pocket of sufficient capacity to hold a considerable accumulation of condensation. Condensation is minimized throughout the entire plant, however, by non-conducting cover-



DETAILS OF THE ROLLER BEARING SADDLES USED TO PROVIDE FOR EXPANSION, IN SUPPORTING THE MAIN STEAM HEADER.

ings on all steam pipes, which are, in addition, re-covered with heavy canvas and painted.

An auxiliary system of steam piping is interestingly arranged to supply steam to the pumps, stoker engines, exciter engines in the engine room, and condenser pumps in the basement. This auxiliary header, which is of 6 and 8-in. pipe in sections, extends through the engine room basement at the rear of the large exhaust header, as shown in the accompanying cross-section D-D, and the basement plan. It consists of two long sections of 8-in. pipe, each fed from the main steam header by the above mentioned 4-ft. radius bends, and the two joined together at the middle by a long-radius bend of 6-in. pipe to provide for expansion.

The basement plan shows the details and arrangement of connections of this auxiliary header. There is a 4-in. branch leading from it to supply the pumps in the boiler room, and a 6-in. "ring" connection, or loop, extends across the engine room basement to supply the exciter engines and condenser pumps. There are also auxiliary connections to the low-pressure cylinder of each of the large engines, so that in case of starting or emergency, they can be operated from that cylinder. The auxiliary header is also divided into two sections by a stop valve, to provide against complete shut down in case of accident.

THE ENGINES.

The engine equipment consists of two 1,200-h.p. and two 650-h.p. compound condensing Corliss engines, direct-connected to 3-phase alternating current generators of 750 and 400 kws. capacity, respectively. The engines are of the heavy duty cross-compound type, with receiver, and have the generators located between the cranks; they were built by the Westinghouse Machine Company, to the new and improved horizontal Corliss design recently perfected and introduced upon the market by them. They are designed to operate at a throttle steam pressure of 140 lbs., with 500 degs. F., total heat, and at an exhaust vacuum of 25 ins.

The engines are designed with particular care, in reference to the parallel operation of the generators; they all have similar characteristics of speed regulation, so that the power delivered is proportional to the load, and there is no tendency to periodic transfer, or surging, of the load from one engine to another. They are further guaranteed to not vary in speed in one revolution so much as to allow the generator, when delivering from no load to full load, to advance ahead or fall behind, a machine running at absolutely constant speed of the same number of revolutions per minute by more than .15 of 1 deg. The speed of any of the engines can be changed from the switchboard by an electric speed-changing attachment to the governor; this permits slight changes of speed while the engines are running, and thus facilitates the synchronizing of alternators or the changing of the load carried by any engine.

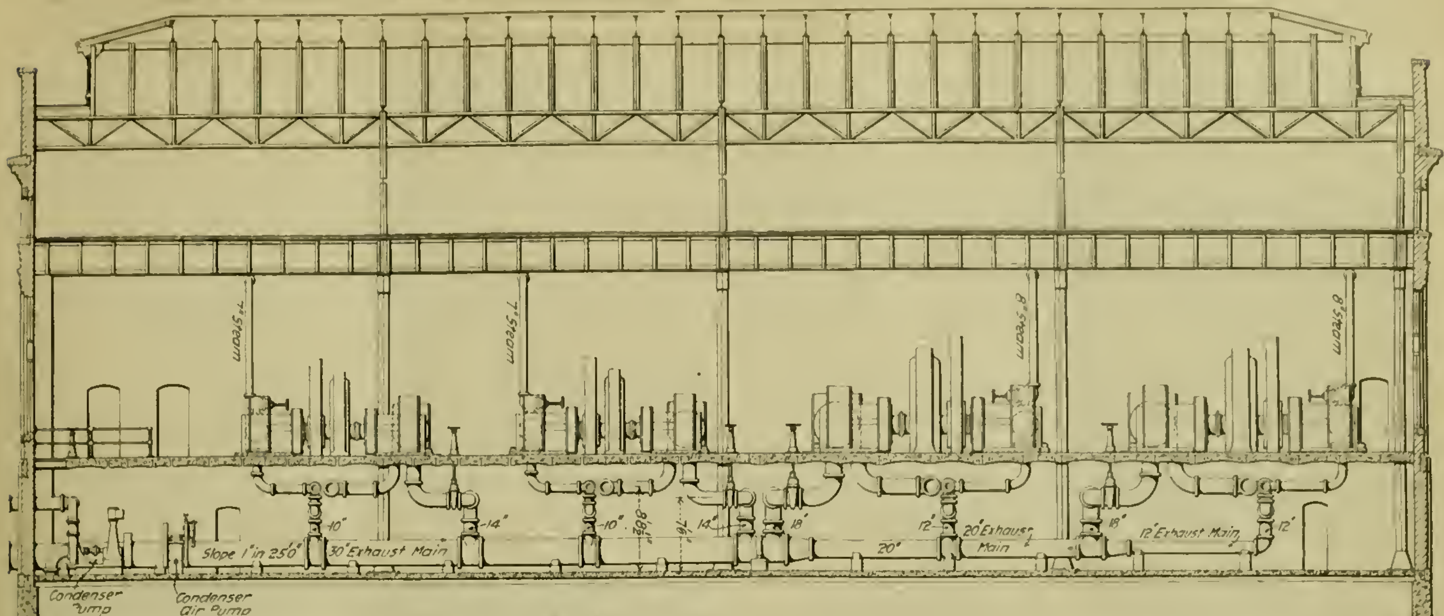
The important dimensions of the 1,200-h.p. engines are presented in the following table:

Diameter of high pressure cylinder	24 ins.
Diameter of low pressure cylinder	48 ins.
Length of stroke	48 ins.
Speed, normal full load	94 rev. per min.
Horsepower, indicated, normal	1,200 h.p.
Cut off, high pressure cylinder, normal	26 per cent.
Cut off, low pressure cylinder, normal	37 per cent.
Cut off, high pressure cylinder, maximum	75 per cent.
Diameter of crank shaft, center	21 ins.
Diameter of crank shaft, bearings	18 ins.
Diameters of piston rods, each	5 ins.
Face of crosshead gibs	22 ins. long by 11 ins. wide
Crosshead pins, length	9 ins.; diameter 8 ins.
Crank pins, length	9 ins.; diameter 9 ins.
Main bearings, length	36 ins.; diameter 18 ins.
Length of connecting rods, c. to c.	132 ins.
Diameter of connecting rods, at center	6 ins.
Diameter of flywheel	216 ins.
Width of face of flywheel	17 ins.
Weight of flywheel	60,000 lbs.
Thickness of piston, H. P. Cyl.	12 ins.
Thickness of piston, L. P. Cyl.	24 ins.
Diameter of main throttle valve	8 ins.
Diameter of main exhaust valve	18 ins.
Length of engine, over all	33 ft. 6 ins.
Width of engine, over all	27 ft.
Height of engine, over all	12 ft.
Total weight of engine, complete	280,000 lbs.

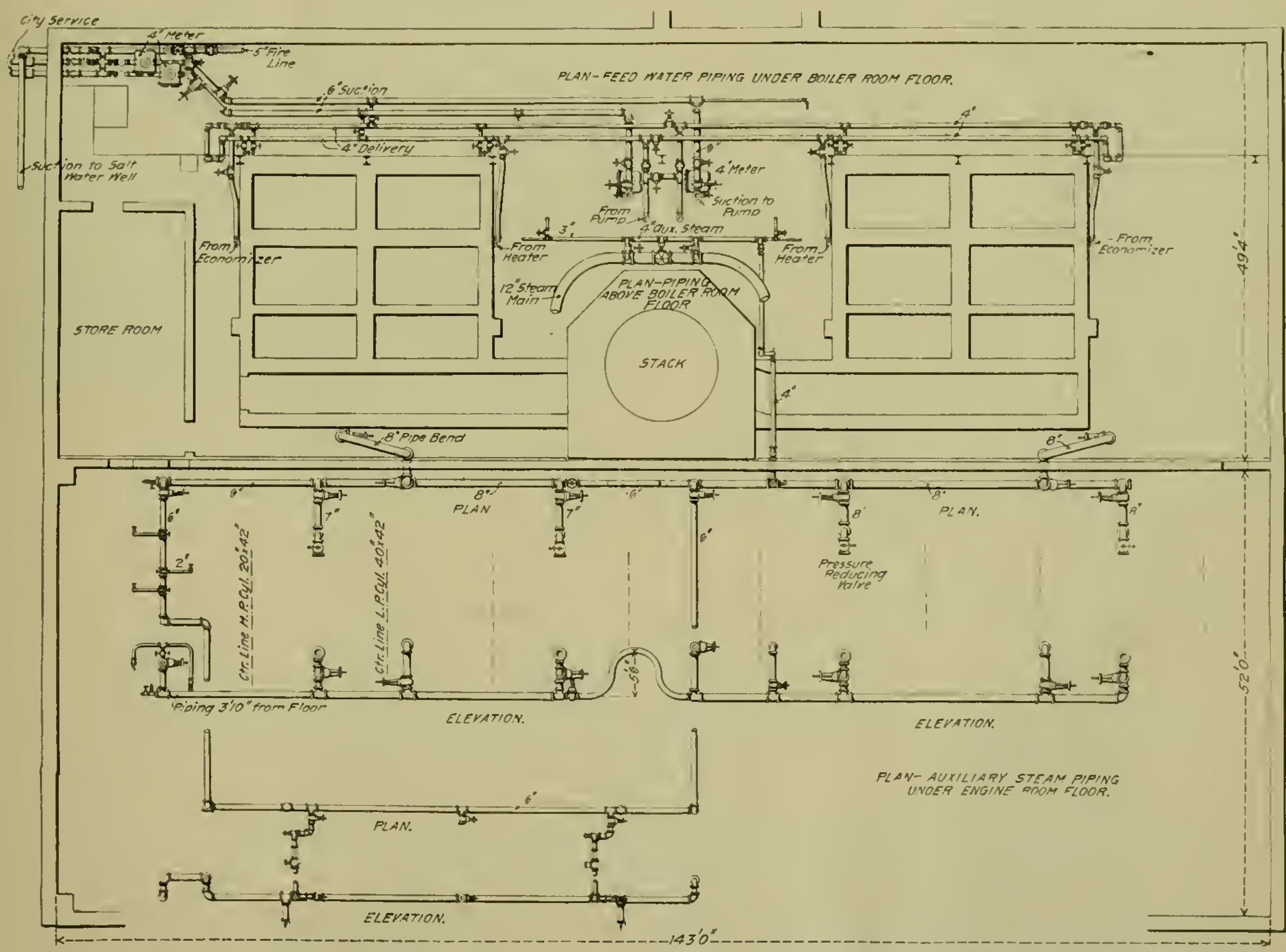
The principal dimensions of the 650-h.p. engines, which are of similar design, are also presented in the following table:

Diameter of high pressure cylinder	20 ins.
Diameter of low pressure cylinder	40 ins.
Length of stroke	42 ins.
Speed, normal full load	120 rev. per min.
Horse power, indicated, normal	648 h.p.
Diameter crank shaft, center	17 ins.
Diameter crank shaft, bearings	15 ins.
Diameters of piston rods, each	4½ ins.
Crosshead pins	length, 7¾ ins.; diameter, 6¼ ins.
Crank pins	length, 7¾ ins.; diameter, 7¾ ins.
Main bearings	length, 30 ins.; diameter, 15 ins.
Length of connecting rods, center to center	115½ ins.
Diameter of connecting rods at center	5 ins.
Diameter of fly-wheel	180 ins.
Width of face of fly-wheel	14 ins.
Weight of fly-wheel	40,000 lbs.
Thickness of piston, high-pressure cylinder	10 ins.
Thickness of piston, low-pressure cylinder	20 ins.
Diameter of main throttle-valve	7 ins.
Diameter of main exhaust-valve	14 ins.
Length of engine, over all	28 ft. 8 ins.
Width of engine, over all	21 ft.
Height of engine, over all	10 ft.
Total weight of engine, complete	195,000 lbs.

The governors of all the main engines are of the fly-ball type, and control the cut-off in both high and low pressure cylinders. They are of the safety type, so arranged that if any part fails or becomes disconnected, the steam is shut off so that destructive racing is not possible. The speed control effected is such that the speed variation does not exceed 2 per cent. for a 5-lb. change in steam pressure above or below normal, and 3 per cent. when full rated load is instantly thrown on or off. In addition to the safety feature of the governor the engines are equipped with safety stop regulators and stop valves, which are arranged to automatically shut off the steam supply in case



LONGITUDINAL ELEVATION OF THE ENGINE ROOM—SECTION A-A.



PLAN SHOWING BOILER FEED-WATER PIPING, AND AUXILIARY STEAM PIPING SYSTEM (PLAN AND PART ELEVATION) IN BASEMENTS.

the engine's speed increases more than 5 revolutions above normal.

The engines operating the exciters are 90-h.p. vertical cross-compound, non-condensing engines, and are of the standard type built by the Westinghouse Machine Company. Each of the two is direct-connected to a 50-kw. direct-current exciter dynamo, and operates at the same initial steam pressure and superheat as the larger engines. These engines are also carefully designed for the same speed regulation, the maximum variation between no load and full load being within 2½ per cent. The usual centrifugal type of shaft governor of the Westinghouse standard is used on these engines.

The important dimensions of these engines are presented in the following table:

Diameter of cylinders	High-pressure, 10 ins.; low-pressure, 18 ins.
Length of stroke	10 ins.
Speed, normal full load	320 rev. per min.
Horse-power, indicated, normal	90
Cut-off, normal	45 per cent.
Cut-off, maximum	85 per cent.
Diameter of crank-shaft, center	4¼ ins.
Diameter of crank-shaft, bearings	4¾ ins.
Wrist-pins	Length, 5 ins.; diameter, 2¼ ins.
Crank-pins	Length, 5 ins.; diameter, 4¼ ins.
Main bearings	Length, 12½ ins.; diameter, 4¾ ins.
Diameter of fly-wheel	52 ins.
Weight of fly-wheel	1,600 lbs.
Diameter of main throttle-valve	4 ins.
Diameter of main exhaust-valve	6 ins.
Floor space of engine	11 ft. 8 ins. x 4 ft. 6½ ins.
Total weight of engine, complete	16,500 lbs.

The design and construction of the engines of this plant are the best possible, according to our latest modern practice. The cylinders of all the engines are designed to permit two reborings, and their construction carefully provides for expansion and contraction. Metallic rod packings are used throughout and each cylinder is covered with magnesia nonconducting covering and lagged with polished sheet iron lagging, with polished corner strips. The cylinders are each provided with special water relief, or snifting, valves, and are drilled and tapped at each end for indicator connections.

The oiling system and its piping is very complete. Each engine has a complete automatic closed oiling system, in addition to the Michigan triple sight-feed lubricators, and 3-in. hand cylinder oil pumps upon each cylinder. The oil system consists of a complete set of drip pans and return pipes which collect and lead the used oil back through an oil filter and purifyer to a 150-gal. return tank, from which it is pumped by a steam oil pump to an elevated 150-gal. supply tank. From the latter tank a very complete piping system leads to the various sight feed oil reservoirs and to all other parts of each engine which require lubrication.

EXHAUST SYSTEM AND CONDENSERS.

The exhaust piping of this plant is divided into two systems, one of which takes care of the exhaust from the exciter engines the condenser pumps, and the boiler feed pumps, and delivers it to the atmosphere through the feed water heater for heating feed water. The other system takes the exhaust from the main engines and delivers it to the condenser; this system is shown in the basement foundation plan, shown herewith. This main exhaust consists of two sections, one of 20-in. and the other of 30-in. cast iron pipe, and leads horizontally through the engine room basement to the condenser connection outside the south end of the building.

The condenser, which is of the barometric, central-jet type, is located outside the south end of the power house, elevated over the hot well, and is directly connected to a 30 x 20 x 20 x 24-in. cross in the exhaust pipe riser, on the top side of which cross is the 24-in. atmospheric relief valve, for creating an open air exhaust in case of failure of the condenser system. The condenser has two cast iron cones or condensing chambers, each flanged for a 20-in. exhaust connection, and it also has a 10-in. cold water injection connection. A dry air connection is provided and a 10-in. tail pipe extends down from the condenser chamber to the hot well.

The circulating water for the condenser injection is furnished by two steam-driven centrifugal pumps in the basement, which take their suction through special strainers and foot valves from an intake well receiving water from the Hudson River. The suction connections are 12-in. and the delivery 10-in. pipe, which lead to the injection nozzle of the condenser. A dry vacuum pump is also provided to remove accumulated air from beneath the condensing cones and thus prevent breaking the vacuum.

The capacity of this condensing outfit is such as to be able to take care of a total of 55,000 lbs. of exhaust steam and maintain vacuum, when the generators are running at full rated load. The combined capacity of the circulating pumps is sufficient for condensing all the steam at 150 per cent. of the rated load. The vacuum at the various loads for which the condensing system is designed is guaranteed as follows: Three-quarter load, 27 ins.; full load, 26 ins.; 50 per cent. overload, 25 ins. The overflow and all other piping is carefully arranged to prevent flooding the steam cylinders in any case.

ENGINE ROOM CRANE.

The engine room is provided with a 20-ton single-trolley traveling crane, of 50-ft. span, which was furnished by the Alfred Box Company, Philadelphia, Pa. The bridge, trolley and hoist movements are all operated by hand power from a suspended platform from the bridge. The bridge girders are of plate girder construction and so designed that no portion receives a maximum stress of over 12,000 lbs. per sq. in. of section under full load. The principal dimensions of this crane are given below:

Span, center to center of bridge truck wheels	50 ft.
Wheel base of bridge truck wheels	9 ft.
Distance, center to center of bridge girders	5 ft.
Maximum lift	30 ft.
Wheel base of trolley	4½ ft.
Diameter of hoist-rope	⅝ in.
Capacity of crane	20 tons

COMMERCIAL VALUE OF ECONOMIZERS.

In a paper read before the Philadelphia Foundrymen's Association, Mr. A. H. Blackburn said:

"From our records we find that the average life of a well built economizer is from 15 to 20 years, with ordinary care and attention, and therefore it is a conservative basis to allow a 6 per cent. depreciation. From records of a number of large plants the cost of maintenance and repairs has not exceeded 1 per cent., but to be on the safe side allow 2 per cent.

"The value of an economizer varies in proportion to the cost of fuel and the heating value of that fuel, and the cost of installation varies according to the designs and conditions of each particular plant. Taking the average manufacturing plant, and estimating saving of 10 per cent. in the total fuel consumed during the year, working 300 days during the year and ten hours per day, the economizer will show the following gross return on the investment:

	Per cent.
With coal at $5.00 a net ton	48.1
With coal at 4.00 a net ton	38.5
With coal at 3.50 a net ton	33.7
With coal at 3.00 a net ton	28.9
With coal at 2.50 a net ton	24.
With coal at 2.00 a net ton	19.2

"Subtracting from this gross return per annum on the investment the cost of depreciation, maintenance and repairs, with coal at a cost of $2 per ton delivered in the boiler house, the economizer pays a good return on the investment. If a plant works 20 hours out of the 24, as a number of manufacturing plants do, the return doubles up. This estimate only takes into consideration the saving of fuel, to which should justly be added the gain from the other advantages mentioned in the first part of this paper.

"In the above estimate I have only considered the average boiler plant, taking a conservative estimate of 10 per cent. saving, but where hot furnace and other gases are available a much larger saving is being made."

MACHINERY ORDERS FOR RAILROAD SHOPS.

Further purchases of fair sized lots of machine tools by some of the railroad companies have served to make more apparent the improvement in the machinery trade, which has become noticeable during the last few weeks. These orders, coupled with the smaller bookings, make up a fair week's business. Conditions generally are brightening, and throughout Liberty street a more confident feeling prevails toward the near future. The next week, it is said, will bring forth some good contracts, among which is mentioned an important lot of machine tools aggregating more than $50,000 in value.

The Delaware & Hudson Railroad Company have placed an order with the Niles-Bement-Pond Company, New York, for about $60,000 worth of machine tools for their shops at Green Island, N. Y. This order was placed against the list which they issued some time ago, calling for upward of $75,000 worth of tools for their shops, including those at Oneonta, N. Y., and Carbondale, Pa., so that, while the company may not contemplate buying further at present, there is probably some $10,000 or $15,000 worth of tools yet to be purchased.

The Southern Pacific Railroad Company have closed for a fair sized lot of tools for installation at Reno, Nev., where they have recently completed the erection of new shops. The transaction has aroused considerable interest in Liberty street, where it is rumored that the entire order was placed with Manning, Maxwell & Moore.

These orders with many others for other than railroad companies are recorded in the *Iron Age* in connection with the general machinery market.

THE APPLICATION OF INDIVIDUAL MOTOR-DRIVES TO OLD MACHINE TOOLS.

McKees Rocks Shops.—Pittsburgh and Lake Erie Railroad.

By R. V. Wright, Mechanical Engineer.

IX.

THE 72-INCH WHEEL LATHE.

In this article the discussion of the motor equipments for lathes at the McKees Rocks shops will be concluded by a description of the motor-driving application to the 72-inch Niles driving wheel lathe which had been used at the old shops. The engravings, Figs. 44 and 45, illustrate this old lathe as thus equipped with the Crocker-Wheeler multiple-voltage system for variable speed driving. This drive involves the important point of difference from the other drives previously discussed in this series, in that here a back-geared type of motor is used.

Fig. 44.—View of the Wheel Lathe at the McKees Rocks Shops, as Changed for the Individual Drive.

develops 25 h.p. at 240 volts, is used to drive this tool, in connection with a type 80-M. F.-21 controller, for obtaining the variable speeds available with the multiple-voltage system.

Referring to Fig. 45 it will be noted that the controller is placed on its side, on the floor, and that it is operated through a long extension shaft which is coupled to it and can be turned from either one of two handles. The extension shaft is carried underneath the projecting part of the bed casting and is entirely out of the way of the operator. One controller handle is placed near each face plate, as shown in view; this arrangement is very convenient when hard spots appear on one of the tires and it is necessary for the operator to slow up or stop, as a handle is always within easy reaching distance. The vertical castiron brackets, each of which supports the extension shaft and carries a vertical shaft upon which is the hand wheel, is fastened to the floor by means of lag screws and is designed with a view to stiffness. It is similar in general design to the vertical controller hand-wheel bracket which was used upon the large Niles lathe and described in Article IV of this series (see page 410, of Nov. 1903).

The arrangement of the step pulley, gearing, etc., for the drive, as used when the tool was belt driven, is shown by one of the diagrams in Fig. 46; when it was desired to true up journals, the lock plate, which was feathered to the shaft upon which the speed cone runs, was locked to the cone and gear 5 was moved over out of mesh with gear 6, so that the face plate was driven through gears 7 and 8. When tires or wheel centres were turned, the lock plate at the end of the cone was unlatched and gear 5 was thrown in mesh with gear 6, thus allowing the face plate to be driven by gears 1-2x3=4x5-6.

The other diagram in Fig 46 shows the arrangement of gearing that was designed for the motor drive. The plate which was used for locking the speed cone to the shaft with the belt drive was retained, and a sleeve was designed to replace the cone and to carry gears D and E; the sleeve was designed so that the lock plate could be locked to it at will. In order to keep the proper ratio between the two runs of gearing with the motor drive it was necessary to replace gears 1 and 2 by the new gears E and F.

The reduction of speed from the motor to the sleeve which replaced the belt cone was so great, the power to be trans-

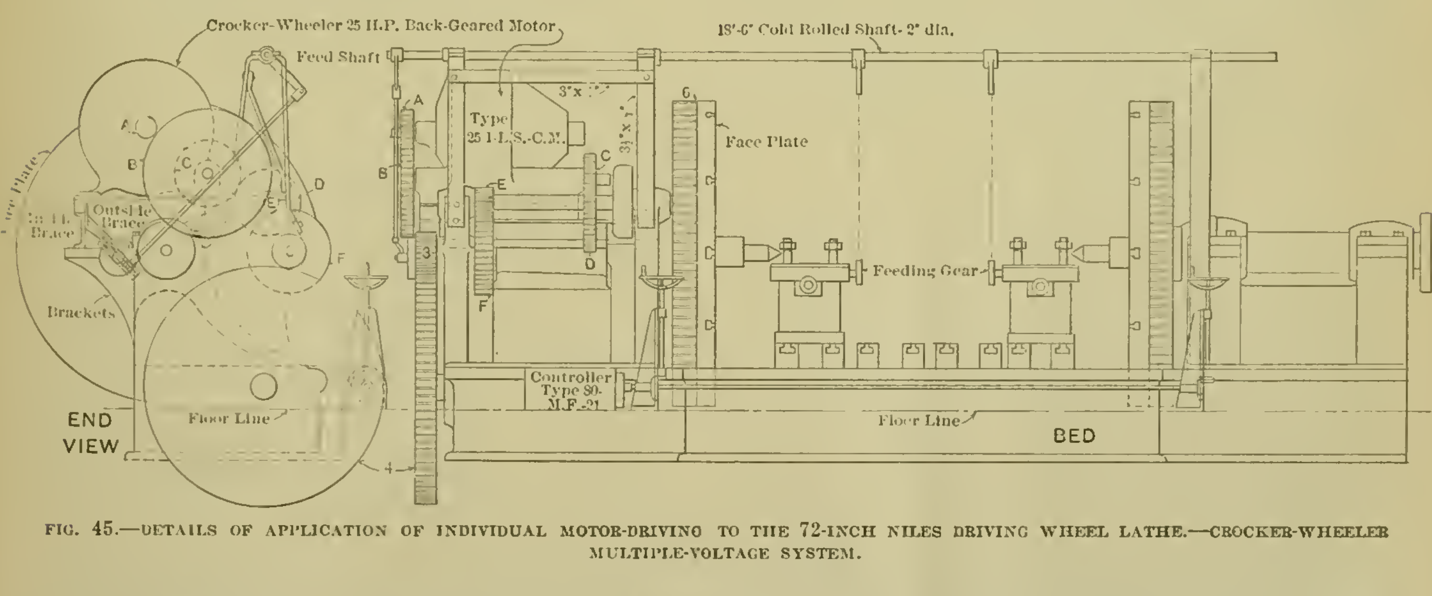


Fig. 45.—Details of Application of Individual Motor-Driving to the 72-inch Niles Driving Wheel Lathe.—Crocker-Wheeler Multiple-Voltage System.

The motor, as applied in this case, is carried upon a ¾-inch steel plate bed, which is supported by two long castiron blocks resting upon two 8-inch channel irons, as shown in the end view. The rear channel rests upon two brackets which are part of the frame of the tool and which formerly carried the quartering attachment—this attachment was done away with as it had been found desirable to confine this work to a special tool provided for the purpose. The channels which support the motor are well braced by wrought-iron straps, as shown. A Crocker-Wheeler type 25I. L.S. C.M. motor, which

mitted was so heavy and the diameter of the large chain sprocket was so limited by the shape of the frame of the tool, that a silent chain to make the necessary reduction would have to be of a comparatively small pitch and be very wide. It was found that by introducing another shaft between the motor and the sleeve, or rather by using a back-geared motor, the reduction could be made by gearing at considerably less expense than by the use of a silent chain, and this was done, as shown.

The shaft which carried the arms for operating the feed mechanism was formerly supported by hangers, fastened to the roof trusses of the shop building; it is now attached to the tool frame by means of wrought-iron braces, as shown. On account of the increased distance necessary between bearings it was necessary to provide a heavier shaft than was used before. This shaft is less than eight feet from the floor and is placed far enough in front of the centre of the face plates so as not to interfere with placing the wheels in the tool with the traveling crane. The reciprocating motion is transmitted to the feed shaft from a gear which meshes with another gear on the end of the main spindle; a rod of ¾-inch pipe with a special casting on each end, is eccentrically pivoted to this gear and thus causes the feed shaft to rock by means of the lever at the end.

An interesting study is afforded by use of the diagram

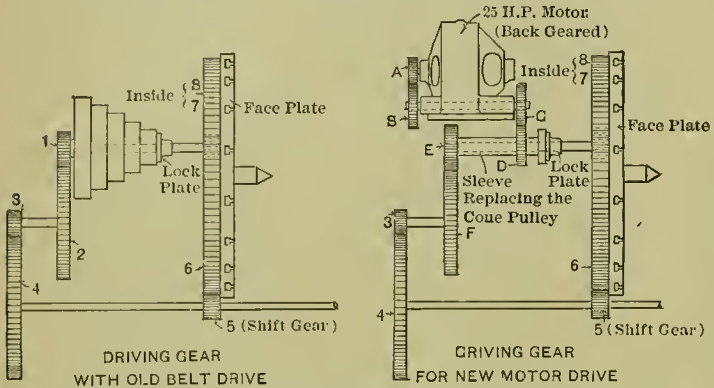


FIG. 46.—DIAGRAMS OF THE OLD AND NEW ARRANGEMENTS OF THE GEARING IN THE DRIVE OF THE NILES DRIVING WHEEL LATHE, SHOWING CHANGES NECESSARY FOR THE MOTOR DRIVE.

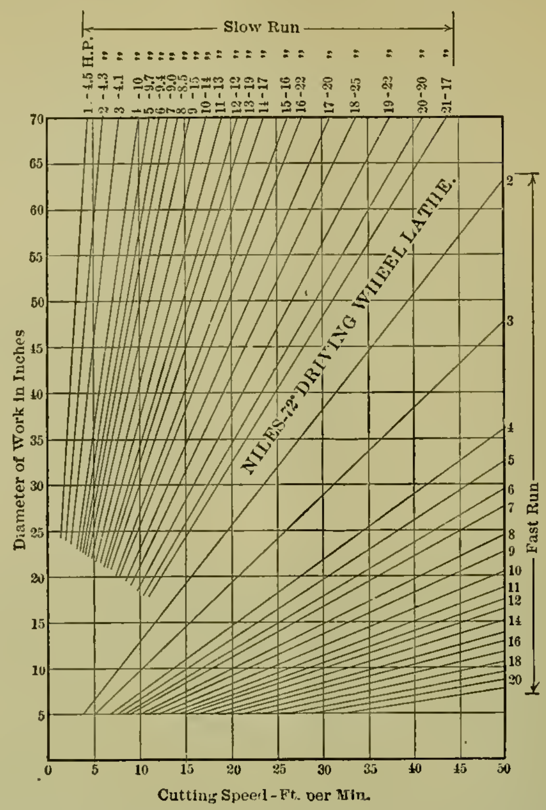


FIG. 47.—SPECIAL CUTTING SPEED DIAGRAM—NILES WHEEL LATHE. THIS SHOWS THE CONTROLLER POINT WHICH WILL DRIVE WORK OF ANY DIAMETER AT ANY DESIRED CUTTING SPEED.

shown in Fig. 47; the point at which the controller handle should be set for any cutting speed, on a given diameter within the limits of the tool, can readily be found from it. The horsepower which the motor is capable of exerting, at the different points without overloading, is also shown.

Between 80 and 90 per cent of the locomotives on the Pittsburgh and Lake Erie are equipped with 44-inch wheel centres and the diameters of the greater portion of the tires that will be turned will therefore vary from about 7-ins. to 51-ins. in diameter, depending on how much they are worn. With high-speed tool steels the tires should be turned at from 18 to 25 feet per minute.

The motor was applied so that its maximum power should be available when tires of about 50 ins. in diameter are turned at a cutting speed of 25 feet per minute. For instance, it will be noted by referring to Fig. 47 and following the diagonal which passes nearest to the intersection of the abscissa from 50-ins. diameter and the ordinate from 25-ft. cutting speed that the controller should be set on point 18 and that at this point the motor develops its full rated power, namely 25 h.p.

EDITORIAL CORRESPONDENCE.

Impressions of Foreign Railroad Practice.

(*Continued from Page* 85.)

Glasgow, December 12, 1903.

At a particularly busy junction near London 1,200 trains pass daily. If locomotives operating past this point are not kept in the pink of condition, such service would be impossible. This matter of maintaining locomotives in England has so deeply impressed the writer that he may be excused for repetition in commenting upon it. Naturally one tries to secure figures for comparison, but this is difficult. It seems to be the general rule for managers to expect perfect locomotive service and every breakdown or failure of any kind to make time is carefully gone into and equally carefully reported upon always to the manager and generally to the directors. At the bottom of this remarkable service lies the fact that if the locomotive superintendent is not sufficiently supplied with engines, so that he can be sure of plenty of time for work upon them at terminals, he at once supplies the deficiency and is given plenty of authority to do so. He builds engines when he needs them.

The perfection of painting and attractive appearance of locomotives is found in England. This must strike the observer as being carried too far. In fact the time and labor cost is great and we could not hold engines from 10 to 14 days in a specially provided locomotive paint shop, yet it will not do to brush aside this practice as entirely foolish and extravagant. It may be carried to an extreme and care in design, which leaves no corners in which dirt may collect, may cost something in the drafting room and in the shop, but the conclusion is unavoidable that these matters exert an important influence in the performance of the engines. One thing is positively certain—English railroad men know how to get the best work out of a locomotive and they also know how to keep it in condition for doing so. In this they are far ahead of the continental railroad men, and they are far and away ahead of us. The engines are kept up even if the stockholders wait a little for some of their dividends. One locomotive superintendent told the astonishing story of only four engine failures in the month of November last. He included all delays of 2 minutes and over which could be chargeable in any way to the locomotive. He was asked to repeat the statement and did so, showing that he fully understood the question. This road operates 830 locomotives. This officer says that it does not cost him anything to keep up his engines because delays would incur very heavy expense.

A parliamentary regulation which is rather carefully enforced by the board of trade limits the working day of enginemen to 10 hours. All cases of overtime must be officially reported, and this tends to keep them down to the lowest possible limits. Some of the most progressive men are introducing "double crewing," but there is little of it done and it is proper to say that the locomotives generally rest when the men rest which allows from 10 to 12 hours for any necessary work. Even the engines making the largest mileage are in the "running sheds" at least four hours daily. As there is very little trouble with flues, this gives time for everything needing looking after.

The "lick and promise" repairs of the American roundhouse are unknown here. Punctuality and economy being required of the engineers, the roads cannot in fairness neglect anything which will tend to help the men to make records. English officials regard pooling with "holy horror" and plainly say so. They cannot understand how we do it, and characterize it as *impossible*. These people do not send a locomotive out to take its train when half the working parts are gone. It is to be regretted that American managers do not come over here and see what an important thing it is to maintain locomotives. With the Englishman this is not sentiment at all, but pure business and it would be worth while for an American road to try the policy to learn whether or not it pays.

Attempts to get figures for mileage per engine failure were not generally successful because few locomotive superintendents could give me the figures and only one of those who gave them was willing to have them printed.

comparisons to be made between their work and that of their neighbors. Figures are usually given in pounds of coal per mile. The methods of keeping the records, however, do not admit of making positive statements with confidence. People over here are not yet educated to the importance of the ton mile as a unit of measurement, and a very well known locomotive superintendent spoke sneeringly of this unit, saying that he took no stock in it whatever. The real reason is that the light loads of freight trains would make no showing at all in tons. Again, when freight service is habitually conducted at speeds of 35 and 40 miles per hour to keep it out of the way of a large number of fast express trains, the speed, as well as the tonnage, becomes an important item. The statement that the most progressive locomotive superintendent in England is cherishing the hope of eventually hauling 1,000 ton trains on a road which is positively a "billiard table grade" all the way, is perhaps enough to say of the freight service. It is interesting to be told that engines capable of hauling 1,000 ton trains are too heavy for present bridge construction and

NEW SIX COUPLED PASSENGER LOCOMOTIVE.—CALEDONIAN RAILWAY.

Most (but not all) of these officials are very "canny" about giving figures concerning their practice. They make a serious mistake in thinking that they ought to conceal their work and methods from their competitors.

I may say that I did not see a single passenger engine hauling its train with any leakage of steam about the valve or piston rods.

Flue troubles, such as we have, appear to be unknown here. The water is not very much better than ours, but of course, the work done is very much lighter. That done by the largest passenger engines, however, is sufficient to start the flues, if it were not prevented. Brick arches in the fireboxes are the rule here and they are very carefully kept in condition. Another good device in the firebox is a deflector over the door which, besides contributing to economy of fuel consumption and reduction of smoke, serves to prevent cold air from striking the tube ends when the firedoor is opened. This deflector sometimes is the door itself, opening inwardly and directing the incoming air down upon the fire, or it may be an inverted trough of sheet steel, secured over the door, and reaching perhaps about two feet into the firebox. In either case the air is prevented from passing directly against the tube ends.

On many of the roads the firebox ends of the flues are not beaded over at all and on others, as previously mentioned, only the lower rows are so treated. In all cases the tubes are well expanded and taper ferrules are driven into the ends of the tubes, *inside* the ends, with the end of the ferrule left projecting far enough from the end of the tube toward the fire, to protect the tube itself from the intense heat. The tube sheets are always of copper, the tubes sometimes of brass and sometimes of steel and the ferrules are of steel.

Comparisons of the performance of locomotives of two countries are difficult to draw, especially when the people, either do not know exactly what their engines are doing or do not wish

also that in at least one case the largest passenger engine which is a fine new design must be disconnected from the tender in order to turn it at the terminals. This appears to be small scale railroading, but nevertheless it is surprising to know what a ton of coal will do here in these small engines.

On the Caledonian Railway, Mr. McIntosh has built two beautiful 4 6-0 passenger engines. These are certainly among the most powerful passenger locomotives in Great Britain. Because of the work they are doing the leading dimensions are presented in the accompanying table:

CALEDONIAN RAILWAY 4—6—0 PASSENGER LOCOMOTIVE.

Weight on drivers	123,440 lbs.
Weight, total, of engine	163,400 lbs.
Cylinders	21 by 26 ins.
Driving wheels, diameter	78 ins.
Boiler, center from rail	8 ft. 6 ins.
Boiler, length of barrel	17 ft. 4½ ins.
Boiler, outside diameter	60 ins.
Firebox, length	102 by 48 ins.
Firebox, depth from center of boiler, front	63 ins.
Firebox, depth from center of boiler, back	45 ins.
Tubes, number	270
Tubes, length	17 ft. 3 ins.
Tubes, diameter, 257	1¾ ins.
" " 13	2½ ins.
Heating surface, tubes	2,255 sq. ft.
Heating surface, firebox	145 sq. ft.
Heating surface, total	2,400 sq. ft.
Grate area	26 sq. ft.
Boiler pressure	200 lbs.
Tractive force	22 050 lbs.
Tender tank capacity	5,000 gals.

This engine is interesting also, because Mr. McIntosh considers it the limit in the matter of size and capacity, in the simple engine and is of the opinion that the next step for consideration is the four-cylinder compound. He is favorably impressed with the De Glehn locomotives and he gave the impression that he would look to that type for further developments. This "50 Class," of which dimensions are given, is quite new and is considered experimental. Indicator cards have been taken, but at the time of the writer's visit, they had not been worked up and no figures of indicated horsepower were available. These engines are hauling the heaviest passenger trains between Glasgow and Carlisle in the West Coast service, connecting with the London & Northwestern for London. One of these trains leaves Glasgow at 10.45 p. m., arriving at Carlisle at 12.55 a. m.—102 miles in 130 minutes or a little better than 47 miles per hour. In this distance for 52 miles there is an average rise of 20 ft. per mile. With a train of 380 tons, back of the tender this is a good run, but the surprising thing about it is the statement that it is never necessary to burn over three tons of coal on this run and that it is sometimes made on two and a half tons. This is Scotch coal, which is not as good as the Welsh coal, generally used in England. The exact coal performance could not be verified for several reasons, but figures will be obtained if possible, as it is important to know positively the terms under which these engines are working. The engineer running one of these engines stated to the writer that he could always count on 200 lbs. of steam in the boiler. This is certainly good work for an engine having 2,400 sq. ft. of heating surface and weighing 163,000 lbs. It is more than questionable whether one of our engines of equal weight and heating surface would do this work on such a small coal consumption and whether the steam pressure would stand at 200 lbs. all the way.

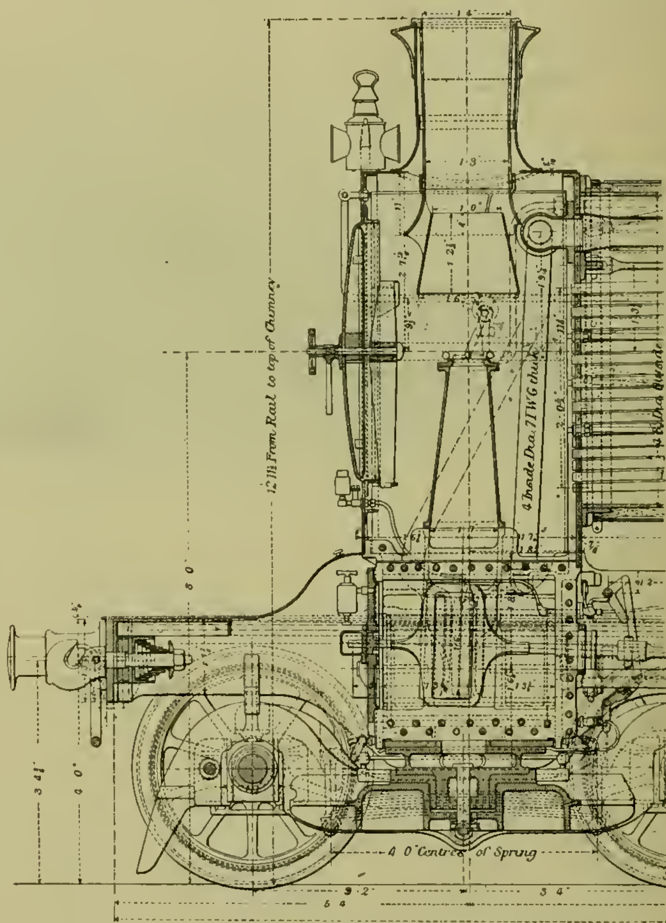
These engines with 21 by 26 in. cylinders are now running with single nozzles 5¾ in. in diameter. They have no netting or deflectors in the smoke boxes and absolutely nothing to obstruct the egress of the exhaust and the waste gases. The nozzle is high, terminating about 3 in. below the center of the boiler and, the cylinders being inside connected, the exhaust passages are direct and short. The stack is extended down into the smoke box and below its flaring base is a short petticoat pipe. While the front end is absolutely open for the passage of sparks, comparatively few are thrown when at speed. In studying the drawings for reasons for the excellent steaming qualities, it was found that Mr. McIntosh had done most careful work in adjusting the exhaust nozzle and the petticoat pipe and also in placing the brick arch in the firebox at exactly the right height. He is a firm believer in bringing the front end and firebox to an exact "focus," and finds it most important to secure the correct relations between the nozzle and the stack. He believes the firebox to be the place in which to burn the fire and aims to keep the sparks on the fire. The firedoor opens inwardly and directs the incoming air downward toward the fire. The grates slope sharply toward the front and the lower line of the brick arch at the center, when prolonged on the drawing, hits the top edge of the firedoor opening. This is done with a view of preventing the passing of cold air from the door, directly into the tubes. It is worth remarking that no smoke boxes are to be seen which have any indications of ever having been hot. The paint upon them and on the boiler fronts seem to be, almost universally, in good condition. This is surprising in view of the small heating surfaces.

Mr. McIntosh makes a practice of cambering all tubes used in his locomotives. They are bent uniformly throughout their length, the center of the tube being offset from the center line through the ends by an amount equal to the diameter of the tubes. This is done in order to relieve the tube sheets from the stresses which straight tubes subject them to in expanding and contracting. The cambering gives them an opportunity to bend still more, or to straighten out to meet the stresses of expanding and contracting. The cambering is done by a laborer who merely passes the tubes through a hole in a large block of wood and bends them slightly by putting his weight upon the free end. By a little practice he gives the tube an easy and smooth curve without jamming or flattening it. This appears to be well worth trying and it is perfectly easy to do.

Tube sheets (the rear ones) here are almost invariably of copper and quite thick. Some were noted on the London & Northwestern which were one inch thick. It is usually the tube sheets which fall first and this necessitates renewing the tubes. It is clear to the writer that the use of the brick arch is very beneficial to fireboxes here, particularly because great care is taken to deflect the cold air from the firedoor, so that it will pass down onto the fire or under the arch and not pass directly against the ends of the tubes and the tube sheet. Deflecting firedoors appear to represent an important principle in this respect.

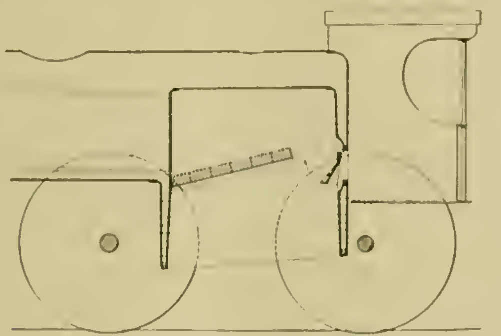
Mr. McIntosh does not believe in pooling engines and in answer to a question as to the number of his engine failures causing delays of 2 minutes or more, he replied that he always received a letter or telegram from the general manager whenever such a delay occurred. This indicates that he does not have many. He believes that a clean engine will be well cared for and that it pays to be most careful in this and in the running repairs. He insists on having certain men to inspect engines and others to repair them, which seems rather important.

Reverting to the matter of adjusting the "front ends" of locomotives, it should be stated that Mr. McIntosh does this work very carefully in the case of every new engine and then by the use of templets and gauges others of the same class are put in correct order in the shop, and require no subsequent adjustment. When the right position of the petticoat pipe is found a pattern is made and the engines of that class are fitted with petticoats which are integral with the cast-iron liner of the stacks, and no adjustment whatever is provided in that member. The best talent of the department is devoted to the drafting of locomotives, and it is done once for all for each class. There is no tinkering with front ends here.



A TYPICAL BRITISH SMOKE BOX ARRANGEMENT.

It will be difficult to convey a correct impression of the attention given to "drafting" British locomotives. The adjustment of the nozzle and petticoat is considered vital to the proper operation of the engine, and to the care devoted to this I attribute in a large degree, the good steaming qualities of engines which we consider very deficient in heating surface. The firebox conditions also help and these will be referred to again. As the new ten-wheel Caledonian engine is still considered as in the experimental stage, it cannot be illustrated in detail now, but the arrangement of a similar "front end" of the latest 4-4-0 class serves to show the nozzle, stack and cast iron petticoat. This petticoat when finally decided upon is not adjustable. As seen in the engraving (reproduced from *Engineering*) there is no diaphragm plate and no netting. There is something occult in the adjustment of the exhaust nozzles on this road for high speed engines, and I suspect that the nozzles are not exactly vertical. The axis of the nozzle is



A TYPICAL BRITISH BRICK ARCH AND FIRE DOOR. THESE ARE ADJUSTED AS CAREFULLY AS THE "FRONT ENDS."

inclined forward, but only a little. Whether there is anything in it I cannot say, but the fact remains that the last adjustment of the new ten-wheel engine which resulted in fine steaming, consisted in a slight tipping of the nozzle. This fact, at least, serves to indicate how carefully the drafting is done, and that is the important fact to be brought out. These parts receive that is the important fact to be brought out. The brick arch receives as careful attention as the drafting, and these little engines steam well without tearing their boilers all to pieces.

An exceedingly important feature of British locomotive practice is the fact that the appearance of a new design is considered an epoch-making event in the department. It is prepared for perhaps two years in advance. The study put upon the drawings is something unknown with us, and the engine is built after every detail has been most carefully studied in the light of what has gone before. The best talent of the department is concentrated for many months upon each new design. This is expensive, but I believe that it pays large interest on the investment.

In passing through the shops at Glasgow attention was arrested by a row of seven boilers, ready, with fittings complete and laid in a convenient place, for use on the standard engines. In case a boiler of a road locomotive needs heavy repairs, and the rest of the engine is in good condition, one of these is used and the engine returned to service within a few days. Its own boiler is then made ready for use on the next occasion of the kind.

G. M. B.

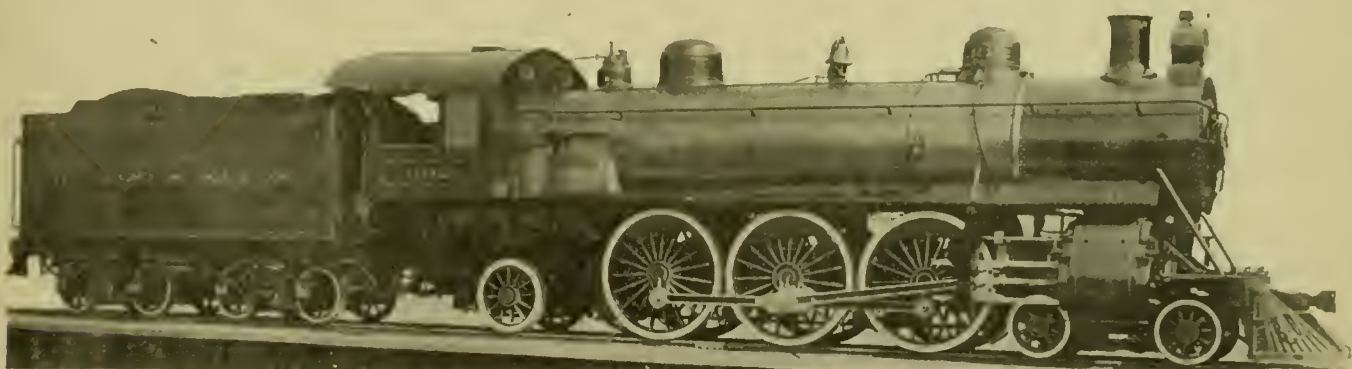
(To be continued.)

A POWERFUL PASSENGER LOCOMOTIVE.

4—6—2 (PACIFIC TYPE.)

CHICAGO & ALTON RAILWAY.

Another record-breaker passenger locomotive has been built for the Chicago & Alton Railway by the Baldwin Locomotive Works. The new one is the heaviest passenger locomotive in the world, and it is specially interesting as a marked example of the present tendency toward a sacrifice of heating surface in order to secure favorable water spaces in the boiler in the hope of avoiding some of the boiler troubles which are becoming more and more serious in connection with the increasing weight of trains. In the March issue of this journal for last year, page 85, were illustrated the very large 4—6—2 type Baldwin locomotives, which were built for the passenger service to the St. Louis World's Fair, and these engines are now followed by a heavier design of the same general arrangement,



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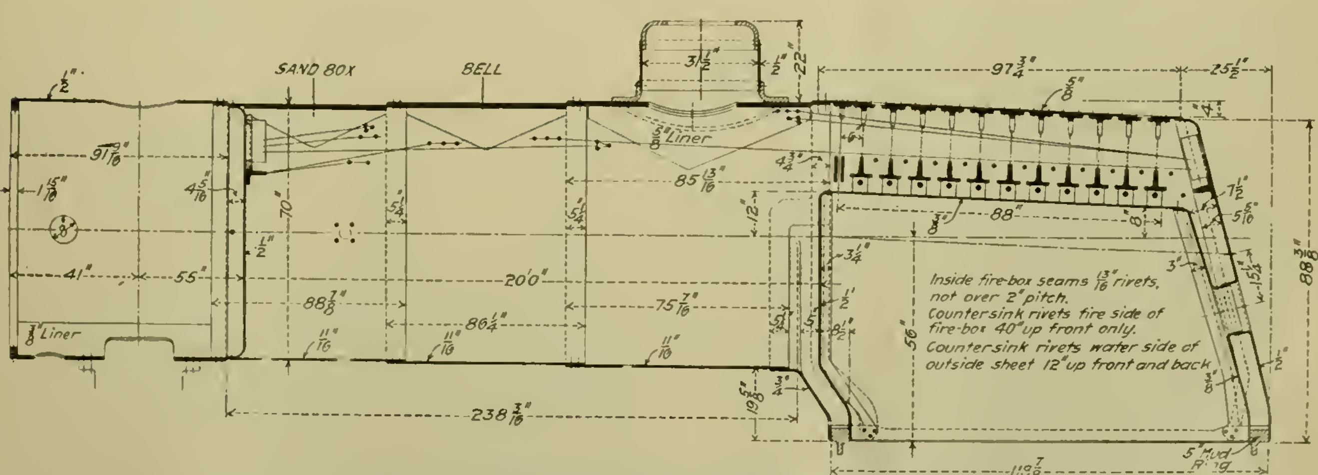
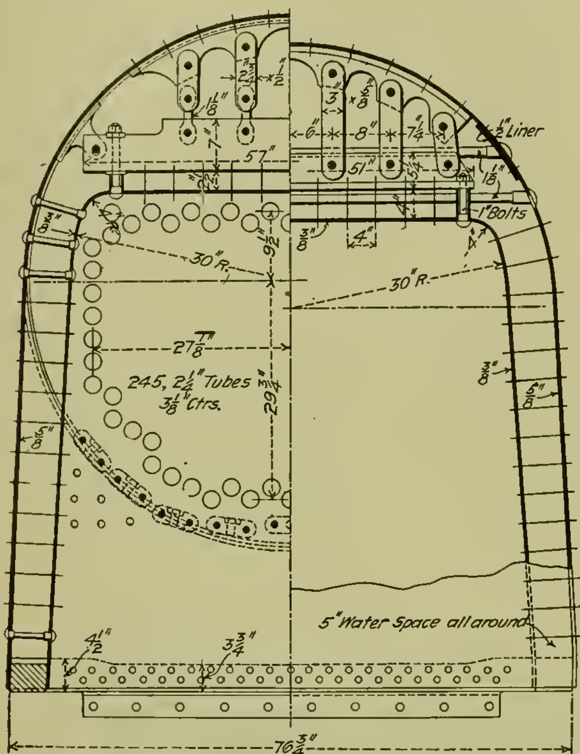


LONGITUDINAL SECTION OF BOILER.

THE HEAVIEST PASSENGER LOCOMOTIVE EVER BUILT.

Mr. C. E. Fuller, Superintendent Motive Power. *Baldwin Locomotive Works, Builders.*

but with quite different boiler conditions. These two designs coming as they do within a year exhibit significant tendencies in boiler proportions which are exceedingly important, and for this reason the leading dimensions are repeated in a table which permits of comparison. Another table shows the ratio of total weight to heating surface of a number of recent large passenger engines. It will be noticed that the new Chicago & Alton engine has 200 lbs. boiler pressure, 245 tubes 2¼ in. in diameter and 20 ft. long, also that the tubes have bridges of ⅞ in. in the tube sheets. Furthermore, the water spaces around the firebox at the mud ring are 5 in. on all sides. These figures indicate the importance which is now given to the matter of circulation space in the boilers, and while the boiler is undoubtedly able to carry 220 lbs., the pressure will



SECTIONS THROUGH FIRE BOX.

not be over 200 lbs., and this should also contribute to long life of the sheets.

When such a radical departure from recent practice is put forth with the approval of the Baldwin Locomotive Works, and the tendency is also apparent in the product of other builders, the facts are worthy of study by all concerned in the American locomotive.

Attention is also directed to the long smoke box and to other features of this design which resemble those of the previous one of this type on this road. Because of the resemblance to the design of last year the general drawings are not reproduced, but special attention is called to the drawings of the boiler.

COMPARISON WITH OTHER LARGE PASSENGER LOCOMOTIVES.

Road.	Engine Number.	Total Weight.	Total Heating Surface.	Total Weight Divided by Heating Surface.
C. & A.	602	221,550	3,053	72.5
C. & A.	601	219,000	4,078	53.7
N. Y. C.	2,794	218,000	3,757	58.2
El Paso & Southwestern	——	209,500	3,818	54.8
Northern Pacific	284	202,000	3,462	58.3
A., T. & S. F.	1,000	190,000	3,738	50.1
C. & O.	147	187,000	3,533	52.9
L. S. & M. S.	650	174,500	3,343	52.2

RATIOS OF CHICAGO & ALTON LOCOMOTIVE.

Heating surface to cylinder volume	= 299.4
Tractive weight to heating surface	= 44.35
Tractive weight to tractive effort	= 5.47
Tractive effort to heating surface	= 8.09
Heating surface to grate area	= 61.55
Heating surface, percentage of tractive effort	= 12.3%
Total weight to heating surface	= 72.5

PASSENGER LOCOMOTIVE, CHICAGO & ALTON RAILWAY.

4—6—0 (PACIFIC) TYPE.

Gauge	4 ft. 8½ ins.
Cylinder	22 x 28 ins.
Valve	Piston
Boiler—Type	Straight
Material	Steel
Diameter	70 ins.
Thickness of sheets	11-16 in.
Working pressure	200 lbs.
Fuel	Soft coal
Staying	Crown bars
Firebox—Material	Steel
Length	108 ins.
Width	66 ins.
Depth	Front, 68 ins.; back, 64 ins.
Thickness of sheets:	Sides, ⅜ in.; back ⅜ in.; crown, ⅜ in.; tube, ½ in.
Water space	Front, 5 ins.; sides, 5 ins.; back, 5 ins.
Tubes—Material	Iron
Wire gauge	0.125 Mm.
Number	245
Diameter	2¼ ins.
Length	20 ft.
Heating Surface—Firebox	179 sq. ft.
Tubes	2,874 sq. ft.
Total	3,053 sq. ft.
Grate area	49.5 sq. ft.
Driving Wheels—Diameter outside	77 ins.
Diameter of center	70 ins.
Journals	Main, 10 x 12 ins.; others, 9 x 12 ins.
Engine Truck Wheels (Front)—Diameter	33½ ins.
Journals	6 x 10 ins.
Engine Truck Wheels (Back)—Diameter	45 ins.
Journals	8 x 12 ins.
Wheel Base—Driving	13 ft. 4 ins.
Rigid	13 ft. 4 ins.
Total engine	33 ft. 4 ins.
Total engine and tender	62 ft. 8¾ ins.
Weight—On driving wheels	135,110 lbs.
On truck, front	40,500 lbs.
On truck back	45,940 lbs.
Total engine	221,550 lbs.
Total engine and tender (about)	376,000 lbs.
Tank—Capacity	8,400 gals.
Tender—Wheels, number	8
Diameter	36 ins.
Journals	5½ x 10 ins.

COMPARISON WITH PREVIOUS C. & A. LOCOMOTIVE OF SAME TYPE.

Type—Drivers	4-6-2	4-6-2
Type—Name	Pacific	Pacific
Name of railroad	C. & A.	C. & A.
Number of road or class	601	602
Builder	Baldwin	Baldwin
Simple or compound	Simple	Simple
When built	1903	1904
Weight, engine, total, lbs	219,000	221,550
Weight on drivers, lbs	141,700	135 110
Weight on leading truck, lbs	36,300	40,500
Weight on trailing truck, lbs	41,500	45,940
Weight of tender (loaded), lbs	155,000	155,000
Wheel base, driving, ft. and ins	13-9	13-4
Wheel base, total, engine, ft. and ins	32-8	33-4
Wheel base, total, engine and tender, ft. and ins	62-0	62-8¾
Driving wheels, diameter, ins	80	77
Cylinders, diameter, ins	22	22
Cylinders, stroke, ins	28	28
Heating surface, firebox, sq. ft	202	179
Heating surface, arch tubes, sq. ft	28	....
Heating surface, tubes, sq. ft	3,848.0	2,874
Heating surface, total, sq. ft	4,078.0	3,053
Firebox, length, ins	108	108
Firebox, width, ins	72	66
Grate area sq. ft	54	49.5
Boiler, smallest diameter of, ins	70	70
Boiler, height of center above rail, ft. and ins	9-5	9-5
Tubes, number, and diameter in ins	328-2¼	245-2¼
Tubes, length, ft. and ins	20-0	20-0
Steam pressure, lbs., per sq. in	220	200
Type of boiler	Straight	Straight
Fuel	Bitum. coal	Bitum. coal
Reference in AMERICAN ENGINEER AND RAILROAD JOURNAL	March, 1903 Page 87	April, 1904

The financial results of the change of motive power of the Manhattan Elevated Railroad of New York City, from steam locomotives to electric traction on the multiple-unit system, has been gratifying and remarkable. The gross earnings during the second quarter of 1903 showed an increase of $414,000 over those of the same quarter of the previous year with steam motive power, while, on the other hand, the expenses in the same time showed a decrease of $99,000; thus the net earnings were increased by $513,000 for that quarter by the change. The electrical equipment was installed with no change in the tracks, rolling stock or character of the traffic, yet the capacity of the system has been greatly increased. The great starting power provided by the multiple-unit system permits six-car trains (all passenger carrying) to be operated with great facility, instead of the five-car trains with steam operation; also the acceleration speed (the determining factor in suburban traffic) has been increased by some 20 or 30 per cent, thus greatly facilitating the quick movement of trains.

A NEW DESIGN OF BACK-GEARED CRANK SHAPER

Springfield Machine Tool Company.

The increasing use of high speed tool steels and the heavy duty imposed thereby has made severe demands upon the capacities of machine tools, and is an important factor in influencing new designs of tools. It is of interest to note, however, that the tool builders are keeping pace with the new requirements and are originating new designs of tools to make the extreme heavy cutting duties possible.

No greater efforts have been made in this line than those of the Springfield Machine Tool Company, Springfield, O., who have recently perfected a new design of 16-in. heavy back-geared shaper. By reason of important changes in this design and improvements to make it adaptable to the heavy work, a description of this tool will be of interest. The general lines of this new tool are shown in the accompanying line engraving. It has a very heavy column or frame, heavily ribbed and of strong design to provide stiffness. The journal boxes of the driving mechanism have bored seats in the column and the flanged sleeve which forms bearing for the crank gear, is fitted into reinforced sections, as shown, to insure steadiness under the heaviest cuts. The top of the column extends beyond the face on each end to provide long bearing surfaces for the ram, and the surface to which the cross rail is clamped is very wide and deep, to give rigid support.

The ram is of semi-circular section and is long, wide and deep. It may be adjusted to suit the work while in motion; the tool head has a graduated swivel adjustable to any angle, and the down feed screw is provided with a micrometer collar.

The cross rail has a long bearing on the column, and is made of extra depth and unusually heavy. It is elevated by means of a screw with ball-bearing thrust. The box table which has a large surface for holding work, is secured to the cross slide by means of two studs and one bolt. The studs are screwed in the box table near its upper surface and pass through the cross slide at points where it is subjected to the pressure of the cut, thus relieving this casting of tension strain. Owing to the extreme depth of cross rail, cross slide and box table, a degree of rigidity is insured which obviates entirely the necessity for an extra support from the shaper base to the box table, therefore, saves the time usually required to adjust this support.

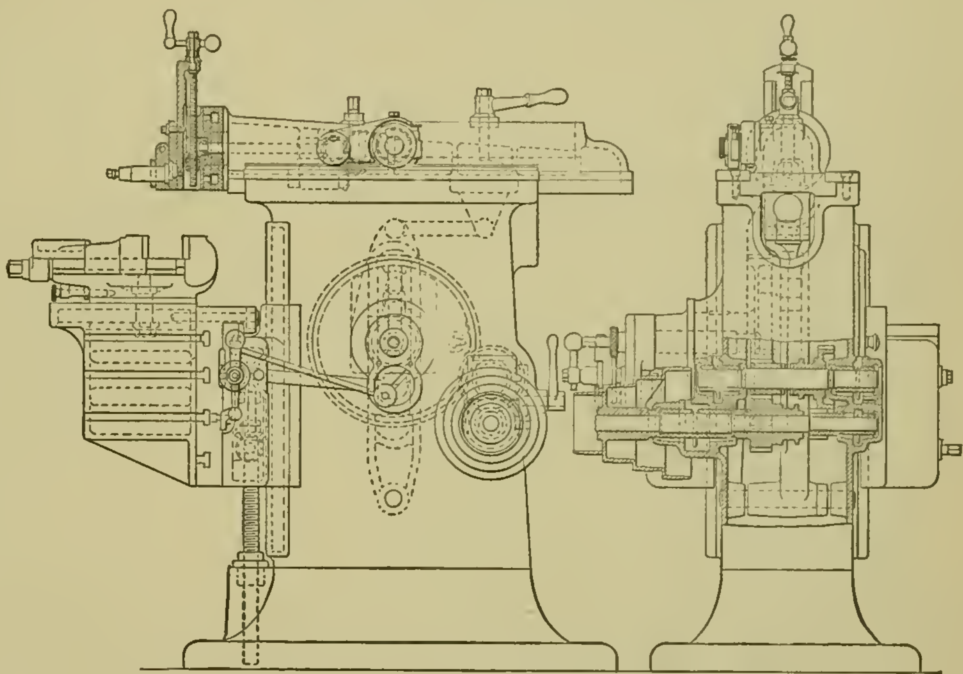
The driving mechanism is arranged for two speeds which, in connection with the wide belt four-step cone gives eight speeds arranged in geometrical progression. The driving shafts are journaled in ring oiling bearings and have large gears with wide faces, which are controlled by a lever at the rear of the column. Provision is made to prevent both sets of gears being engaged at the same time, hence breakage from such causes is avoided.

The stroke of the ram is varied with equal facility, while the machine is in motion or at rest, by means of a heavy wrist block, adjustable in large guides planed into the crank gear. The forward motion imparted to the ram by the driving mechanism is nearly uniform, with a quick return motion. The stroke arm is attached to the ram by means of a connecting rod placed in such a manner that a 2¼-in. shaft may be passed under the ram to allow of key seating.

The important dimensions of this tool are presented in the following table:

PRINCIPAL DIMENSIONS.

Stroke, maximum	17 ins.
Vertical adjustment of table	15 ins.
Cross motion of table	20 ins.
Tool block feeds (in any direction)	6 ins.
Vise jaws	8 ins. x 11 ins.
Width of front face of column	14½ ins.
Top surface of box table	13 ins. x 11¼ ins.
Depth of cross rail	14½ ins.
Length of bearing in column for ram	26 ins.
Width of ram	8¾ ins.
Size of base	24 ins. x 43 ins.
Floor space required	38 ins. x 80 ins.
Net weight	2,200 lbs.



DETAILS OF THE NEW DESIGN OF 16-INCH BACK GEARED SHAPER.—SPRINGFIELD MACHINE TOOL COMPANY.

AMERICAN LOCOMOTIVE COMPANY IN CANADA.

By the purchase of the Locomotive & Machine Company, of Montreal, the American Locomotive Company adds another excellent plant to its equipment. The price paid was $1,500,000, and besides the fine new locomotive plant the property includes a structural steel shop and valuable frontage on the river. The capacity of the locomotive shops is 250 locomotives per year, which may easily be increased to 300.

COKE AS LOCOMOTIVE FUEL.

Boston & Maine Railroad.

For a number of years the Boston & Maine has used coke on its locomotives running into Boston and the practice has been described in this journal. Figures from the performance sheets of the last six months of the year 1903 have been received from Mr. Henry Bartlett. These are from passenger service and are not stated in terms of ton miles. They indicate the amount used and the record in train miles for all classes of passenger service.

COKE USED ON LOCOMOTIVES, BOSTON & MAINE RAILROAD.

1903.	*Engine Mileage.	*Tons.	*Engine Miles per Ton.	Passenger Car Miles.	Pounds Used Passenger Service.	Pounds per Passenger Car Mile.
July	391,036	12,192	32.07	602,118	14,155,250	23.51
August	391,288	11,730	33.36	686,636	15,194,180	22.13
September	380,021	11,320	33.57	599,628	13,540,240	22.58
October	382,420	11,871	32.21	559,504	14,406,060	25.75
November	337,608	11,175	30.21	542,526	14,349,940	26.45
December	411,803	14,315	29.37	605,355	16,807,750	27.77

*All classes of service.

PROPOSED STANDARD SPECIFICATIONS FOR LOCOMOTIVE CYLINDERS.

Committee B, of the American Society for Testing Materials, proposes the following specifications for locomotive cylinders:

Process of Manufacture.—Locomotive cylinders shall be made from good quality of close grained gray iron cast in a dry sand mold.

Chemical Properties.—Drillings taken from test pieces cast as hereafter mentioned shall conform to the following limits in chemical composition:

	Per cent.
Silicon	From 1.25 to 1.75
Phosphorus	Not over 0.9
Sulphur	Not over 0.10

Physical Properties.—The minimum physical qualities for cylinder iron shall be as follows: The Arbitration Test Bar, 1¼ inches in diameter, with supports 12 inches apart, shall have a transverse strength not less than 2,700 pounds, centrally applied, and a deflection not less than 0.08 inch.

Test Pieces and Method of Testing.—The standard test shall be 1¼ inches in diameter, about 14 inches long, cast on end in dry sand. The drillings for analysis shall be taken from this test piece, but in case of rejection the manufacturer shall have option of analyzing drillings from the bore of the cylinder, upon which analysis the acceptance or rejection of the cylinder shall be based. One test piece for each cylinder shall be required.

Character of Castings.—Castings shall be smooth, well cleaned, free from blow holes, shrinkage cracks or other defects, and must finish to blue print size. Each cylinder shall have cast on each side of saddle manufacturer's mark, serial number, date made and mark showing order number.

Inspector.—The inspector representing the purchaser shall have all reasonable facilities afforded to him by the manufacturer to satisfy himself that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of the manufacturer.

The following is schedule of fast run made by a Chicago & Alton Railway special train carrying Mr. Pabst, the prominent brewer, and his party, Chicago to St. Louis, February 13, 1904:

Left Chicago	2.43 P. M.
Arrived Joliet	3.35 P. M.
Arrived Bloomington	5.24 P. M.
Arrived Springfield	6.38 P. M.
Arrived St. Louis	8.55 P. M.

Elapsed time six hours and twelve minutes, which included stops of seven minutes for train orders, six minutes in changing engines, eight minutes for obtaining water and one minute on account of being held by adverse signals. Total time lost by necessary stops, twenty-two minutes, which, substracted from elapsed time, gives a net running time of five hours and fifty minutes for the 283 miles.

PROPOSED STANDARD SPECIFICATIONS FOR MALLEABLE CASTINGS.

Committee B, of the American Society for Testing Materials, proposes the following specifications for malleable iron castings:

Process of Manufacture.—Malleable iron castings may be made by the open hearth, air furnace or cupola process. Cupola iron, however, is not recommended for heavy nor for important castings.

Chemical Properties.—Castings for which physical requirements are specified shall not contain over 0.06 sulphur nor over 0.225 phosphorus.

Physical Properties.—1. *Standard Test Bar.*—This bar shall be 1 inch square and 14 inches long, without chills and with ends left perfectly free in the mold. Three shall be cast in one mold, heavy risers insuring sound bars. Where the full heat goes into castings which are subject to specification, one mold shall be poured two minutes after tapping into the first ladle, and another mold from the last iron of the heat. Molds shall be suitably stamped to insure identification of the bars, the bars being annealed with the castings. Where only a partial heat is required for the work in hand, one mold should be cast from the first ladle used and another after the required iron has been tapped. 2. Of the three test bars from the two molds required for each heat, one shall be tested for tensile strength and elongation, the other for transverse strength and deflection. The other remaining bar is reserved for either the transverse or tensile test, in case of the failure of the two other bars to come up to requirements. The halves of the bars broken transversely may also be used for tensile strength. 3. Failure to reach the required limit for the tensile strength with elongation, as also the transverse strength with deflection, on the part of at least one test rejects the castings from that heat.

4. *Tensile Test.*—The tensile strength of a standard test bar for casting under specification shall not be less than 42,000 pounds per square inch. The elongation measured in 2 inches shall not be less than 2½ per cent.

5. *Transverse Test.*—The transverse strength of a standard test bar, on supports 12 inches apart, pressure being applied at centre, shall not be less than 3,000 pounds, deflection being at least ½ inch.

Test Lugs.—Castings of special design or of special importance may be provided with suitable test lugs at the option of the inspector. At least one of these lugs shall be left on the casting for his inspection upon his request therefor.

Annealing.—Malleable castings shall neither be over nor under annealed. They must have received their full heat in the oven at least 60 hours after reaching that temperature.

Finish.—Castings shall be true to pattern, free from blemishes, scale or shrinkage cracks. A variation of 1-16 inch per foot shall be permissible. Founders shall not be held responsible for defects due to irregular cross sections and unevenly distributed metal.

Inspection.—The inspector representing the purchaser shall have all reasonable facilities given him by the founder to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made prior to shipment.

THE TECHNOLEXICON.

A brief statement has been received from the secretary of the Society of German Engineers indicating the work done in connection with this universal dictionary of technical terms up to February, 1904.

The universal technical dictionary for translation purposes, in English, German and French, the compilation of which was begun in 1901 under the auspices of the Society of German Engineers, has received help up to the present time from 363 technical societies at home and abroad: 51 of these are English, American, South African, etc., 274 German, Austrian and German-Swiss and 38 French, Belgian and French-Swiss societies. Of firms and individual collaborators 2,573 have promised contributions. The excerption of texts in one, two or three languages (handbooks, pamphlets, business letters, catalogues, price lists, etc.) and of the existing dictionaries has yielded 1,920,000 word cards so far. To these will be added within the next two years (by the middle of 1906) the hundred thousands of word cards that will form the result of the original contributions.

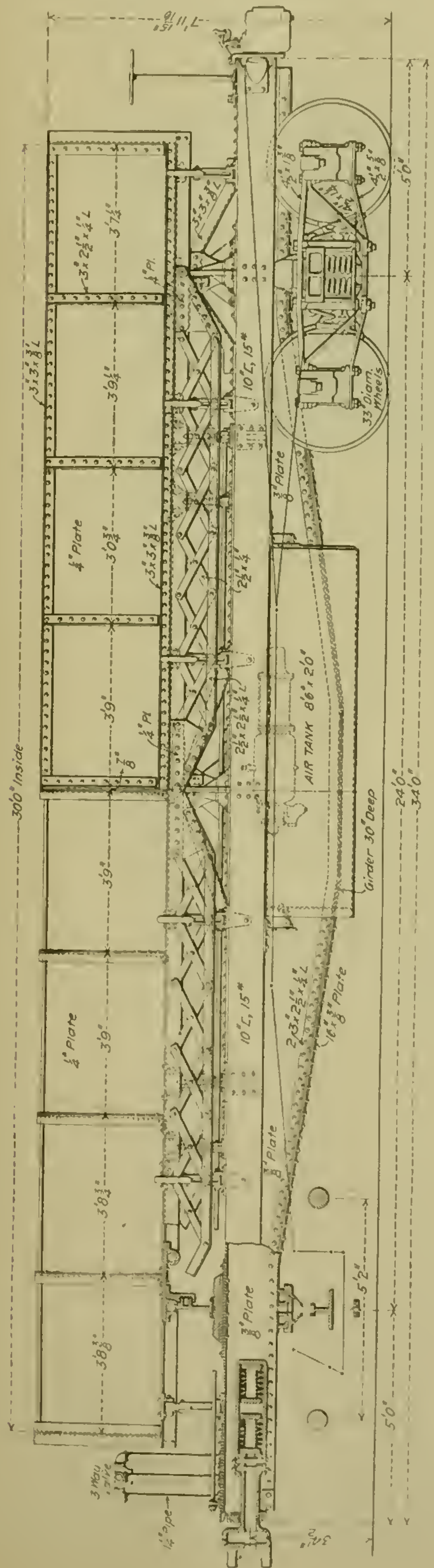
All the outstanding contributions will be called in *by Easter of this year*, 1904. The collaborators are therefore requested to close their note-books or other contributions—unless a later term has been especially arranged with the editor-in-chief—by the end of March and to forward them to the address given below. As the printing of the Technolexicon is to begin in the middle of 1906, delayed contributions can be made use of in exceptional cases only up to that time.

The editor-in-chief will be pleased to give any further information wanted. Address Technolexicon, Dr. Hubert Jansen, Berlin (N. W. 7), Dorotheenstrasse 49.

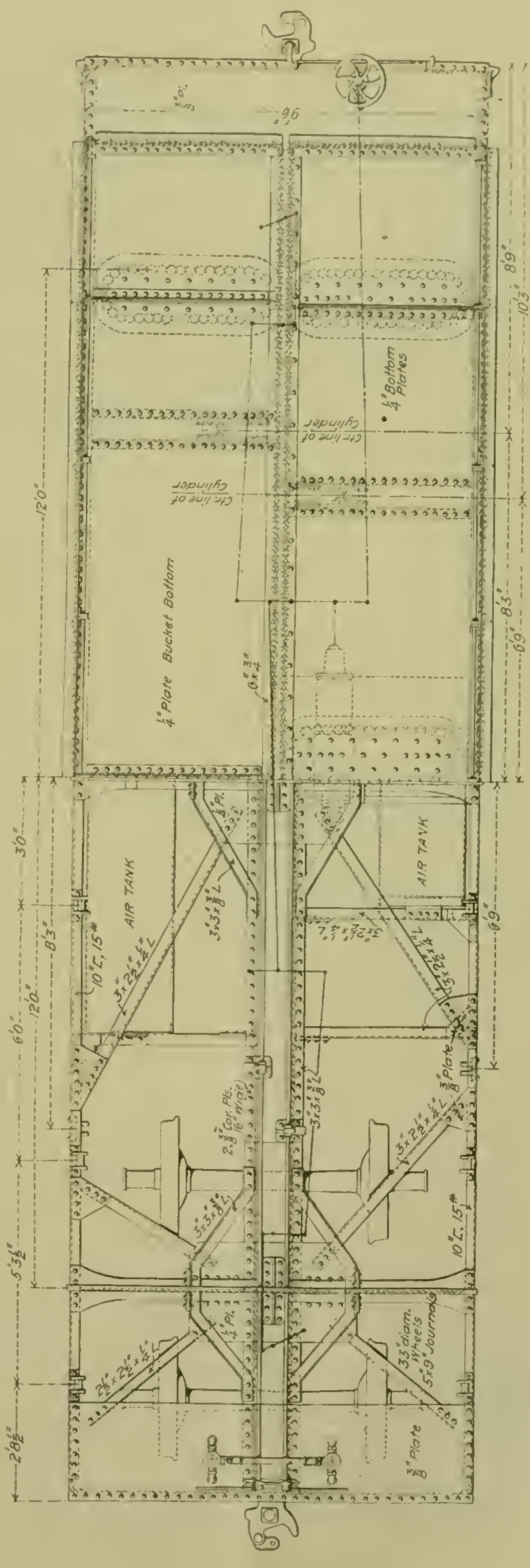
THE LAWSON IMPROVED DUMPING CAR.

This car has passed out of the experimental stage and is ready for service in the exacting work to which equipment of this kind is subjected in handling ballast, ore and other material which must be loaded conveniently and unloaded quickly. Severe service tests have demonstrated its satisfactory operation and orders have been placed for a number of cars to be built by the Middletown Car Works.

The Lawson car carries its load in two long, plate steel boxes, each having a cubical capacity of about 415 cu. ft. When these are in the loading position they rest upon three cast steel transverse supports which are provided with ball races. In dumping, compressed air is admitted to oscillating cylinders, two for each box, which first slide the box toward the side of the car and then tilt it to dump out the load through the side doors, which are automatically unlocked by devices which in operating, pass out of the way of the load



SIDE ELEVATION AND PARTIAL LONGITUDINAL SECTION.



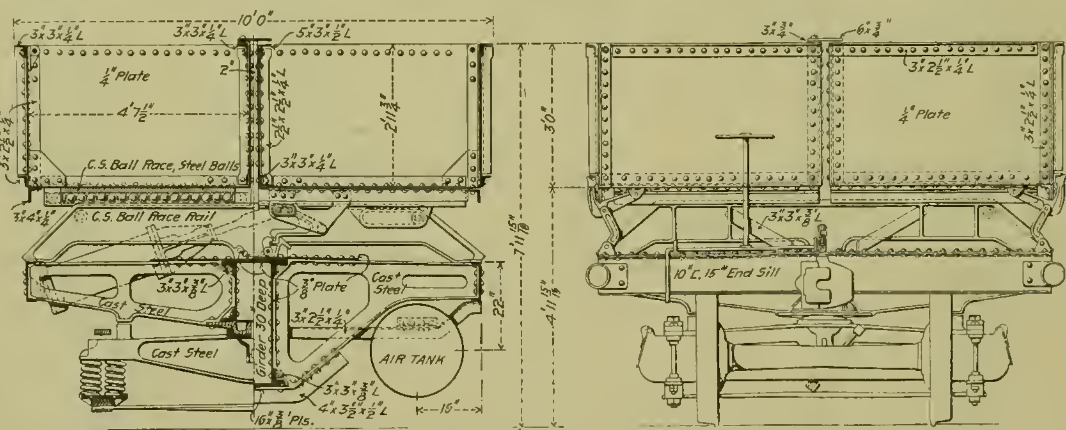
HALF PLAN OF CAR AND UNDERFRAMING.

THE LAWSON IMPROVED DUMPING CAR.

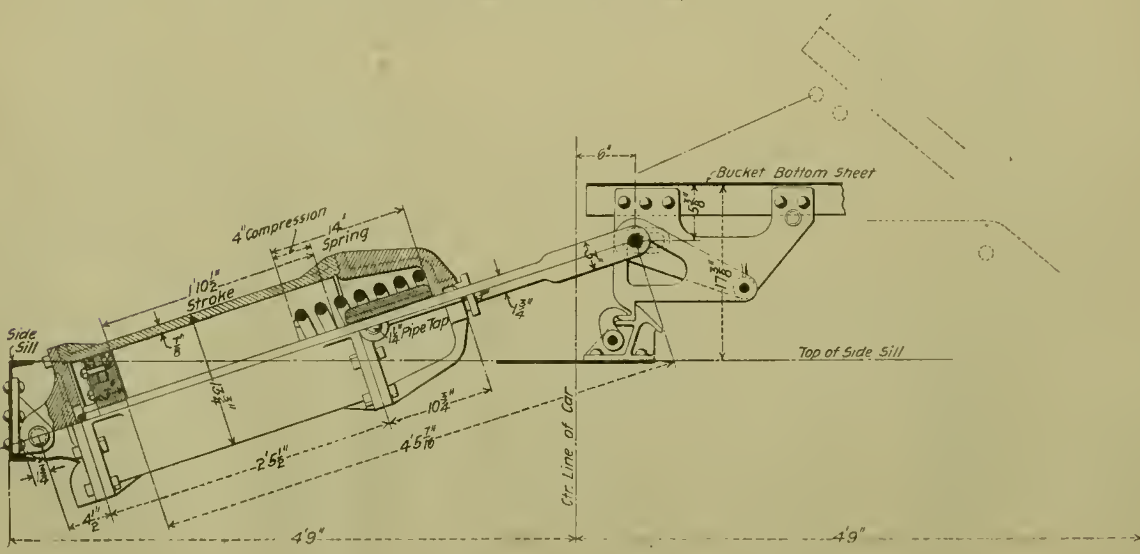
and are protected by the floor of the box. After dumping, the cylinders restore the box to its normal position and the door locks return automatically into position to close the doors tightly and the car is again ready for loading. To accomplish this, a surprisingly small number of parts are required. In fact, it appears to be the simplest mechanism possible to use for such work.

The under frame has a back bone of box girder construction which is 30 ins. deep at the center of the car and tapers toward the body bolsters. The side sills are 10-in. channels and the center and side sills are strongly connected and braced by angles and large gusset plates, as indicated in the plan view. The body and also the truck bolsters are of cast steel, their form being clearly shown in the engravings. In the sectional

LAWSON DUMP CAR WITH BOTH BOXES IN DUMPED POSITION.



END ELEVATION AND CROSS-SECTION, SHOWING BOLSTERS.



DETAIL OF OPERATING CYLINDER AND LATCH.

THE LAWSON IMPROVED DUMPING CAR.

end view of the car the arrangement of the air cylinders and their slotted attachments, also the slotted hinge connections to the boxes are shown.

In order to provide sufficient power for dumping the load with low pressures of air the cylinders are 12 ins. in diameter, which insures sufficient power with air pressure as low as 40 lbs. per sq. in. An air reservoir 24 ins. in diameter by 8 ft. long, gives sufficient supply for four complete operations, even if the hose is uncoupled from the engine. This cylinder connects with the air brake train pipe, and a check valve prevents the reservoir air from passing back into the train pipe. The leading dimensions of the car are given in the accompanying table.

LAWSON DUMPING CAR.

Length over end sills	34 ft.
Length inside of boxes	30 ft.
Height, rail to top of boxes	3 ft.
Height to floor of boxes	5 ft.
Width over side sills	9 ft. 6 ins.
Width of boxes, inside	4 ft. 7½ ins.
Depth of each box	2 ft. 11¾ ins.
Weight of car	50,000 lbs.
Capacity	830 cu. ft., 40 tons

In the photographic side view lattice girders are seen, under the sides of the boxes. These are used to stiffen the floors of the boxes. The construction throughout is very strong, which was done to provide for stresses due to possible rough handling in shaking out a frozen load. To operate the air conveniently the controlling valves are placed upon the platforms at the end of the car. Records of tests are at hand showing that loads of ordinary material have been dumped and the car put into position for loading in 50 seconds. This car, which was recently tested on the Central Railroad of New Jersey, has a capacity of 40 tons. It has been tested with 95,000 lbs. of frozen ore with entirely satisfactory results. Very ingenious locking devices are provided. They lock and hold the sides firmly in place and release automatically when the boxes are raised for dumping. Being operated by linkages, the locks draw away from the door and pass under the floor where they are out of the way of the load. Six of these locks are provided on each side of the car. Additional locks are applied to the air cylinder piston rods to prevent the cylinders from accidental operation. In dumping a load the pistons of the air cylinders are brought up against heavy spiral springs which surround the piston rods and provide a resistance capacity of about 8,000 lbs. in closing 4 ins. This makes it possible to shake out a refractory load and insures clearing all the load.

The writer raised the question of the stability of this car in dumping one side when the other side is empty and was informed that frozen ore has been shaken out of one side under these conditions without raising the wheels on the empty side or otherwise indicating any lack of stability. The details of this design were worked up by the Commonwealth Steel Company and the cars are being built by the Middletown Car Works, Middletown, Pa.

This type of dumping car seems to be the best which has thus far been developed for such work as trestle filling, ballast handling and general construction work. It is highly spoken of by railroad officials who have tested it. Further information may be obtained from the Lawson Improved Dumping Boat & Car Company, 260 West Broadway, New York City.

SOMETHING EVERY RAILROAD SHOULD PROVIDE.

At the Point St. Charles shops of the Grand Trunk Railway at Montreal, Mr. William McWood, superintendent of the car department showed a representative of this journal a reading room and mess room which have been maintained at that point for 46 years. The library receives regularly 93 periodicals and has nearly 11,000 books. The attendance in the reading room last year was 40,500. The Grand Trunk Railway Literary and Scientific Institute is the name of this institution, which is encouraged by the company and assisted by the local officials. Members pay ten cents per month or $1.00 per year for the use of the reading room, astronomical telescope, maps, globes, air brake apparatus sectioned, link and valve motion models, reference library and admission to lectures and classes. Mechanical drawing classes meet twice a week and other classes study the air brake, valve motion, etc. Prizes to the value of $15.00 are given annually to the mechanical drawing class.

The messroom adjoins the library in a building opening into the shop grounds on one side, and near the entrance gate. At one end of the room is a stage for theatrical performances and the room is supplied with long tables and benches. On each side of the room is a large steam oven. Shop men who live at a distance from the works bring their lunches and leave their "dinner pails" at the messroom in the morning. These are placed in the ovens before the noon hour by a regular attendant who keeps the room in order. At noon the men find their lunches hot and ready for them. They enjoy them together at the tables and after 12.30 smoking is allowed. Out of a total of about 2,500 men at these shops an average number of about 500 make daily use of this room, and it is not necessary to dwell upon the advantages to the company derived from this provision of a pleasant, warm and very comfortable room in which to spend an enjoyable hour by those who otherwise would gather in knots of four or five roosting in sundry uncomfortable and not too attractive corners of the shops where the working hours are spent.

The writer was greatly impressed with this simple inexpensive and eminently sensible contribution on the part of the company to the comfort of the men. It is handled in exactly the right way and has been through the test of 46 years. Why does not every railroad do likewise?

PROTECTING COATING FOR AIR BRAKE HOSE.

Deterioration of rubber when exposed to the atmosphere has led to many attempts to secure a satisfactory protection which will keep the air from the rubber and prolong its life by preventing the formation of weather cracks.

The editor of this journal has had his attention drawn to a very promising experiment with a material prepared for this purpose by two gentlemen who have had wide experience in the use of air hose on cars. They applied the material which they made to half the length of a piece of hose and left the other half in its original condition. After exposure to the atmosphere where it was in all kinds of weather for thirty months, the half which was covered with this interesting material was in perfect condition, while the unprotected portion had weather cracks clear through the rubber. The gentlemen referred to state that the cost of this material is low and that they are sure it will absolutely prevent weather cracks in the outside cover of the hose. It will soon be placed on the market, and our readers will be informed of the fact, as this appears to be a very promising development in the protection of air hose.

REDUCED CLEARANCE ON A LOCOMOTIVE.

In connection with the general subject of reducing clearance in locomotive cylinders a circumstance which occurred on a Southern road has been brought to our attention. Some new locomotives were found to be wasteful of fuel and also "logy" and "lame." Indicator cards were taken, and by setting the valves with greatly increased lead the cards were improved. It was found necessary to give ¼-inch lead in full gear to accomplish it, and the engines were not improved as to starting or as to fuel consumption. It was then discovered that the clearance was too great and that a mistake had been made by the builders, in the thickness of the pistons. By increasing the thickness 1 inch and reducing the clearance to about 8 per cent. the trouble was remedied and a material saving in fuel resulted. These engines were burning wood, and the saving amounted to from four to five cords of wood per round trip, where the wood cost $5 per cord.

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

A CRITICAL STUDY OF ROUNDHOUSES.

The subject treated by Mr. R. H. Soule in this issue is of transcendent importance. Because of its influence upon efficient locomotive operation the roundhouse now receives a large amount of attention and the necessity for liberal construction appropriations is becoming appreciated. In his railroad experience Mr. Soule was a leader in roundhouse improvement and he consistently advocates increased head room, large spans of roof, absence of intermediate roof supports, good drop pits, ample natural lighting and adequate shop facilities and tool equipments. In this article will be found a table of dimensions for roundhouses which presents information which locomotive men and civil engineers will both find to be helpful in laying out new roundhouses, and taken as a whole it is believed that no safer guide to practice is available than the discussion contained in this article.

LOCOMOTIVE REPAIR RECORDS.

A Rational System.

In order to operate the mechanical department of a large road in accordance with business principles, it is necessary to know the cost of locomotive repairs at each shop, and to have an intelligent basis for comparing one shop with another. The comparison of the records of one road with another are not now under consideration.

Repair records expressed in cost per mile are almost valueless, because they contain no information as to the amount of work done and they consider heavy and light locomotives on the same basis. No one would for a moment consider paying money out of his own pocket for repairs to a miscellaneous lot of locomotives, doing a variable quantity of work on such an indefinite and obscure basis as the miles made in service. It is too indefinite. Motive power officers must find a better method of expressing their shop performances if they are to meet the need of the times for commercial management of their department.

In this issue is printed a description of a plan for classifying locomotive repairs which is to go into effect on one of the large railroad systems and it is presented in this journal with the conviction that it is one of the most important articles contained in these pages for years. This plan is a step in the direction of commercializing railroad motive power matters, which should be carefully studied and put into effect generally, because it permits of comparing the work of various shops and bringing all up to the standard of the best.

This system is based upon the assumption that the cost of repairs is roughly proportional to the weight of the locomotive and the mileage it makes. The output of a shop is better stated in terms of weight than in number of locomotives of varying weight. The cost is also proportional to the work done by the engines.

Unless the roundhouse or running repairs are also kept on the ton mile basis there is no way of knowing absolutely the proportion of running and shop repairs, but the running repairs may be kept on the ton mile basis also.

INFORMATION.

Two kinds of information are necessary for the successful conduct of any enterprise requiring the concerted efforts of a large organization. Before the plan of operation can be formed information must be had upon which to build the plan and arrange the campaign. This fact is very generally understood and many men know how to begin the management of an enterprise and many who are called to undertake the management of difficult work begin promisingly but fail because they do not appreciate the necessity for another kind of information which is quite as important and quite as necessary as that which forms the basis of the plan. In a large organization the chief officer must necessarily issue instructions. This also is easy, but it is not easy to know positively that the instructions are understood by the subordinates and that they are being carried out. This is the information, the lack or the possession of which determines success or failure of those who manage men.

A military officer who issues the right instructions to his subordinates and then makes sure, through his aids, that they are carried out, is a "genius." He would not be one if he issued the best possible instructions and yet failed to inform himself upon every movement of his forces in order to know how his instructions were being carried out.

The writer recently had an opportunity to watch a very successful railroad officer in the handling of a rather difficult labor question. Every step was based upon information concerning a rapidly changing situation and the affair was concluded with everybody happy. The work was all done by subordinates who acted under his directions, each one carrying out his instructions and reporting the result. This reporting was as vital a factor as the instructions.

In the management of a department of a railroad it is often quite difficult to know whether circulars of instructions are understood and obeyed. It becomes necessary to occasionally revise and change such instructions, and the department chiefs who succeed are those who know either by personal observation, or by some other means, whether the subordinates are doing what is expected of them. On a large road it is impossible for him to know by observation, and it becomes necessary to establish a plan which will take its place. This matter has been referred to before in these columns, but it is sufficiently important to justify repetition.

A superintendent of motive power, who is well known as a successful man, requires his chief clerk to send out, at intervals of three months, a blank form to all the master mechanics and others who have occasion to work under general circulars of instructions. The circulars are numbered as issued, and on these forms each subordinate is required to report the number of the circulars under which he is working and to state that he has just read the instructions and fully understands them. A man making such a report either has just read the circulars and understands them or he prevaricates, for an answer is required from all. This enables the chief to keep a check upon the instructions, it aids him in keeping them up to date and gives him a valuable check upon the part of his work which is controlled and directed in this way. This is a commendable plan, and one which is worthy of wide acceptation and adoption.

These remarks suggest another upon the value of statistics as a help in the administration of a department. There is probably no lack of statistics on any well-managed railroad. It is one thing to secure working statistics and quite another thing to use them. There are various kinds of statistics. Many figures are collected and reported upon blanks, only to be deposited in an imposing array of files, to become dusty additions to dusty collections of preceding files. Others are vital working tools for immediate use and for comparison with other statistics showing whether the curve of efficiency is rising or falling. These are the living figures which indicate how well the instructions are framed for the subordinates and how effectively they are carried out.

Upon the instructions, the knowledge that they are being carried out and their effectiveness when carried out, much of the success of the administration of the department depends.

Specialists who through careful study and experience in management of industrial enterprises are able to modernize the management of manufacturing plants are much in demand today, simply because they understand and are able to put into effect the principles under discussion in these paragraphs.

No branch of mechanical management offers a more favorable field for such effort as the motive power departments of railroads and that officers of these departments are seriously studying these principles is a conspicuous "sign of the times."

An important and significant appointment of a consulting mechanical engineer for the Southern Railway and its allied lines is announced on another page of this issue. In the movement of the past few years toward the concentration of ownership and operation of railroads into large systems there lies an opportunity for great improvements leading to substantial economies through the application of the principles which have contributed in a large way to the financial successes of other industrial combinations. This appointment renders it possible to apply standardizing methods to a large mileage with no harmful possibilities and with promise of large savings which may be secured by using uniform construction for equipment. The owners of large properties are beginning to appreciate the advantages of this policy and a new era is opening in which things relatively small in themselves are becoming large by aggregation and they must be handled in a broad and liberal way. Those who hold the responsibilities for the design of railroad equipment and shops have new problems before them and their work is continually increasing in importance. The care of design and construction of the mechanical equipment of 12,000 miles of railroad is a charge worthy of the best talent, and outside of the management of the operation of the lines and the administration of labor there is scarcely a more important trust than this. It necessarily involves knowledge, experience and business ability which the owners of railroad systems will do well to recognize and encourage.

Mr. W. E. Chester has been appointed general master mechanic of the Central Railroad of Georgia with headquarters at Savannah, Ga. Mr. W H. Fetner has been appointed to succeed Mr. Chester as master mechanic at Macon, Ga.

LOCOMOTIVE REPAIR RECORDS.

ENGINE TON MILES AS A MEASURE OF WORK DONE.

A Rational System.

This article describes a new system which is about to be tried on one of the large railroads. It is considered one of the most important articles appearing in these pages in a long time.—Editor.

UNIFORM SYSTEM OF CLASSIFYING REPAIRS TO LOCOMOTIVES.

The reasons for which a classification was required may be expressed as follows:

First, to ascertain mileage or duration of service to be expected, before requiring further repairs, from engines turned out each month from the various shops, in order to determine the average condition of power and whether same is improving or deteriorating;

Second, to enable a rough comparison to be made of the output of any shop as compared with other shops or with its previous record;

Third, to advise mechanical officers not concerned with the shops of the general condition of the engines when turned out.

In order to intelligently discuss the classification necessary to furnish information to satisfy item 1, it is necessary to explain the system adopted on the various roads for keeping account of the condition of power. On this road this consists of a statement of the general condition of the engines as determined principally by tire wear and the number of month's service which may be expected from them, whereas on the other roads concerned a record is kept of the mileage made by each engine since it last underwent general repairs, or in the case of flues, since flues were last renewed. Knowing the average mileage which may be expected from one general repair to another for machinery and the mileage which is obtained from one renewal of flues to another, the average condition of the power is obtained, by determining the average mileage for all engines or for each class of engines made since last general repair or since last renewal of flues. If this average is above half the mileage which may be expected between general repairs or flue renewals it shows that the condition of power is below normal; if it is below the condition of power it is above normal. At the same time by obtaining the mileage to be expected from engines turned out of shop each month that have had machinery and flue repairs it is possible to ascertain whether the condition of power has been improved or not during that month. Both of these classifications require information in common, therefore, first as to whether an engine turned out of the shop has undergone general repairs or not; secondly, as to whether or not the flues have been renewed.

Previous classifications have depended largely upon two distinctions; first, on whether the engines repaired had light or general repairs to their machinery; secondly, on the amount of boiler work done, whether flues were replaced, new firebox or new boiler applied. So far as the last two items are concerned, they may be ignored by the classification so far as condition of power is concerned. If an engine is turned out of a shop it is presumed that the firebox will be put in sufficiently good condition to continue in service until next shopping. The same remarks apply to the boiler, and if the application of a new boiler alters the design sufficiently to change the class of the engine, all concerned are thus notified.

The above remarks do not apply to any consideration of shop output, but simply to items 1 and 3, and for this purpose the following classification of repairs is proposed:

Class 1 General repairs to machinery.
Class 2 Light repairs to machinery.
Class EH Engine house repairs.
Class A Accident repairs.
Class W Wreck repairs.

And that letter "F" be suffixed to any of the above classes to indicate flues renewed.

The difference between Class 1 and Class 2, repairs can be determined by the superintendent or general foreman at the shop; in general it is intended that if engines are taken in for flues or tire turning, after making 40,000 to 60,000 miles or so, and are given light machinery repairs and not thoroughly overhauled, they are classified as Class 2. Engines shopped after 70,000 or 80,000 miles and receiving a general overhauling are classified as Class 1, indicating that they are put into condition to make fresh mileage on that date, or that they are turned out of the shop in first-class condition. So far as machinery, firebox and boiler work are concerned if an engine has received Class 2F repairs it indicates that it has received light repairs to machinery and that flues have been renewed so that they are ready to run their expected time or for their expected mileage.

Engine house repairs are incidental repairs made in the main shops for the sake of convenience or economy, but which may properly be considered as roundhouse work; as will be seen later, the distinction between these repairs and Class 2 can be left to the decision of the shop or division force on the system proposed without affecting the output of the shop.

Accident repairs are those due to breakage of machinery or other occurrences for which the mechanical department is responsible.

Wreck repairs are those due to collision or derailments, etc., for which the operating department is properly responsible.

Class A and W repairs may of course be combined with Class 1 or 2 and F repairs, if condition of engine justifies it. Thus an engine may receive Class A-1-F repairs, indicating that it was shopped on account of accident, but that condition of engine at that time warranted its undergoing a general overhauling with renewal of flues. The question of the number of flues to be renewed to justify repairs being classified as F should be left to the division force subject to other instructions, but if an engine is reported as F repairs, even if all flues are not replaced, it must be understood that all flues not taken out are in sufficiently good condition to make mileage equal to the new flues which are put in so that flue mileage can be properly started at that shopping.

This classification satisfies the requirements of items 1 and 3, but to afford information as to whether condition of power is improving or not it would be necessary for shops to report mileage made by engines having Class 1 and F repairs turned out each month and on the assumption that these engines will make as good mileage in the future as they have in the past, this figure for each class of engines would determine whether the condition of that class had been improved or not. The mileage reported would of course be the mileage since the previous Class 1 or F repairs.

To satisfy item 2 in which the engines undergoing a certain class of repairs are used as a criterion of shop output a different system must be employed.

Classes EH, A and W repairs are exceedingly variable. The shops are not in control of their expenditures on them and they should be eliminated entirely from any consideration of shop output and be considered separately. This can be done by separating both the output of this class of repairs and its cost each month together with its proper proportion of expense from the remaining output and expenditure at the shop, leaving the balance of cost which may be considered as the equivalent of the output of regular repair work.

Expense for manufacturing work and work done for roundhouses should be separated in the same way from the regular repair work at each shop in considering its output.

Inasmuch as boiler work and machinery repairs are made in different departments these could be subdivided so that a shop would be considered as turning out a certain amount of machinery repairs, renewing a certain number of flues, and applying a certain number of new fireboxes and new boilers each month or period. If preferred flues could be considered as being in sets, but we believe that the better plan would be simply to state that a certain number of flues were renewed. For firebox work the total number of firebox sheets applied in any month should be divided by four to obtain the output of new fireboxes. It is certain that in the case of a shop applying a number of side sheets, or repairing several engines each requiring three or four firebox sheets, that the cost will be considerably higher than if the same number of sheets were applied in completed boxes.

It is difficult to say just how many sheets would on the average represent the cost of a completed firebox were they put in separately, but for the present four sheets may be considered equivalent to one firebox. This arrangement would overcome to a large extent the present discrepancy in the cost of repairs of the same class on the road occasioned by the distinction between an engine having general machinery repairs without firebox work and one having same machinery repairs, but receiving two or three new sheets in the firebox. Even in the classification in which a class of repairs is assigned to, engines having general machinery repairs and one or more firebox sheets, but not a complete firebox, there is a large discrepancy between the costs on account of the variation in the amount of firebox work. The number of new boilers applied can of course be readily arrived at and there does not seem to be any possible way of taking of miscellaneous boiler repairs other than flues or firebox without being too complicated.

This leaves the output of machinery repairs to be considered and in this connection two points of difficulty arise; the first is that for repairs of the same class the cost varies widely dependent on the size of the engine; the second is that repairs of the same class on engines of equal size will represent a large difference in the amount of work to be done. There appear to be two widely different practices in vogue; in the first an engine is brought in after 50,000 to 80,000 miles and undergoes a general overhauling, the work done in the meantime being properly classified as engine house; in the second an engine obtains light repairs after 40,000 to 60,000 miles service and general repairs at 90,000 to 120,000 miles. Without determining as to which of these should be considered the best method it is evident that on an engine obtaining three general repairs in 300,000 miles' service or possibly two in 240,000 miles such a general overhauling will be more expensive than on the engine which obtains four general repairs in 300,000 or three in 240,000 miles service.

In regard to the first question, namely, the variation in cost of a given class of repairs on account of the size of the engine there is but little question that the cost is roughly proportional to the weight of the engine. The cost of material certainly varies almost directly in this proportion and figures which have been investigated indicate that the total cost is, if anything, fully proportional to the weight. The question is really one of whether the number of engines or whether the weight of engines is most nearly proportional to the work done, and as a matter of fact if the cost of repairing a 100-ton engine is more than 140 per cent. of the cost of repairing a 50-ton engine, then the tonnage basis is more accurate than the engine basis; if less of course the engine basis would be more accurate. This practically proves from costs we have obtained that the tonnage basis is the more accurate and should be adopted; in other words that the output of a shop should be measured by the tons of engines turned out rather than by the number. The cost of overhauling engines is certainly also affected by the mileage. It may not be directly so. Thus an engine that has run 70,000 miles may have so much work done on it that it costs as much to repair, as an engine that has run 100,000 miles, but taking this question broadly, the shops are keeping engines in repair year after year and the shop that adopts the best system for taking them in and over a life of 300,000 or 400,000 miles repairs these engines for the minimum cost per mile, is presumably doing the best work. It may be objected that the cost per mile is largely dependent upon the manner in which the engine has been maintained while in service. This is certainly true, but at the same time the work to be done under any classification of repairs is dependent on the same factor. No classification can allow for an engine coming in in good or poor condition on account of its maintenance at the roundhouses and it would appear that the fairest way to measure the output would be by the mileage made by engines repaired. If this is granted, namely, that the output should vary as the mileage made by engines repaired and as their weight then a very simple method of comparison can be employed for machinery repairs. A 100-ton engine that has made 100,000 miles, or multiplying these two amounts together 10,000,000 ton miles of engine repairs may be taken as a unit; and a shop can then be credited as turning out each month a certain number of units of machinery repairs dependent on the number of units that the total sum of the mileage for each engine turned out since last 1 or 2 repairs multiplied by its weight is equivalent to. One of the advantages of this system is that it eliminates all discussion so far as output is concerned as to whether an engine has a Class 2 or Class EH repairs. If a shop chooses to consider an engine that has made 30,000 miles as a Class 2 repairs, it simply loses that amount of credit the next time the engine is shopped; if it calls such a repair Class EH the next time the engine is shopped the output obtains credit for it. Also so far as output is concerned it makes it immaterial as to whether a shop considers an engine receives Class 1 or Class 2 repairs; in either case the shop simply obtains credit for the mileage made since the engine last received repairs of either of these classes.

If this plan is adopted the shop output for any month would therefore be stated somewhat as follows: that a given shop with a certain expenditure of money has turned out say 10 units of machinery repairs, 8,000 flues, four fireboxes, and one boiler. This puts the amount of repairs turned out on a distinct basis irrespective of what class they are, and in the long run will tell not only whether the shop is doing well, but whether the methods employed on that division are good or not.

If this method of dividing output is adopted it would be advisable to put the roundhouse repairs on the same basis, namely their cost per unit of engine ton mile. The engine ton mile is in reality the most accurate unit on which to base cost of repairs. It is practically taking the cost of repairs per mile by classes on the assumption that the cost for each class varies with its weight which, while it may not be actually true, is certainly closer than assuming that the engines of widely different weights cost the same amount for repairs. A statement of the total cost of repairs per unit of engine ton mile would be practically independent of the grades on any division or class of service, since providing engines are loaded to capacity, which can be safely assumed, the work done by them is very closely in direct proportion to the total weight of the engines; in other words an engine of any given weight should cost approximately the same amount to repair per mile, whether employed in passenger or freight service, or on a level or hilly division. If the cost per engine ton mile is known on any division for roundhouse and shop work it would be possible to determine whether that division is doing a greater or less proportion of work in the roundhouses and whether if greater the extra work is compensated for by sufficient decrease in shop cost to produce a smaller total cost and show that it was the better system. It is evident that the proposed system, while simply suggested for machinery repairs as a comparison of output, could be advantageously extended to investigate the relative cost of roundhouse and shop work of various divisions with different proportion of light and heavy engines.

We are strongly impressed with the importance of a unit for judging cost of repairs which enables a comparison to be made of the efficiency of repairs made at shops, regardless of the repairs made at roundhouses.

It is quite probable that the unit of engine ton miles will enable such conclusions to be drawn accurately, but at the same time, with our present lack of experience, it seems probable that the cost of shop repairs to engines per ton would also afford a valuable basis for judging the relative efficiency of shop output; for this reason it seems advisable that for the present at least the cost of general repairs made at shops should be kept on the basis of the ton as well as the basis of the engine ton mile.

The weight of the engines referred to, should be the weight of the engines loaded without tender. The reason for this is that tender repairs cost far less for a given tonnage, than engine repairs do; in fact so far as labor is concerned 100 tons of tender only requires about 10 per cent. of the cost that the 100 tons of engine does. The material item, however, is heavier, so that this would be very closely compensated for by the weight of water in the boiler which can be included in the tonnage.

The second advantage of taking the weight of the engine loaded as a method of measuring tonnage is that the cost per ton mile of engine repaired is obtained and this figure is closely proportional to the work done by the engine when in service, since this work on any division or in any service is, providing the engines are loaded to capacity, which can be safely assumed now-a-days, in direct proportion to the total weight of the engine.

In recapitulation the recommendations are as follows:

First, that to ascertain mileage or duration of service to be expected before requiring further repairs from engines turned out each month from the various shops in order to determine the average condition of power and whether same is improving or deteriorating and to advise mechanical officers not connected with the shop of the general condition of the engines when turned out, that the following classification of repairs be adopted:

Class 1—General repairs to machinery.
Class 2—Light repairs to machinery.
Class EH—Engine house repairs.
Class A—Accident repairs.
Class W—Wreck repairs.

And that letter "F" be suffixed to any of the above classes to indicate flues renewed.

Second—To enable a rough comparison to be made of the output of any shop as compared with other shops or with its previous record, that the expenditure, together with its proper proportion of expenses at each shop on Classes EH, A and W, repairs should be separated from the total expenditure and expenses at that shop and should be considered separately from the regular repair work; and that the expenditure, together with its proper proportion of expenses for manufacturing work and work done for roundhouses, should be separated from total expenses at each shop in each month and be considered separately; the balance of expenditure and expense which may be considered as equivalent to the regular repair output which is to be determined in the following manner:

Third—The flue output is determined by the total number of flues replaced in each month.

Fourth—The output of fireboxes is determined by the total number of firebox sheets renewed, divided by four.

Fifth—The output of boilers is determined by the number of boilers built.

Sixth—The output of machinery repairs is determined by multiplying the loaded weight in tons without tender of each engine turned out, by the mileage it has made since last shopping for Class 1 and Class 2 repairs, and dividing the total of such amounts in each month by 10,000,000 to arrive at the number of units of machinery repairs turned out.

Seventh—That in addition a record be kept of the ton-weight of engines turned out receiving Class 1 and Class 2 repairs.

Eighth—It is advisable that the engine ton-mile basis be extended to roundhouse work in order to indicate whether a greater or less amount of work is done on engines on each division at the roundhouses, and determine the results obtained therefrom both in costs at shop and total cost per engine ton-mile.

By the purchase of the trolley system of street railroads of the city of New Haven, the New York, New Haven & Hartford Railroad adds 110 miles to its electrically operated lines. This gives that system 187 miles of electric lines in Connecticut, or nearly one-third of the total mileage of the electric roads of the State. This purchase is believed to have been made to control the electric railroad situation with respect to preventing a possible through line from New York to Boston by connecting the various trolley roads.

LETTERS TO THE EDITOR.

SUGGESTIONS.

To the Editor:

As a friend of young men, I desire to ask you to print the following hints, which may help some one to be patient while getting started:

"Do not expect a raise in salary every sixty days, but increase your usefulness, and the time will come when you can demand a raise and get it.

"To do a thing well is the first offering on the altar of ambition.

"People who never do any more than they are paid for never are paid for any more than they do.

"Forgetfulness is the cause of many a failure.

"The smart set may be all right, but smartness of the wrong kind destroys your chances with your employer and the public.

"Recognize the fact that the man employing you has some privileges. Let him dictate. You draw your salary and work.

"If you follow out these rules very carefully, you are bound to be a success: Be punctual, be practical, be courteous, be pleasant, be accurate, be thoughtful, be willing, and be hustling.

"Do not despise little things. Remember you must be little before you are big. With bigness comes strength.

"Be pleasant. A kind word or a smile to your associates may secure to you an enduring friend." RETIRED.

NUMBERING SHOP MEN.

To the Editor:

On page 108 of the March issue of the AMERICAN ENGINEER "Foreman" says, "I wish to register a protest and I hope you will put your foot of disapproval down on any system of numbering men as recommended in the article on "Railway Shop Management." I believe this to be the most detestable thing in any shop and will antagonize any intelligent man. Let us devise something to elevate the men instead of lowering them like animals at a county fair."

Now, this is an entirely new feature of the case. It has never occurred to me before that an *intelligent* man would be *antagonized* because he had to call out a number when passing the office of the shop in which he is employed. I had looked upon this as being a rather simple way to give an intelligent man equal opportunity to know that his time was being properly kept.

Of course, I would not want to go before the public with any system of time-keeping and accounting that would include a proposition to "lower men like animals at a county fair," and beg to insure "Foreman" that I am heartily in accord with him in any scheme that will elevate shopmen.

A hollow assertion that certain methods are vicious and antagonistic is not, however, sufficient to induce me to discard a system of numbers; but if "Foreman" has a scheme whereby as good or better results can be obtained than by numbering workmen, and can at the same time show substantial reasons why an intelligent man should be antagonized by calling a number, I think I shall be the first to adopt it.

I suggest here that "Foreman" give in detail what he considers a thorough system of handling the time of railroad shopmen, and also that he sign his name in full and the road by which he is employed.

W. S. COZAN.

RECTANGULAR VS. ROUND ENGINE HOUSES.

To the Editor:

May I profit by the results of your observations abroad to the extent of having your views of the comparative merits of our American roundhouse and accessories, and the rectangular English form served by a transfer table? MECHANICAL ENGINEER.

EDITOR'S NOTE.—English locomotives are usually housed in rectangular "running sheds," which are sometimes served by turntables, and often the turntable is outside. The locomotives stand in long "strings," which are awkward if a locomotive in the middle of a string is wanted in a hurry. American roads should carefully consider the relative advantages of roundhouses and rectangular ones two lines of engines standing on both sides of a transfer table. Where room and track connections permit, it is a question whether it will not pay to build rectangular houses, and provide for turning locomotives on "Y" tracks, or even on turntables outside of the house. During the past severe winter great difficulty has been experienced from fog in roundhouses, due to the frequent opening of a number of doors. A modern house, in which the heating and ventilating system changes the entire volume of air once every fifteen minutes has been a conspicuous offender in this matter, and the fog not only delayed work on the engines, but also caused serious danger of getting engines into the turntable pit when the air was still outside. A plan permitting of reducing the number of doors to one appears to be very attractive, in the light of this experience. Also the matter of crane service in a rectangular house is worth considering. Anything which tends to improve locomotive terminals and to facilitate prompt movement of locomotives between runs is worth a reasonable amount of increased cost.

A SUGGESTION IN CRANES.

To the Editor:

Under ordinary conditions in the up-to-date longitudinal locomotive shop with its two sixty-ton overhead traveling cranes, one of these cranes is usually in the boiler shop, leaving the other to serve the erecting floor, except when engines are to be lifted or traversed across the shop. Furthermore, the sixty ton crane is very heavy, and weighs probably not less than fifty-five tons, and is made for heavy work. In every erecting shop there is a great deal of light lifting; setting a stack, an arch front, a cab, an air pump, etc. For this purpose it would seem that a light electric traveling bracket crane over each side track would be of considerable value, and would avoid many unnecessary waitings, which would otherwise occur when the large crane was busy. Its capacity need not exceed 5,000 lbs., its speed might be high. In a very large shop an operating cage could be provided; otherwise, it could be operated from the floor by cords. A crane of this kind would probably weigh not more than 10,000 lbs. It would not be a tax of much consequence to the power plant, and the added cost to the building on account of the runs or girders would be a very nominal figure.

To provide for such a crane the operator's cage of the large cranes should be in the center of the bridge. But this gives the operator a better command of the floor. If the cages are hung from the outside of the bridge and opposite each other, as I have shown in the accompanying sketch, Fig. 2, an engine will swing between them. Figure 1 shows a half lateral section of such an erecting shop with an engine suspended to show clearances. Fig. 2 is a diagram showing the location of the operator's cages on the sixty ton cranes, and the clearances between a suspended engine and the operator's cages.

L. S. & M. S. Ry., Cleveland, Ohio. MALCOLM HARD.

LOCOMOTIVE FAILURES IN ENGLAND.

To the Editor:

I noticed in the March number of the AMERICAN ENGINEER a statement to the effect that engine failures are regarded as unpardonable sins on English railways, and hence infer that they have very few failures. If this is the case, I should like to know how, in your opinion, they accomplish such results? Is the design of their engines better, or do they get better care, or are the trains enough lighter that their freedom from engine failures can be accounted for in this way?

SUPERINTENDENT OF MOTIVE POWER.

EDITOR'S NOTE.—English locomotives are most carefully designed in all their details. They are better cared for than ours. They are not required to do unreasonable service, and their mileage is not so great as to preclude proper running repairs. The adjustment of the brick arch, deflector over the fire-door, and the front-end appliances, is the work of weeks or months in the case of every new class of engine turned out. The boilers, while small, make plenty of steam without burning up the tubes and sheets, and the locomotive superintendents have sufficient authority to keep their equipment in the best possible condition; in fact, they are required to do so, and the connection between the locomotive department and the stock market is less direct than it is in this country. Further discussion of this subject will be found elsewhere in this issue.

A bill was introduced in the House of Representatives March 3 by Mr. Esch, the purpose of which is to compel railroads to build no passenger equipment cars after January 1, 1906, without steel side and end sills and at least four other steel longitudinal sills extending from end to end of the car, including platforms. The bill also requires steel vestibule and body frames. It was referred to the Committee on Interstate and Foreign Commerce.

BOILER SHOP TOOLS.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

Before Mr. G. R. Hendrson severed his connection with this road as superintendent of motive power, he sent us a copy of a systematic set of rules for boiler work, put into force by him for use of the mechanical superintendents and master mechanics. The rules include lists of equipment for the guidance of mechanical superintendents and master mechanics in ordering the small portable tools and in making recomendations for large machine tools when they are considered necessary. It is not intended that all shops in the several classes shall be equipped with all the machinery in this list, but that when tools are ordered they shall be selected from these.

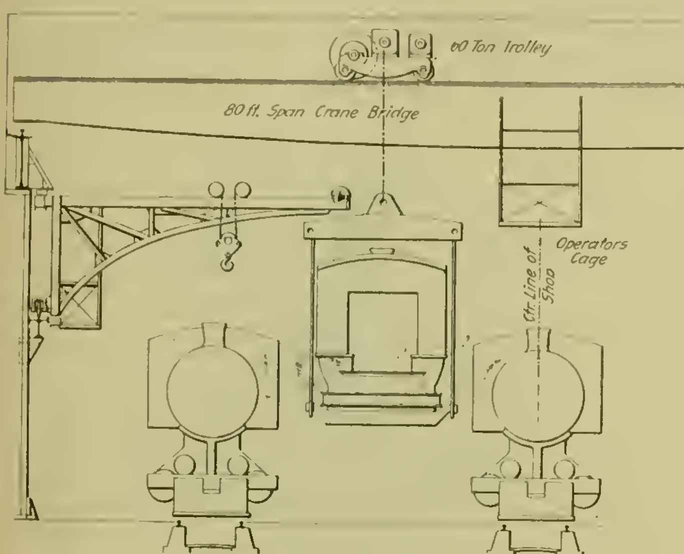


Fig. 1.

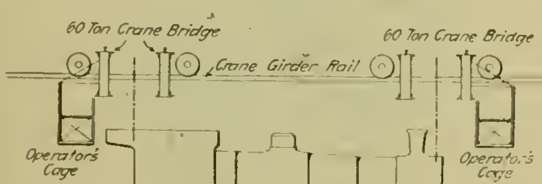


Fig. 2.

A SUGGESTION IN SHOP CRANES.

BOILER SHOP EQUIPMENT FOR DIVISION SHOPS.

With reference to boiler work tools, division shops are divided into three classes according to the work for which they are equipped, and the number of engines cared for. Class A shops do flue setting, light patching, tank repairs, ash pan, grate repairs, etc., for about thirty-five engines. Class B shops do the same as Class A, and in addition renew crown sheets, flue and door sheets, and do general repairs, caring for about seventy-five engines. Class C shops do the same as Class B, and in addition renew fireboxes and do all kinds of general boiler work except building new boilers; the number cared for in this class of shops is about 150.

Class A Boiler Shop Equipment.

Hand punch and shears, for punching 13-16-in. holes in 3/8-in. plate, 20-in. gap, and for shearing 3/8-in. plate.
Hand or power rolls for 3/8-in. plate, 42 ins. between housings.
Small pair of clamps.
Power flue cutter.
Drill press.
Air drill, No. 2 reversible.
Two chipping and caulking hammers, 1 1-16-in. piston, 3-in. stroke.
Taps.
Flue rolls.
Sectional expanders with octagonal pin.
Riveting hammers (hand).
Sledges.
Blower.

Class B Boiler Shop Equipment.

Power punch and shears for punching 1-in. holes in 3/4-in. plates, 36-in. gap, and for shearing 5/8-in. plate.
Radial drill, 5 ft. radius, for drilling 3½-in. holes in flue sheet.
Power rolls 3/4-in. plate, 10 ft. between housings.
Hand or power rolls 3/8-in. plate, 42 ins. between housings.
Pair of clamps, 10 ft.
Flange forge.
Hertz flue welder.
Flue rattler, 54 ins. diameter, 20 ft. long.
Flue welding oil furnace.
Flue cutter.
Emery wheel.
Staybolt threading machine.
Air drill, No. 2 reversible.
Two air drills, No. 11, reversible, with angle attachment.
Long stroke riveting hammer, No. 80.
Four chipping and caulking hammers, 1 1-16-in. piston, 3-in. stroke.
One pneumatic flue cutter.
Taps.
Flue rolls.
Sectional expanders with octagonal pin.
Riveting hammers (hand).
Sledges.
Blower.

Class C Boiler Shop Equipment.

One power punch and shears for punching 1¼-in. holes in 1⅛-in. plate, 54-in. gap, and for shearing 1-in. plate.
One power punch and shears, for punching 1-in. holes in 3/4-in. plate, 42-in. gap, and for shearing 5/8-in. plate.
One power punch for punching 5/8-in. holes in 3/8-in. plate.
One power bevel shears, for 5/8-in. plate.
One power angle iron shears for 4-in. x 4-in. x 3/4-in. angles.
One plate planer for long plates.
One power rolls to roll 1⅛-in. plate, 12 ft. 6 ins. between housings.
One hand or power rolls to roll 3/8-in. plate, 42 ins. between housings.
One power stationary riveter, for 1¼-in. rivets. 12-ft. 6-in. gap.
One radial drill press, 7-ft. radius, for 4-in. holes.
Two radial drill presses, 5-ft. radius.
One small lever drill press for light work.
One triple-head staybolt threading machine.
One double-head staybolt threading machine.
One Hertz flue welder.
One flue rattler, 54 ins. x 20 ft.
Two flue cutters.
Two flue welding oil furnaces.
One emery wheel.
One pneumatic swager.
Two pneumatic punches.
One pair pneumatic clamps, 12 ft. 6 ins.
One flange forge.
One annealing furnace.
One flange punch, 1-in. hole in 7/8-in. plate.
One staybolt clipper.
One staybolt breaker.
One tank riveter.
One truck riveter.
Three oil furnaces for rivets.
One oil separator.
One safe end scarfing machine.
Two air drills, No. 2 reversible.
Four air drills, No. 11 reversible with angle attachment.
Two long stroke riveting hammers, No. 80.
Six chipping and caulking hammers, 1 1-16-in. piston, 3-in. stroke.
Two pneumatic flue cutters with motors.
Taps.
Flue rolls.
Sectional expanders with octagonal pin.
Riveting hammers (hand).
Sledges.
One blower.

Mr. J. R. Slack has been appointed assistant general superintendent of the Delaware & Hudson. Mr. Slack was mechanical engineer of the New York Central and later of the Central Railroad of New Jersey. For the past two years he has been superintendent of motive power of the Delaware & Hudson and is succeeded in that position by Mr. J. H. Manning, recently resigned as second assistant superintendent of rolling stock of the Canadian Pacific.

THE CORRINGTON AIR BRAKE.

This system combines automatic and straight air apparatus in such a way as to maintain each at all times independent of the other, so that while operating one the other may be brought into action if desired. The objects are: (1) to provide continuous control of passenger or freight trains; (2) to render it possible to make smooth stops with a minimum expenditure of air; (3) to avoid the parting of trains and increase the safety on grades by providing apparatus permitting the engineer to release the automatic brakes on the train and retain straight air on the engine while recharging; (4) to render the pumps and reservoirs of both engines available in double-heading; (5) to render it possible for either engineer to control the train and permit either engineer to release his engine brakes in case the tires are heating.

These features are combined in a new consolidated engineer's valve, substituted for the existing valve on the engine, and, in fact, all of the apparatus is made interchangeable with that of existing systems. This company has a triple valve unnecessary the use of the present reversing cock, two feed valves and pipe bracket. The positions and directions of movement of handle for full release, running, service, lap or emergency, with the exception of the position for the extra feed valve mentioned, are precisely the same as in valves of the Westinghouse type. The method of operating the equalizing piston with train line air also differs from, but is precisely equal in efficiency and time to the existing type, and owing to the design of the port leading to the under side of this piston, as shown in Figs. 2 and 3, will not open after an emergency application or a heavy train line reduction when the handle of the brake valve is moved to full release position.

Owing to a special arrangement of ports train line pressure is indicated by the black hand of the duplex gauge when the handle of the brake valve is on lap position.

Referring to Figs. 2 and 3, it will be obvious, excepting for the adjustments of design to suit the triple portion of the consolidated engineer's valve, that main reservoir air has access to, and the train line air from and to, the brake valve in the usual manner. For convenience in double-heading, and in

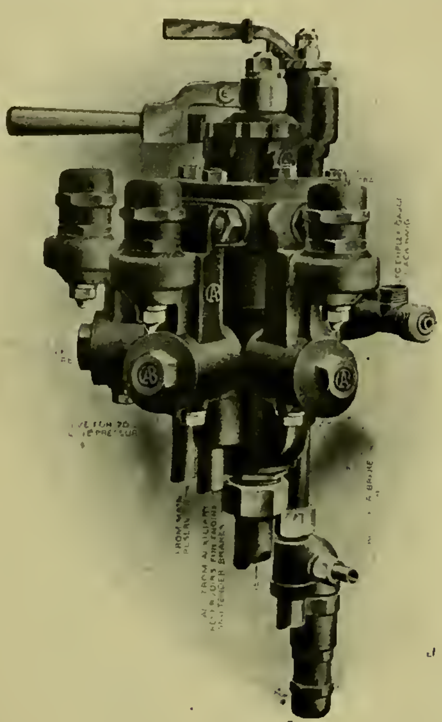


FIG. 1.

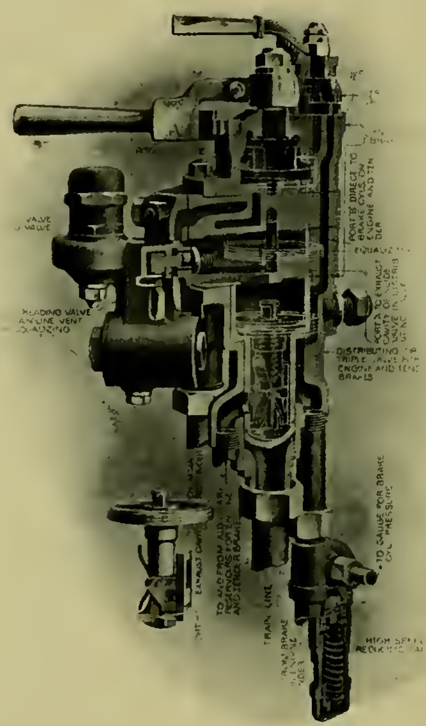


FIG. 2.

venting the train pipe into the atmosphere in emergency applications, a new form of high-speed reducing valve and other devices. The most important is the new engineer's valve, which concentrates a large number of functions into a single device and is designed to give the engineer less rather than more to think about in handling his brakes. This system does away with the necessity for retainers on the cars.

There is but one way to properly study a brake system, and that is to inspect the apparatus as arranged in an exhibit specially installed in connection with a rack of car equipments. A general description of the consolidated valve, however, is presented by aid of the accompanying engravings.

It will be noted by reference to Figs. 1, 2 and 3 that the consolidated engineer's valve includes, in one device, the brake valve, with operating handle, rotary valve, equalizing piston and feed valves; a triple valve, with piston, graduating valve and slide valve; an automatic high-speed reducing valve and a straight air valve, with operating handle, rotary valve and slide valve feed valve, and that the whole is a combination of well-known and thoroughly tested devices.

In the engineer's valve an additional feed valve and running position of the handle is provided, permitting the use of two train line pressures and the possibility of using either according to the position of the operating handle, making order that the automatic features of the brake may be absolutely maintained on the second engine, a small rotary valve is provided at the termination of the outlet of the train line from the equalizing piston. For double-heading it is only necessary to close this valve and place the handle of the brake valve on lap, leaving the triple portion of the consolidated engineer's valve operative from the first engine precisely as though the second engine and tender were a car forming a portion of the train.

While the sequence of operation is precisely similar to the best valves of similar types, owing to design and arrangement of ports and passages, the time required for release and recharge, with the handle in full release position, has been very materially reduced, and this is also true concerning the running position, owing to the size and arrangement of ports and the construction of the slide valve feed valve.

The triple valve portion of the consolidated engineer's valve is identical in principle with plain triples now in use, and it is operated by a reduction or increase in train line pressure through the ports and passages connecting with cylinder and train line, as shown in Figs. 2 and 3. The size of the ports in the slide valve, and in the slide valve bushing, is such as to accommodate in one triple valve the full requirements of the brake cylinders on engine and tender, and in result equal to that obtained by the two triples at present used. The piston, slide valve and graduating valve, as shown in detail in Fig. 2, perform the usual functions, admitting air to the brake and exhausting the brake cylinder pressure to the atmosphere through the cavity in the slide valve, the port A and the straight air valve when in release or normal position, as shown in Figs. 2 and 3. The feed groove for recharging is of sufficient capacity, within the proper time, to recharge the auxiliary reservoirs for the engine and tender brake cylinders, but not sufficiently rapidly to cause a reapplication of the brakes on the engine and tender. For compactness, the graduating stem and spring for use in emergency application is included in the triple piston. The main reservoir, train line, equalizing reservoir and gauge connections, as well as all other pipe connections, are for convenience of cleaning and making repairs, made directly to the triple valve body, making it unnecessary to break any pipe connection for the removal of any portion of the consolidated engineer's valve, and the dimensions from the stud to any of these unions or connections are precisely the same in all respects as the present Westinghouse type of brake valve. Two ¾-inch pipe connections are made to this triple, one leading to the auxiliary reservoirs on the engine, and the other to the brake cylinders on the engine and tender, the latter containing a special fitting for the automatic high-speed valve and gauge connection for brake cylinder pressures.

Fig. 3.

Referring to Figs. 1, 2, and 3 it will be noted that the straight air portion of the consolidated engineer's valve constructively forms a part of the cap, enclosing the rotary valve and key which is enclosed or covered by a separate cap held in place by two studs. This cap is provided with an index plate containing notches indicating the release, normal, lap and service positions of the operating handle, the relative location of this handle to the brake valve handle being such as to afford easy and prompt operation of either by the engineer with one hand, and without interference.

Referring to Fig. 4, the openings constituting port A, port B, and the exhaust to the atmosphere, are shown in the seat of the straight air rotary valve, the port A being the termination of a direct connection of the exhaust port from the triple valve, and the port B the termination of a direct connection to the triple valve, and the port B the termination of a direct connection to the brake cylinders and service port of the triple valve, as indicated in Fig. 2 in dotted lines and full section respectively. The additional ports shown in Fig. 4, and not specially indicated, and connecting with the cavity in the seat, are provided for the purpose of securing additional area of opening and avoiding excessive movement of the valve. A fourth, or reduced main reservoir air port is provided, being the termination of the reduced main reservoir air passage leading from the special slide valve feed valve, to which main reservoir pressure is supplied from the cap enclosing the rotary valve of the brake valve and through the port C as indicated.

In the release position of the straight air valve both ports A and B are open to the atmosphere. In normal position the port A and the exhaust of the triple are open to the atmosphere. In the lap position all ports are closed. In the service position the reduced main reservoir pressure is admitted into B leading to the brake cylinders. In release position of the handle a warning or alarm port is also opened as a suggestion for returning the valve to the normal position. The normal or release position of the handle of the straight air valve corresponds to what might be termed a running position, and in this position provides a continuous and free outlet to the atmosphere of port A from the exhaust cavity of the slide valve and port of the triple. The necessity for rapid trans-

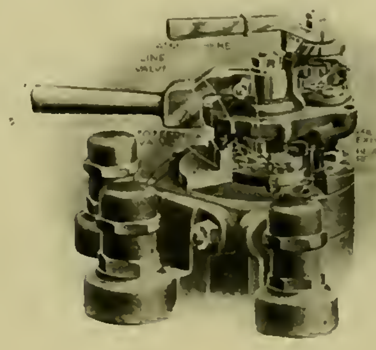


Fig. 4.

mission of air to, and exhaust from the brake cylinders, where straight air is used for switching service, has been anticipated in the areas of ports A and B, both of which form a continuous passage from the brake cylinders when the automatic is not in use, and according to position of straight air valve handle, reducing the time in which this is accomplished by other forms of apparatus.

At the works of the Corrington Air Brake Company at Matteawan, near Fishkill, N. Y., the entire apparatus may be seen in connection with equipments of a 50-car train and chronograph recording devices for studying the action of the brakes.

The importance of the utilization of waste products of manufacturing and metallurgical operations was emphasized some time ago by Mr. Maw in his James Forrest lecture before the Institution of Civil Engineers (England) when he said: "It has been stated by Messrs. Cochrane, as a result of their experience, that the gases from a blast-furnace making 120 tons of Cleveland iron per day are capable, if utilized in a gas-engine, of developing 4,500 h.p. continuously. This corresponds to 37½ h.p. developed continuously for each ton of iron produced per day. Of course, the value of blast-furnace gases for power purposes will vary with the class of ore smelted and other circumstances; but even if we reduce the power available to 30 h.p. per ton of iron made per day, then with our British output of over 20,000 tons of pig-iron per day, we get 600,000 h.p. as capable of being generated continuously by the utilization of our blast-furnace gases, these gases thus replacing a consumption of, say, between 4 and 5 millions of tons of coal per annum."

MOTOR-DRIVEN MACHINE TOOLS.

RECENT TENDENCIES IN INDIVIDUAL LATHE DRIVING.

The important developments that are being made in motor driving, as applied to machine tools, attest the increasing popularity of this mode of machine driving. It is not uncommon now to find shops in which it is difficult to find traces of the former methods of driving machines by overhead belts. The inevitable difficulties and drawbacks of the motor-drive have been revealed by experience and are being provided for, and standard designs for motor-driving applications are being worked out by the tool builders.

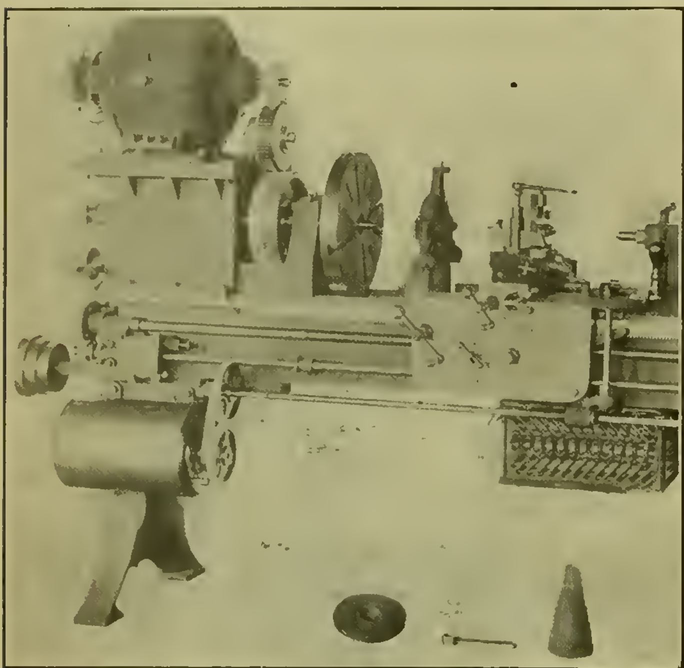


FIG. 1.—GEARED HEADSTOCK DRIVE UPON A 16-INCH BLAISDELL LATHE.— 2 H. P. BROWNING VARIABLE-SPEED MOTOR.

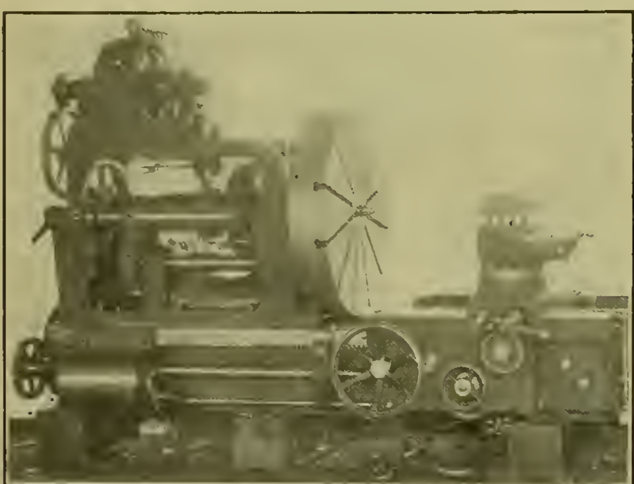


FIG. 2.—GEARED HEADSTOCK DRIVE UPON A 48-INCH POND LATHE.—15 H. P. WESTINGHOUSE MOTOR ARRANGED FOR VARIABLE-SPEEDS.

As an example of the development of standard designs, attention should be called to the case of motor application that was made to the Jones & Lamson flat-turret lathe at the old shops of the Pittsburgh & Lake Erie, for use at their new shops at McKees Rocks, as described on page 89 of the March issue by Mr. R. V. Wright in his series on, "The Application of Individual Motor Drives to Old Tools," part VIII. It was very interesting to note that the Jones & Lamson Machine Company had anticipated the demand for motor driving on their standard designs of turret lathes and had designed a special single-piece motor-support bracket that can be bolted to the headstock of any one of their lathes for carrying the driving motor, as illustrated in detail in the above-mentioned article. This arrangement of drive proved very neat and to be the easiest possible method of adapting the standard type of tool to the individual drive, and indicates the appreciation of the tool builder of the importance of motor driving.

A neat arrangement of motor driving for a lathe has recently been developed by P. Blaisdell & Co., Worcester, Mass., as indicated in the view, Fig. 1. This shows a 16-inch Blaisdell screw-cutting engine lathe, which has been equipped with a 2-H.P. Browning direct-current variable-speed motor. The motor is neatly and conveniently supported by a cast-iron bracket, bolted above the headstock and occupying the usual position of a cone pulley, which is omitted; the drive is carried direct to the spindle by gearing through an intermediate idler pinion, which is of rawhide to reduce noise.

A wide range of speed changes is afforded in this drive by

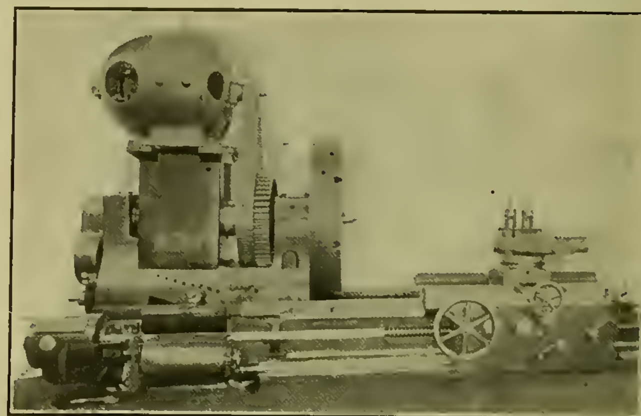


FIG. 3.—SILENT CHAIN HEADSTOCK DRIVE UPON A LODGE AND SHIPLEY LATHE.—CROCKER-WHEELER VARIABLE-SPEED MOTOR.

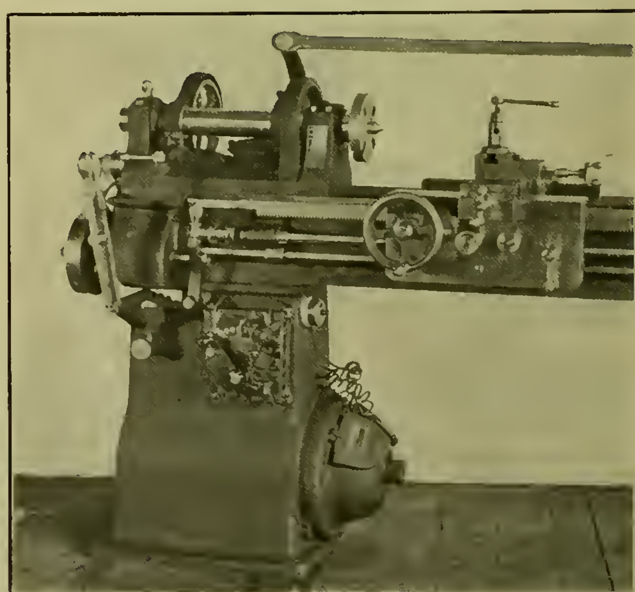


FIG. 4.—INTERESTING NEW DESIGN OF GEARED VARIABLE-SPEED, ENCLOSED DRIVE FOR A LATHE WITH CONSTANT SPEED MOTOR.—FLATHER & COMPANY.

means of the controller, shown beneath the headstock, which is conveniently operated from the lathe's carriage; the controller handle on the apron turns the splined shaft running lengthwise beneath, and this operates the controller through gearing. The resistance box necessary with the controller is placed out of the way beneath the bed, and is protected from short-circuiting troubles by a cover pan.

This is unquestionably a most excellent arrangement of motor application for individual driving. It is especially commendable as it is applicable to standard types of lathes without alteration of their design and the expense of the motor application is thus greatly reduced—this feature, the original cost of applying the drive to a machine tool, has been a great drawback to the general adoption of electrical driving methods.

Fig. 2 illustrates a very similar arrangement of motor driving as applied to a large 48-inch engine lathe, built by the Pond Machine Tool Company. In this case, also the motor is supported above the headstock, but here a skeleton frame is used to support the motor, which spans across the headstock bearings and leaves the headstock gearing open and unobstructed. In place of the usual cone pulley a special gearing arrangement is provided at the spindle by means of which six changes of speed may be obtained through slip and back gears. The motor drives the spindle gear through a reduction gearing equipped with rawhide pinions for smooth running.

The motor used upon this lathe is a 15-H.P. Westinghouse direct-current variable-speed motor, operated by field-control through a controller. The controller is located upon the bed beneath the headstock, and is manipulated directly from the

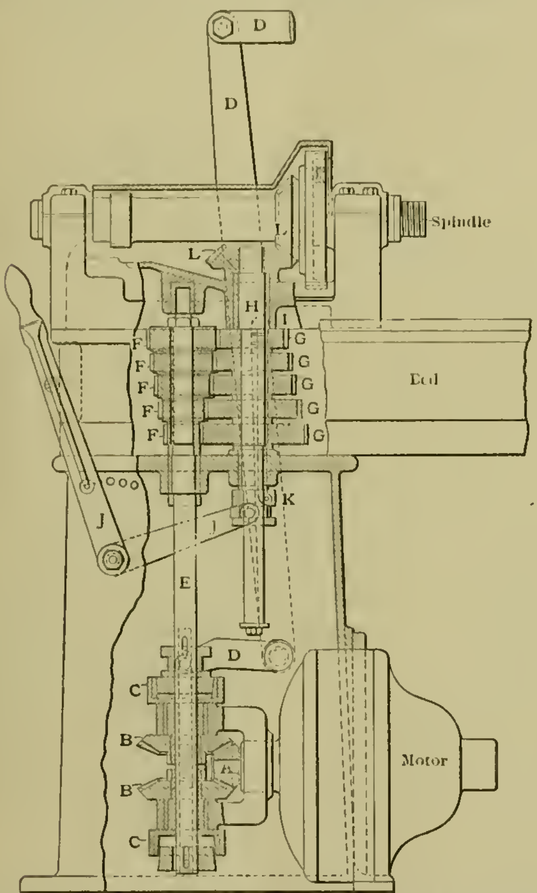


FIG. 5.—DETAILS OF THE VARIABLE-SPEED GEARING AND ARRANGEMENT OF MOTOR IN THE BOX LEG.—THE FLATHER LATHE.

carriage, through the agency of a longitudinal splined rod and sliding bevel gear arrangement, by means of which the handle shown at the right hand edge of the apron actuates the controller. Thus with a 50-per cent. speed control at the motor and six gear changes at the spindle gear, a very flexible arrangement of drive is afforded.

In Fig. 3 is shown another interesting and important motor drive for a large lathe which indicates the general tendency toward mounting the motor above the headstock. This lathe is the heavy model 60-inch lathe, built by the Lodge & Shipley Machine Tool Co., Cincinnati, O., with their special type of headstock and spindle for motor driving. In regard to motor supporting bracket this design resembles that of the application shown in Fig. 1, but here the motor drives through a silent chain. The other features of the drive are very similar to those of the Blaisdell motor-driven lathe, shown in Fig. 1. The motor here used is a 20-H.P. Crocker-Wheeler motor, operating at variable-speeds by the multiple-voltage system; the controller, which is in this case also located in front of the headstock and operated from the carriage, is the standard Crocker-Wheeler multiple-voltage controller by which a 3 to 1 speed range is afforded at the motor.

In Fig. 4 is illustrated a new and radically different design of motor driving for lathes, which is of great importance, as it involves some features which may meet with general adoption for lathe driving. It was designed and built by Flather & Company, Nashua, N. H., and is shown in Figs. 4 and 5 as applied to a 14-inch Flather engine lathe. The neatness and compactness of this drive, as well as its great convenience of operation, have drawn marked attention to it from all sides, and it is worthy of careful attention as being one of the first instances of a lathe designed especially for and made a standard for motor driving.

The motor is, in this arrangement of driving, placed in a box leg beneath the headstock. While in the present case it is shown on the right hand side of the leg, it can be placed at the left, or arranged otherwise equally as well. When placed as shown in this view, a plate is cast in the bed to protect the motor from chips and dirt falling upon it and doing harm; the body of the motor is held firmly in place by means of lugs fastened to it and in turn screwed to the leg, while the inner end fits into a hole bored in the cross ties cast in the leg.

The details of the drive are clearly shown in the sectional view of the headstock and box leg, Fig. 5. On the end of the armature shaft is a rawhide pinion, A, meshing with metal bevel gears, B-B, turning them in opposite directions. These gears are keyed to the friction clutches, C-C, and are connected to either, or disconnected, at will, by the lever D; this lever, which starts, stops and reverses the lathe, has an extension handle running the full length of the bed and is convenient at all times to the operator.

On the upper end of shaft, E, are keyed five metal-flanged rawhide-gears of different diameters, which mesh with five corresponding gears running loosely on shaft, H. These gears are connected to shaft, H, one only at a time, by means of key I, which slides in a keyway cut in the shaft; when this key, I, is moved from gear to gear by means of lever, J, it is depressed flush with the shaft by the collars placed between the gears, G-G. By this means the key must be entirely out of one gear before the springs placed under the key can force it into the keyway in another gear; hence there is absolutely no way by which more than one gear at a time can be connected to the shaft H. On the upper end of shaft H is a bevel gear, L, meshing with a similar gear on the lathe spindle where the cone is usually placed. The back gear is retained and operated as usual.

The lever, J, is very convenient for the operator and can be moved for varying the speed while the lathe is running, giving a quick change instantly, with practically no shock or jar; the starting, stopping and reversal of the drive is most conveniently provided for by the extension handle, D. The lathe has been so designed that nearly any make, speed or style of motor, either direct or alternating current, can be used and thus meet the needs of any class of service. The motor can be removed for inspection without disturbing any other part. The bevel gears have planed teeth which tends to reduce the noise to a minimum, while placing the motor in this way as low as possible, prevents any swaying or vibration.

As above stated, this design of motor driving merits careful attention of those interested in this important subject, as it accomplishes several important things that the other styles of drive do not. In the first place, the motor is unobtrusively placed below the bed in an unoccupied space, which not only eliminates the possibility of vibration, but also leaves the headstock free and open for inspection and care; in the second place, the drive is thus made enclosed and entirely protected, and instead of losing in convenience of operation its flexibility is greatly increased—and without undue complication. The objection that has been offered to this arrangement of driving, that only certain types of motors may be used is useless, as it can easily be arranged for any modern enclosed-type of motor, whether for direct or alternating current. This design is indeed an important innovation in the field of motor driving and offers many new ideas.

THE CARD INDEX IN THE DRAFTING ROOM.

BY J. H. LONIE.

The card index system now occupies an established place in commercial and professional offices. One of the places where it can be employed to the best advantage is the railroad draughting room. Much valuable time is often unnecessarily wasted in searching for drawings or prints which, were they properly indexed, could be located in a few minutes. The card index system, by reason of its simplicity, accessibility and expansibility, is especially adapted to this work. It will be found impossible to so apportion a series of numbers in a book that each drawing will be listed in its proper place, while in the card system they may always be listed in alphabetical order.

An outfit for this work may be purchased from any stationery dealer. As many persons will handle these cards it is desirable to have some form of locking device to avoid the danger of a spill. A tinted card is preferable to a white one,

FRAME, TENDER.

1352—G	Class 7, 7 B
1377—G	Class 24 A, 25 A, 25 B, 25 E
1750—G	Steel, 33-in. wheels
1357—G	Class 25 A, 25 B, 25 C
Cancelled	See 1743—G

as it is not so easily soiled by constant handling. Any desired size of card may be used. In the drawing room of the road with which the writer is connected (the Chicago, Rock Island & Pacific), a plain card 4 by 6 ins., perforated at the bottom for the locking rod, is used. If the office typewriter is equipped with a card writing attachment these cards may all be written upon it and a very neat record be made. Each drawing may be listed on a separate card or several drawings of the same part for different classes of cars or locomotives may be listed on the same card. The latter method has the advantage that it keeps the index more compact, but not more tnan six or eight drawing numbers should be placed on one card. If the latter method is used a space should always be left between lines upon which to enter any additional information relative to the drawing. If it is cancelled, for example, this information should be entered upon the card, together with a reference to the new drawing. It will often be found

1434—C.

Party.	Date.	Party.	Date.	Party.	Date.
G. Hess	1-14-03				
A. E. McL.	1-22-03				
J. B. K.	2-2-03				
J. B. K.	2-4-03				
A. McC.	2-7-03				
C. W. Larner	2-17-03				

necessary or advisable to list a drawing showing several pieces, under two or more heads. In that case a letter or letters showing under what additional heads the number may be found should follow the title. This will aid very materially in making records of cancellation, etc. In general it is desirable, for simplicity, to have the drawing number appear on as few cards as possible, but a liberal use of cross cards is recommended. Many parts of cars and locomotives are known by different names and it is not desirable to list these parts for each class under all these heads. Here again the cross card comes to the rescue. Take, for instance, the "fountain" of a locomotive. This is known as the "steam stand," "piano box," etc. This may be indexed under one head as "Fountain" and cross cards reading "Steam Stand," see "Fountain," etc., be made out and filed in their proper order. No definite rule can be given regarding headings, but, in general, the noun should govern. As an example, driving axles, engine and tender truck axles, etc., should all be indexed under Axles, and cross cards may be filed under D, E, etc. If only one person were to use the index an extended use of cross cards would not be necessary, but it must be borne in mind that every person in the office will have occasion to consult it.

If the cards for engine, car and miscellaneous drawings, foreign prints, etc., are all filed together it will be necessary to go through a considerable number to find the one sought. A better plan is to have a drawer for each. Guides (i. e., heavier cards with a part projecting above the common ones) should be used, not only for the alphabet, but for subjects as well. These will save considerable time, as by their use it will be necessary to go through only a few cards each time a drawing is wanted.

The card system can be applied with equal facility to the keeping of pattern and blue print records. Patterns are indexed in the same manner as the drawings, with the exception that in adition to the pattern number the number of the drawing on which it is shown, if any exists, is also given. For the blue print record a ruled card is used. At the top is placed the drawing number. The initials of the party to whom the print is sent appear in the first column and the date in the second. If receipts are required for prints the date of the receipt may be placed in the first column under the first date, or in a third column, as preferred. These cards may be used on both sides. They show at a glance a complete record of all prints made from a drawing.

Closely allied with the subject of indexing is that of numbering and filing drawings. It will be found difficult, if not impossible, to so assign a series of numbers that the series will be properly filled. Either not enough numbers will be assigned or many vacant spaces will be left. In the former case it will be necessary to assign a new series or to start the series over again, using a letter either before or after the number. This is likely to lead to confusion, as there will be two or more drawings of the same number distinguished in the index only by the letter. One of the simplest systems is to number drawings consecutively as made, regardless of size or subject. The sizes may be designated as "A," "B," "C," etc., and the letter added or prefixed to the number. All drawings of the same size are then filed in numerical order in a shallow drawer or drawers suitably arranged and marked on the outside with the size and inclusive numbers. The compartments may also have the inclusive numbers conspicuously placed upon them. With this system no reference need be made in the index to drawers and compartments or set numbers, and if at any time a change is made in the filing no change whatever need be made in the index.

By a conclusive vote the American Society of Civil Engineers has declined to join the other engineering societies in the union engineering building made possible by the generosity of Mr. Carnegie. This action stamps this society as exclusive, fearing the loss of prestige by contact with equally important organizations by uniting in establishing quarters in the same building. Notwithstanding the disappointing result of the vote the union engineering building will still be the center of engineering of this country.

In the equalization of 2-6-2, or Prairie type locomotives it has been discovered that difficulties have, in certain cases developed. In certain cases it has been found that derailments of the forward drivers have occured when these drivers and the leading truck have been equalized together and the two rear pairs of drivers and the trailing wheels have formed the other unit. By changing the hanging so that the front truck and the first two pairs of drivers are in one group with the rear drivers and trailers in another, the difficulty has been removed. This suggests the advisability of careful study of the equalization of this type.

A LOCOMOTIVE WHEEL LATHE RECORD.

A Very Efficient Performance.

One lathe in the shops of the Chicago & Great Western Railway turns all of the tires of all of the engines in service on that road, and the performance is so efficient that Mr. Van Alstyne, superintendent of motive power, has been asked to supply the information for the readers of this journal.

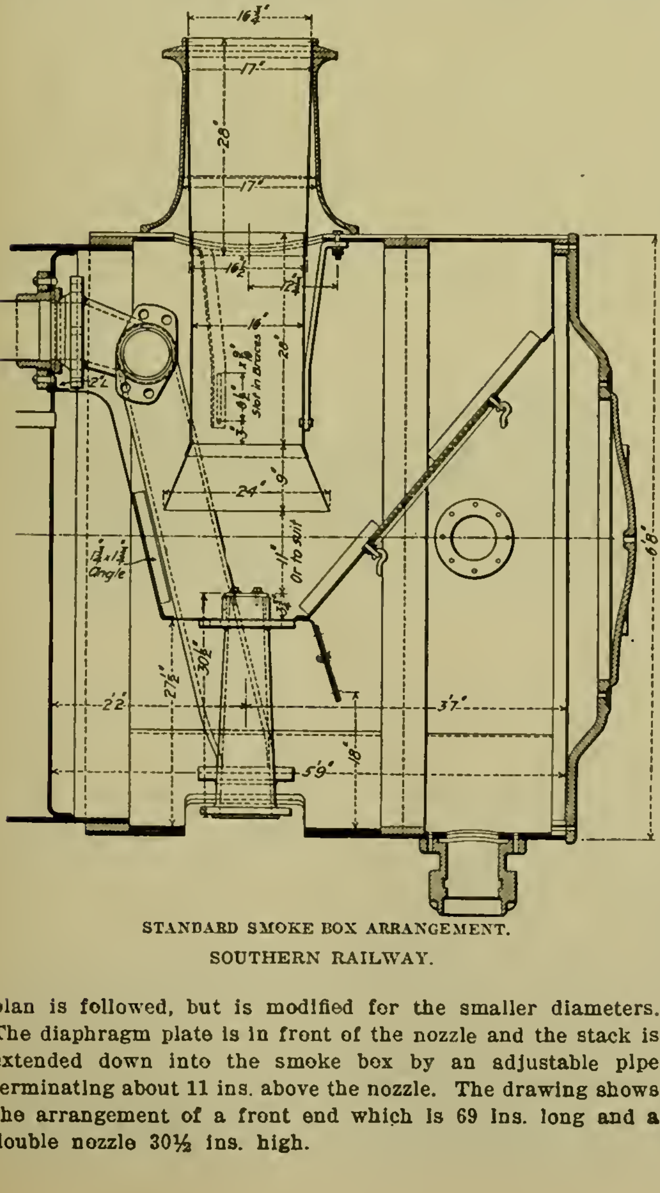
This lathe maintains the tires on 287 locomotives, or 768 pairs of tires, which made in 1893, 8,385,354 miles. It is an 84-in. Niles, double-head wheel lathe, and the cutting speed varies, according to the tires, from 25 to 30 ft. per minute. With Novo and Allen tool steel the cuts are ⅜ in. deep and the feed is 3-32 in. These tires are of the Standard, Midvale and Latrobe makes, and the work regularly turned out averages three pairs of tires per day, with 56-in. centers. The power required is about 15 horsepower.

If others can show records which equal or surpass this, space will be gladly found in this journal to record the facts.

STANDARD SMOKE BOX ARRANGEMENT.

Southern Railway.

A standard arrangement of smoke boxes on 22 by 30 ins. locomotives of the 2-8-0 (consolidation) type on the Southern Railway is illustrated in the accompanying drawing recently received from Mr. S. Higgins, mechanical superintendent of that road. This arrangement is shown as adapted to smoke boxes 80 ins. in diameter, and for smaller engines the same

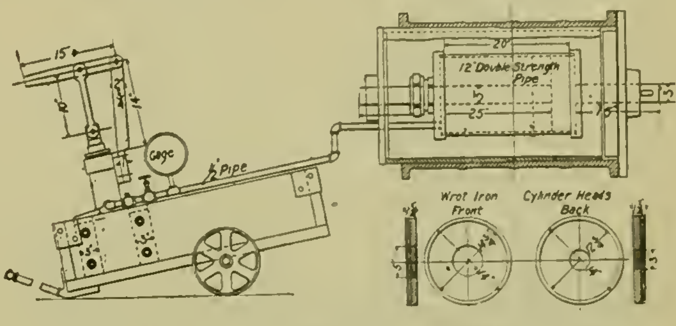


STANDARD SMOKE BOX ARRANGEMENT. SOUTHERN RAILWAY.

plan is followed, but is modified for the smaller diameters. The diaphragm plate is in front of the nozzle and the stack is extended down into the smoke box by an adjustable pipe terminating about 11 ins. above the nozzle. The drawing shows the arrangement of a front end which is 69 ins. long and a double nozzle 30½ ins. high.

HYDRAULIC PRESS FOR CYLINDER BUSHINGS.

A sketch of a convenient, portable, hydraulic press for drawing cylinder bushings into place has been received from Mr. R. D. Smith, superintendent motive power of the Burlington & Missouri River Railroad. It is in use in all the locomotive shops on that road and is found to be infinitely more satisfactory and convenient than the crude methods of expanding the cylinder by inserting a red hot billet. In the first place, a hot chunk of metal is inconvenient to handle, several men are usually waiting about for it to heat up, the cylinder is always expanded in such a way as to distort its shape, and the process of inserting a bushing partakes of the character of



PORTABLE HYDRAULIC PRESS FOR CYLINDER BUSHINGS.

the job of shrinking jackets on modern ordnance. The troubles are all avoided by the use of this press, which may be wheeled to the engine in the shop or roundhouse. The pulling cylinder is inserted in the cylinder of the locomotive, the bushing is placed in position, the pipes being connected and the keys driven in the piston rod and the pump started. Water for the pump is carried in the tank on which the pump is mounted and the cylinder goes into place without the least trouble. The accompanying engraving shows the bushing when nearly "home" in the locomotive cylinder. All the material may be picked up in any shop and the practice of bushing cylinders is now so common as to warrant the construction of similar devices for use in all shops and roundhouses.

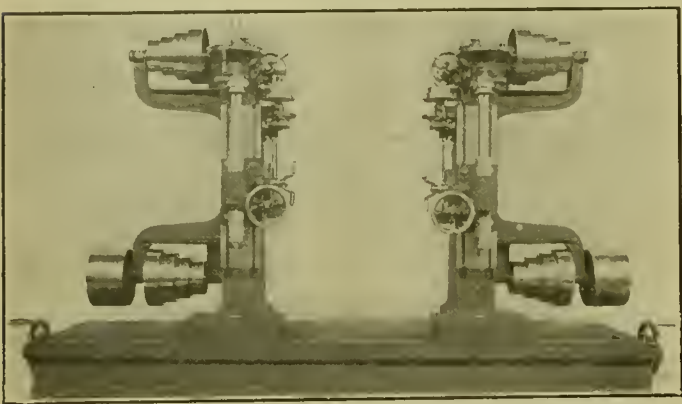
Mountain grade work naturally develops expert handling of the air brake. The writer recently rode in the rear car of an eleven-car passenger train from Yampai, Arizona, to Needles, California, and did not once feel the brakes go on or off. The distance is 126 miles and the difference in elevation is 107 ft. less than one mile. The engineers on the Santa Fe who do this regularly, every day, deserve most prominent mention of their work.

In that section air brake failures are unheard of. No chances are taken. The Santa Fe will accept a freight car without brakes, but these cars are piped before being switched into trains. The yards near mountain grades are all equipped with air piping and near at hand is an engineer's valve in the cabin of the air brake inspectors. A through freight arriving in one of these yards is stretched from the rear end by the hand brakes and is stopped by the engineer with a 20-lb. reduction. This sets the brakes hard and the road engine leaves the train ready for the inspectors. Four men inspect the train. Two start at each end at opposite sides and work toward the center. They make the usual inspection of trucks and wheels and also of the brakes, noting carefully the piston travel. A fifth man follows them and makes adjustments and replacements in accordance with the chalk marks of the inspectors. When through, the train is tested and defective triples and other parts are replaced. All this is done in about twenty minutes. The triples are cleaned and tested by the repairman, between trains, and those requiring repairs are sent to the shops. These inspectors are intelligent men and are encouraged by the officers of the company by promotion.

A NEW DOUBLE BORING MACHINE.

For Boring Locomotive Connecting Rods.

The accompanying half tone illustrates a new design of double boring machine that Prentice Bros. Co., Worcester, Mass., have recently developed for the simultaneous boring of both ends of a locomotive connecting rod at one setting of the rod upon the table. This is a special tool and has a wide field of usefulness, both with the locomotive builders and at large locomotive repair shops. Its important details are worthy of note.



THE NEW PRENTICE DOUBLE BORING MACHINE FOR SIMULTANEOUSLY BORING BOTH ENDS OF LOCOMOTIVE CONNECTING RODS.

This tool consists of two complete and independently driven drilling machines, mounted upon a heavy base and having lateral adjustment thereon, as shown. The head of each machine is adjustable upon its upright and each spindle is amply counterweighted to provide for heavy boring bars. Each base is bored for a bushing to support and guide the boring bar. Each machine has an oil pump and the necessary piping for delivering oil in steady flow through the spindle and the subbase has a deep trough around the edge to catch the oil.

Each head is provided with the usual hand and power feeds, and also the well-known Prentice improved quick return and stop motion, which permits the spindle to be quick returned or approached with power feeding, and the point of the boring tool to be brought to the work and power feed thrown in by the same lever, while the machine is in operation. The drive has eight changes of speed by means of the 4-step cones and back gears, and four changes of feed are provided. The remaining important features and dimensions are presented in the following table:

SPECIFICATIONS.

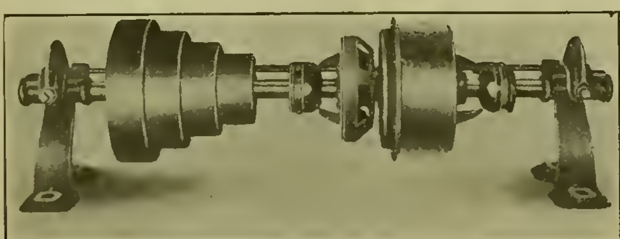
Capacity	12-in. holes in each end of a connecting rod
Spacing of holes	From 32 ins. to 126 ins. between centers
Maximum distance, spindles to bases	33 ins.
Minimum distance, spindles to bases	5 ins.
Traverse of spindles	13 ins.
Diameter of spindle in sleeve	2¾ ins.
Nose of spindle	3⅛ ins.
Total ratio of driving gearing	1 to 20; of back gears, 1 to 5
Height of tool, over all	8 ft. 9 ins.
Floor space	13 ft. x 4 ft.
Weight	17,500 lbs.

THE SMITH ONE-BELT REVERSING COUNTERSHAFT.

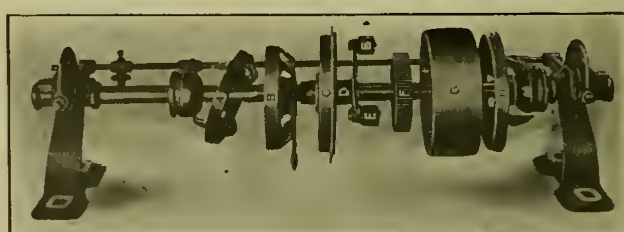
The Smith Countershaft Company.

A novelty in a countershaft for driving machine tools and other machinery from main line shafts is being introduced by the Smith Countershaft Company, Melrose, Mass. This new type of countershaft is illustrated in the two accompanying illustrations, one of which shows the speed cone removed and parts opened out to view.

The important feature of this new device is that it obviates the use of two belts, one straight and the other crossed, for the reversing feature, as is commonly resorted to in the usual types of countershaft. A single driving pulley is used, pulley G in the detail view, and the gears are used only for reversing. Its operation, however, does not differ from that of the ordinary counter shaft, as by moving the shipper handle in one direction, the forward motion is obtained and, in the other direction, the reverse motion.



THE NEW SMITH SINGLE BELT REVERSING COUNTERSHAFT.



UNASSEMBLED VIEW OF PARTS OF THE SMITH SINGLE BELT REVERSING COUNTERSHAFT.

The principle of operation of the mechanism may be understood by reference to the detail view: The driving pulley G turns loosely upon the shaft, unless clutched by friction plate, H, which is drawn against its right hand side for forward motion. The reverse motion is obtained through the special gear arrangement within pulley G.

This gear mechanism consists of the three pinions, E-E, which are mounted upon a strong spider, D, and mesh with both gear, F, and the internal gear, I, cut inside the rim of pulley, G. Gear, F, is keyed rigidly to the shaft and when spider, D, and pulley, G, are brought into position they enclose it and mesh exactly. The friction ring B is held stationary at all times, the hub of the spider running freely in it. The friction cone A is threaded to the hub of the spider D and is capable of being clutched to the ring B, thus holding the spider stationary and giving the reverse drive. The friction ring, B is held stationary and prevented from revolving.

For reverse motion, the process is as follows: The shipper handle is thrown so as to engage friction ring, A, with frame, B, which stops ring, A, and thus spider, D, from revolving; then with pulley, G, in motion as usual, and pinions, E-E, held stationary, gear, F, and consequently the shaft are given a reverse motion at a speed similar to pulley G; the countershaft will run faster backwards than forwards, the internal gear being the driver and the spur the driven member.

This principle of planetary gears which is made use of is well known and has been well tried for such work as this; this application is quick acting and efficient, and the use of the friction clutches makes the starting and stopping action smooth. The gears, E E, are fiber pinions, cut to mesh accurately with both gear, F, and the internal gear, I, and thus in reverse motion the mechanism causes a minimum of noise.

The most important feature of this countershaft is to be found in the reduction by 50 per cent of belts and pulleys required; for the belt maintenance of a large railroad shop this would be an item of considerable importance. The additional room that is made available upon the main line shaft is also an item of considerable importance, as it permits more machines to be placed in a shop per unit of main line shaft length. Also the reduction of extra belts and pulleys actually makes this new countershaft cheaper and easier to install than the older style. The makers, the Smith Countershaft Company, will be pleased to give further information to anyone interested upon request.

PASSENGER LOCOMOTIVE FOR THE VANDALIA.

4—4—2 (ATLANTIC) TYPE.

Four passenger locomotives for this road have just been delivered from the Schenectady works of the American Locomotive Company. These are heavy engines, weighing 179,444 lbs., with 109,500 lbs. on driving wheels. This is the most remarkable feature of the design, as a weight of 27,375 lbs. per wheel is the greatest driving wheel load in our record of locomotives. This even exceeds the practice of the Pennsylvania Railroad in the Class E 2 and E 2a engines, which have 109,033 and 109,000 lbs. on drivers, respectively. The Vandalia engines have 9½ by 13 ins. driving journals, and the details show unusual care, especially in the valve motion, where the links and motion pins are made to give a straight pull and thrust to the connections. These engines have boilers 70⅝ ins. in diameter, which is one of the largest ever put into a passenger engine. But the heating surface is 3,100 sq. ft., which is in line with the tendency toward sacrificing a few tubes for the purpose of securing good circulation space between them. These boilers have 351 2-in. tubes with 13-16 in. vertical spaces between them. Water spaces of 4 ins. are provided all around at the mud ring. In the accompanying tables the usual dimensions and ratios are presented:

PASSENGER LOCOMOTIVE 4-4-2 TYPE VANDALIA LINE.
W. C. Arp, Superintendent Motive Power. AMERICAN LOCOMOTIVE COMPANY, *Schenectady Works, Builders.*

RATIOS.

Heating surface to cylinder volume	= 298.00
Tractive weight to heating surface	= 35.36
Tractive weight to tractive effort	= 4.43
Tractive effort to heating surface	= 7.97
Heating surface to grate area	= 61.8
Heating surface to tractive effort	= 12.8%
Total weight to heating surface	= 57.7

GENERAL DIMENSIONS.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal
Weight in working order	179,000 lbs.
Weight on drivers	109,500 lbs.
Weight engine and tender in working order	321,820 lbs.
Wheel base, driving	7 ft.
Wheel base, rigid	16 ft. 6 ins.
Wheel base, total	27 ft. 3 ins.
Wheel base, total, engine and tender	57 ft. 10¾ ins.

CYLINDERS.

Diameter of cylinders	21 ins.
Stroke of piston	26 ins.
Horizontal thickness of piston	5¾ ins.
Diameter of piston rod	3¾ ins.
Kind of piston packing	Cast-iron rings
Kind of piston-rod packing	U. S. metallic
Size of steam ports	18 x 1⅝ ins.
Size of exhaust ports	18 x 3 ins.
Size of bridges	1⅜ ins.

VALVES.

Kind of slide valves	Allen American
Greatest travel of slide valves	6 ins.
Outside lap of slide valves	1 in.
Inside lap of slide valves	Line and line inside
Lead of valves in full gear:	1-16 in. negative lead, both front and back motion
Kind of valve-stem packing	U. S. metallic

WHEELS, ETC.

Number of driving wheels	4
Diameter of driving wheels outside of tire	79 ins.
Material of driving-wheel centers	Cast steel
Thickness of tire	3½ ins.
Driving-box material	Cast steel
Diameter and length of driving journals	9½ ins. diameter x 13 ins.
Diameter and length of main crankpin journals:	(Main side, 7 ins. x 4¼ ins.) 6½ ins. diameter x 7 ins.
Diameter and length of side-rod crankpin journals:	Front, 5 ins. diameter x 3¾ ins.
Engine-truck journals	6 ins. diameter x 10 ins.
Diameter of engine-truck wheels	36 ins.

BOILER.

Style	Straight top, radial stays
Inside diameter of first ring	70⅝ ins.
Working pressure	200 lbs.
Thickness of plates in barrel and outside of firebox	¾ in., ½ in., ⅝ in.
Firebox, length	96⅛ ins.
Firebox, width	75¼ ins.
Firebox, depth	Front, 80¼ ins.; back, 69 ins.
Firebox plates, thickness:	Sides, ⅜ in.; back, ⅜ ins.; crown, ⅜ ins.; tube sheet, ½ in.
Firebox, water space	Front, 4 and 6 ins.; sides, 4 ins.; back, 4 ins.
Firebox, crown staying	Radial
Firebox, staybolts	Ulster special iron, 1 in. diameter
Tubes, number	351
Tubes, diameter	2 ins.
Tubes, length over tube sheets	16 ft.
Heating surface, tubes	2 923.3 sq. ft.
Heating surface, firebox	177.1 sq. ft.
Heating surface, total	3,100.4 sq. ft.
Grate surface	50.2 sq. ft.
Exhaust nozzles, diameter	5¼, 5½, 5¾ ins.
Smoke stack, inside diameter	16 and 17 ins.
Smoke stack, top above rail	14 ft. 11 9-16 ins.

TENDER.

Style	Water bottom
Weight, empty	56 320 lbs.
Wheels, diameter	36 ins.
Journals, diameter and length	5½ ins diameter x 10 ins.
Wheel base	21 ft. ½ in.
Water capacity	7,500 U. S. gals.
Coal capacity	12 tons

A VISIT TO THE WORKS OF J. G. BRILL COMPANY.

When the business of the J. G. Brill Company, car and truck builders, had outgrown the large plant at 31st and Chestnut streets, eighteen and a half acres of land at 62nd street and Woodland avenue were purchased and much larger shops and buildings erected. That was about fifteen years ago. Since that time, and from time to time, these buildings have been increased in size, several of them have been replaced by larger structures, many new buildings added, and to-day the works are the most complete and best equipped for the building of electric cars and trucks of any in the world.

Passing in at the gate, the visitor sees at the right a large two-story finishing shop with a frontage of 200 ft. and nearly as deep. It contains nearly three-quarters of a mile of railroad tracks, and has a specially designed combination transfer table and elevator electrically operated in a long pit at the front of the building, by means of which the largest cars are quickly placed on any track on either floor. After crossing many tracks filled with cars and trucks ready to be shipped, one approaches the office building at the end of a line of buildings 680 ft. long. The rear doors of the offices open almost at the center of the works, and are very conveniently located for the frequent trips of the officials through the shops. Let us start from this point and passing the stock room for castings and the pattern department, enter the blacksmith shop. At first one sees small furnaces with many men wielding hammers, and is confused by the deafening roar of a multitude of machines. A couple of hundred feet farther, we come upon many one, two, and three thousand-pound steam hammers and heavy "bulldozers." Here some of the side frames of the trucks are forged, and large pieces of ironwork for cars, such as bolsters and trusses are made. Leaving this building, we pick our way among great piles of iron and steel billets to another forge shop, 75 by 160 ft., equipped with heavy steam hammers and 2,000-ton hydraulic presses, where the most intricate large forgings in the world are made—a process of manufacturing side frames for trucks peculiar to this firm. The operation of these enormous presses, and the rapid and carefully trained movements of the gangs of men who handle the bulky pieces of white-hot metal with wonderfully devised derricks, is perhaps the most fascinating of all the wonderful things that are to be seen in this busy hive. In the shop adjoining, a building of equal size to that from which we have just come, are a great variety of the latest types of spring-making machines, which mix their clatter with the roar of oil-burning furnaces.

Next we shall go to the machine shop, a three-story building, 100 by 125 ft., erected during the past year, and enclosing at the rear a chimney stack 175 ft. high, with opening at the top 8 ft. in diameter. The shop is filled with multiple drills, planers, lathes, milling machines, boring mills, turret lathes, and many specially devised automatic machines. The material from the forge shops is bored and finished here; castings are also bored and finished, sheet metal stamped, and dies for the hydraulic presses cut. A part of the first floor is occupied by the engine and pump rooms. A large Corliss engine furnishes 300 h.p. to machinery in the wood mill, and drives two-belted generators, furnishing light and power; a direct-connected 200 KW. unit is driven by a Harrisburg and held in reserve for use, when the belted units are stopped; a Ball engine drives a high-voltage generator which furnishes current for the trolley system of the plant; an arc-light engine and generator furnishes 5,000 volts for 100 lights. The company is changing its entire system from belt to motor-driven machinery, using 25-h.p. motors as standard, and at the present time have four 25-h.p. motors in the machine shop, three in the wood mill, one 50-h.p. motor in the spring shop, four ranging from 15 to 40 h.p. in the blacksmith shop, and others in various departments. A new boiler house at the rear of the machine shop contains a main battery of four return-tubular boilers of 600 h.p. capacity each, and two boilers of 400 h.p. each. Connected with the machine shop by a bridge and a transfer table is the truck-assembling shop, where the heavy parts are handled by pneumatic hoists. This is a three story building, 160 by 60 ft., and includes an axle and wheel-grinding department. An engine room adjoins which furnishes air for the pneumatic hoists and tools. The wood mill, a three-story building, 80 by 180 ft., is connected with the lumber sheds and drying rooms by bridges and a number of trolley lines. Here, as elsewhere, the most improved types of machines are used. A 75-h.p. high-speed Harrisburg engine operates blowers which draw the sawdust and shavings from the machines through a system of piping to two large separators over the boiler room. Crossing a bridge, we find ourselves on the second floor of a building 100 by 140 ft., the first floor of which is used for boxing cars and large pieces of material.

Before going to the erecting shops, we will look in at the door of the bending house, a two-story building, 120 ft. long. The wood is steamed in tanks of various sizes, after which the pieces are clamped to forms and placed in drying rooms. Returning between the wood mill and packing shop, taking care not to get in the way of a traveling crane which extends the entire length of these buildings, we cross the tracks of a transfer table which runs for 340 ft. between the machine shop, wood mill, and packing shops, and a long section of erecting shops. In the first erecting shop we enter, we see car sills being put together with cross members and tie-rods, and covered with flooring. This comprises the bottom framing, which as soon as completed, is mounted on shop trucks and commences its journey which ends when the completed car rests on its own trucks in the finishing shop. In the next shops the side posts are set up, the ends built in, and the roofs put in place. Those who know nothing of car building can have but a faint conception of the framed skeleton that is between the panels and sheathing and the finished woodwork. As lightness is essential in an electric car body, and as it is not uncommon for the body to carry a load twice its own weight, every piece of wood and material is placed in such a manner as to give the greatest possible strength, trusses and tie-rods playing an important part. Leaving this section of the erecting shops, which cover 200 by 320 ft., we cross another transfer table electrically operated over a pit 360 ft. in length, with another section of erecting shops extending the full length of the table, and see cars in every stage of building, from the bare framework to the nearly completed cars. Platforms, vestibules, headlinings, windows, and interior woodwork are installed, and the first coats of paint applied. Following a track which leads from the end of the transfer table around the rear of these buildings, we find ourselves back at the finishing shop whence we started. In this shop the painting, lettering, decorating, and varnishing is done; the seats, heaters, and the rest of the equipment are put in place, and the cars mounted on their trucks. It is interesting to note the large variety of types of cars all of which have their special fitness for the conditions found in those cities whose names are seen on the letter boards: Double-deckers for England, Europe and Mexico; combination open and closed cars for the mild climates of the Pacific coast, South America, South Africa, and elsewhere; convertible cars, whose windows and panels slide up into pockets in the side roofs; semi-convertible cars with large windows which are also stored in roof pockets when not in use; the "Narragansett" type of long open car with its convenient pair of steps at each side, and many others, including sumptuously furnished private cars, powerful electric locomotives, sprinkling cars and sweepers. One is impressed with a large number of cars approximating in size and appearance the finest coaches in steam railway service, and showing the rapid development of interurban electric railroading.

A LARGE HYDRAULIC FORGING PRESS.
AT THE WORKS OF THE J. G. BRILL COMPANY.

Before leaving, the visitor should know about a few departments and other things he has missed—the extensive varnishing rooms, the glazing, upholstering, drafting, and electrical equipment departments, the shipping platforms and wheel sheds, the equipment for fire protection, including an elevated 50,000-gallon reserve tank, and two "Underwriter's" fire pumps, each with a capacity of 1,000 gallons per minute. Tracks from the Pennsylvania and the Baltimore & Ohio lines enter the yards and pass through the principal buildings, and a complete trolley system connects all of the buildings—about six and a half miles of tracks in all.

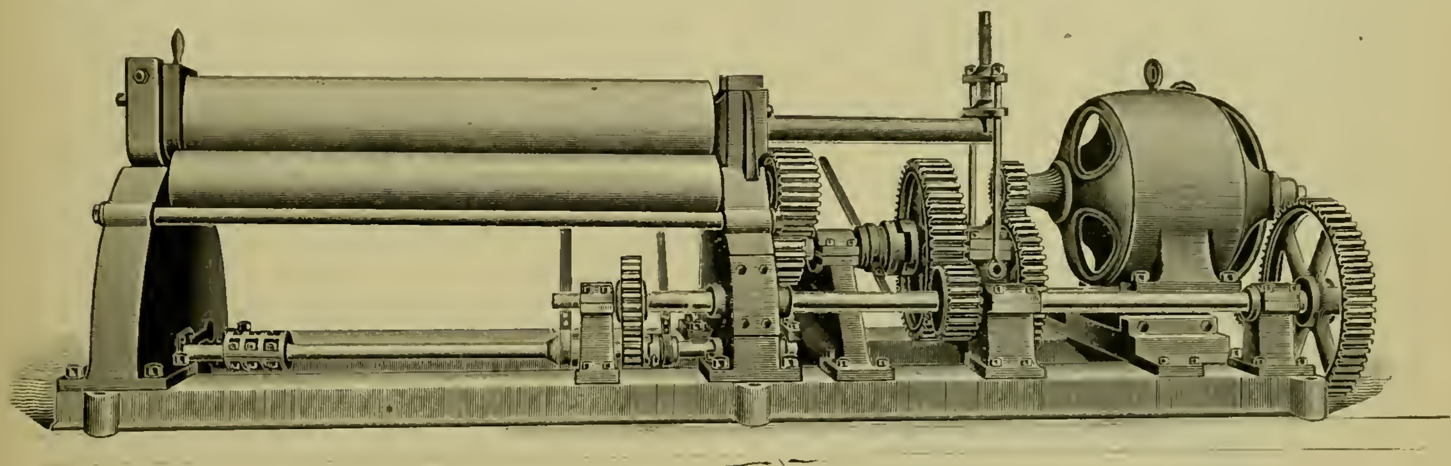
A HEAVY POWER BENDING ROLL.

Cincinnati Punch & Shear Company.

The illustration presented herewith shows a new motor-driven power, pyramid bending roll of improved design, recently built for the government by the Cincinnati Punch & Shear Company, Cincinnati, O. As shown, the machine consists of three forged steel rollers placed in pyramid form; the upper one, which is the heaviest, has a solid extension arm for tilting it, when it is desired to take out the formed cylinder, and the opposite end has a hinged housing which may readily be tipped back clear of the upper roll journal.

The machine is triple geared, and the gears connected with motor are cut, while those on ends of the rolls are of steel and are in all cases ample for the maximum capacity of the machine. The upper roll is raised and lowered by power, and this device is usually heavy, so that, with the lower rolls at rest, the upper may be used for corner bending and other like work. In connection with this there is a clutch, with which, when disengaged, cone work may be formed. The upper roll housing is reinforced on both sides and at both ends by heavy forged steel bars, which take much of the strain off of the screws.

The motor used is a heavy General Electric motor of the reversible type, which gives the operator instant control of the machine. The rolls and the driving mechanism are all mounted on a heavy cast iron bed frame. The width in this particular case between the housings is 6 ft. 2 ins., but this type of machine is built by the Cincinnati Punch & Shear Company in several sizes up to 16 ft., the wider ones having a four-point contact center bearing beneath the lower rollers.



A NEW PYRAMID BENDING ROLL (MOTOR-DRIVEN) OF PARTICULARLY HEAVY DESIGN.
BUILT BY THE CINCINNATI PUNCH & SHEAR COMPANY.

OVERLOADING LOCOMOTIVES.

Overloading of locomotives is a practice which no progressive manager will permit, after he has studied its effects. The tonnage rating craze has brought a remarkable development to the locomotive, but it is now time for sensible and intelligent loading of locomotives—in short, for common sense in this matter. It has been satisfactorily demonstrated that about 15 miles per hour is an economical speed for freight service and this speed should be the basis for tonnage rating, where the grade conditions permit. Mr. G. J. Bury, general superintendent, Canadian Pacific, says: "If freight trains average 15 miles an hour, train and enginemen can make 5,000 miles a month, while if the average be reduced to eight miles an hour the men cannot stand more than 3,000 miles a month. Sixty crews at 15 miles an hour will make 300,000 train miles per month, while at an average of eight miles an hour it will take 40 more crews or 200 extra men to handle that business.

"Looking at the matter from a financial standpoint, a consolidation engine hauls a train weighing 1,100 tons (tare and contents), over 118 miles in a district where there are several grades of 1 per cent.; taking into consideration the time for meeting trains, and letting faster trains pass, slowing up over grades, etc., it averages eight miles an hour, the cost being as below:

Wages engineer and fireman	$6.90
Wages engineer and fireman overtime	1.75
Wages conductor and brakemen	7.73
Wages conductor and brakemen overtime	2.88
Oil and waste for locomotive	$ .30
Fuel (7 tons at $3 20)	22.40
	$41.96

Or 32.3 cents per thousand ton miles.

"The same train, if loaded with 1,000 tons (tare and contents) averages 15 miles an hour over the same district, and the cost is as follows:

Wages engineer and fireman	$ 6.90
Wages conductor and brakemen	7.73
Oil and waste for locomotives	.30
Fuel (6 tons at $3.20)	19.20
	$34.13

Or 28.8 cents per thousand ton miles.

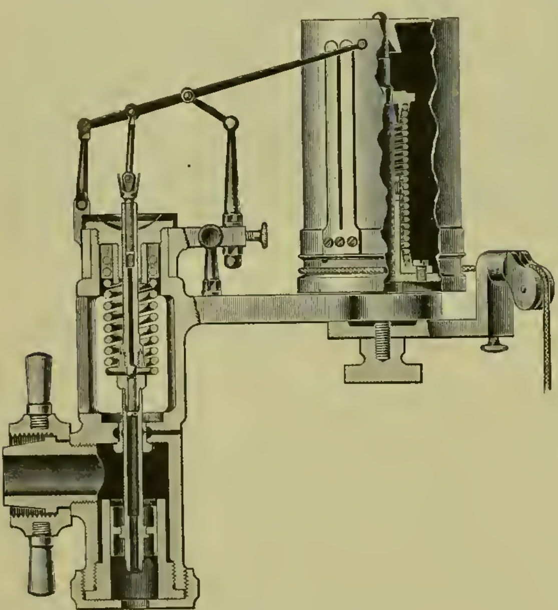
"The economical engine load is variable and is governed, not only by the number and length of grades, but by the density of traffic. On a road where traffic is very light at certain periods and dense at other periods, it might be good transportation to load engines heavily during light traffic, but it would be suicidal to load engines heavily when traffic was dense, even one train staggering and doubling over a district will demoralize the trains following and those met, resulting in overtime, extra consumption of fuel, and the risk of train accident which increases when train and enginemen are long hours on duty. In loading engines it has been the practice on some roads to so load them that they would haul a train at seven miles an hour over the steepest grade. If the steepest grade were of short length, no great delays might result, but if the steepest grade for instance, was to be eight miles in length, an engine, with a run for it, would take one hour to make the eight miles and the longest time it takes to make the distance between two stations is what limits the traffic. With trains loaded in this way, the traffic would be greatly restricted.

"In a general way locomotives should be so loaded when traffic is dense that they may make an average speed over a district of 15 miles an hour, providing there are no unusual delays, and while theoretical tests are all very well for a basis on which to work, the only way to arrive at the engine load is by actual tests in practice. After ascertaining what an engine will do in actual practice the load should be shaded slightly from this. No fixed rule can be given for the loading of engines, but the conditions of each district at each period must be closely studied and the load be made such that the train can make reasonably good time. It may be taken as a general principle (providing engines are in good condition) that, where trains are a long time on the road, and the dispatching is not at fault, that the engines are too heavily loaded. A live superintendent will hustle over his district on freight trains, be on the ground where the trouble lies, and fix the load to meet the conditions without delay."

THE STAR IMPROVED STEAM ENGINE INDICATOR.

This indicator has two specially strong features. It has an outside spring and a very small piston area which admits of using a light spring with a free motion.

It has been developed by the Star Brass Manufacturing Company, Boston, Mass. The Bureau of Steam Engineering, U. S. Navy Department has taken the position that hereafter all indicators furnished for the use of the government must have outside springs. This instrument was developed to meet this requirement and it has been done without increasing the veight of the moving parts. The drum pencil motion is the same as that previously used by this company, but the area of the piston has been reduced from one-half to one-quarter of a square inch which permits of using a small size of wire in the spring. Instead of being compressed, this spring is elongated in action, which tends toward bringing the motion in a direct line, avoiding cramping and excessive friction. The pencil operates in a way directly opposite to that of inside spring indicators and the atmospheric line is at the top of the drum. Instead of being at the bottom, the cylinder connection is at the side of the instrument and an angle cock is used to mount it, which brings the steam pressure on top of the piston. It is easy to remove the cylinder for cleaning or examination, without interfering with other parts and from the engraving it will be noticed that the end of the cylinder has no connection



IMPROVED STAR INDICATOR.

with the outer walls of the indicator. This permits of jacketing the cylinder with live steam and avoiding distortion of the cylinder by the heat. The drawing shows how the spring is removed from the hot steam and is not liable to change of tension or to deterioration.

Automatic stokers for locomotives were highly spoken of by Mr. J. F. Walsh, superintendent motive power of the Chesapeake & Ohio Railroad, and Mr. S. M. Vauclain, of the Baldwin Locomotive Works, at the March meeting of the New York Railroad Club. Both of these gentlemen considered the experience of the past few years sufficient to indicate a promising future for stokers, and they thought that the device would make very rapid progress in the near future.

"What is the true principle of organization in a democratic community? *Getting others to do what you want done while they are doing what they themselves wish to do."—Mr. Frenyear, before the Electric Club.*

Fairbanks, Morse & Company, of Chicago, have secured the services of Mr. M. Greenwood, formerly Pittsburg manager for the International Steam Pump Company, to take charge of their steam pump business in the Pittsburg territory.

PERSONALS.

Mr. William Rourk has been appointed car foreman of the Michigan Central at Chicago.

Mr. J. Dewey has been appointed acting master mechanic of the Erie Railroad at Galion, Ohio.

Mr. W. H. Wilson has been transferred as master mechanic of the Erie Railroad from Dunmore to Susquehanna, Pa.

Mr. W. S. Ganby has been appointed master mechanic of the Atchison, Topeka & Santa Fe Railway at Arkansas City, Kan.

Mr. T. J. Cole has been appointed acting master mechanic of the Erie Railroad at Meadville, Pa.

Mr. F. O. Bunnell has been appointed engineer of tests of the Chicago, Rock Island & Pacific Railway with office in Chicago.

Mr. R. F. McKenna has been appointed master car builder of the Delaware, Lackawanna & Western Railroad, with headquarters at Scranton, Pa.

Mr. T. Rumney has been transferred as master mechanic of the Erie Railroad, from Meadville to Jersey City, to succeed Mr. W. S. Haines.

Mr. E. R. Webb master mechanic of the Michigan Central at Michigan City, Ind., has had his jurisdiction extended over the Chicago district.

Mr. T. H. Ogden has been appointed master mechanic of the Mexican Central Railroad at Monterey, Mex., to succeed Mr. W. J. Wilcox who has been transferred to Chihuahua, Mex.

Mr. J. G. Riley the veteran master mechanic of the Michigan Central died at his home in Chicago, February 21. He began service with the Michigan Central in 1836 at Ann Arbor.

Mr. C. Graham, master mechanic of the Philadelphia & Reading at Philadelphia, has been transferred to the same position at Reading in charge of the Reading and Lebanon branches.

Mr. S. W. Taylor has been appointed master mechanic of the Chicago, Rock Island & Pacific at Cedar Rapids, Ia, to succeed Mr. J. H. Stubbs. Mr. Taylor has been superintendent of shops at that point.

Mr. J. H. Stubbs has been transferred as master mechanic of the Chicago, Rock Island & Pacific from Cedar Rapids, Ia., to Fiarbury, Neb., to succeed Mr. D. A. Hathaway who has resigned.

Mr A. H. Gairns, master mechanic of the Chicago, Rock Island & Pacific at Esterville, Ia., has been transferred to Trenton, Mo., in the same capacity, to succeed Mr. M. S. Monroe.

Mr. W. S. Haines, division master mechanic of the Erie Railroad at Jersey City has been appointed master mechanic of the Jefferson and Wyoming divisions and the New York, Susquehanna & Western Railroad with headquarters at Dunmore, Pa.

Mr. George W. Smith, assistant superintendent of machinery, and master mechanic of the Burnside shops of the Illinois Central, has been appointed superintendent of motive power of the Chicago & Eastern Illinois, with headquarters at Danville, Ill., to succeed Mr. Thomas A. Lawes, resigned.

Mr. George K. Hatz has been appointed master mechanic of the Chicago & Alton, with headquarters at Bloomington, Ill. Mr. Hatz has heretofore been general foreman of the Illinois Central at Burnside, Ill.

Mr. Henry Hardie has been appointed master mechanic of the Cumberland Valley division of the Knoxville branch of the Louisville & Nashville with headquarters at Corbin, Ky. He has been promoted from the position of general foreman of the shops at that point.

Mr. R. F. Kilpatrick has been appointed superintendent of motive power of the Delaware, Lackawanna & Western Railroad to succeed Mr. T. S. Lloyd. Mr. Kilpatrick has for several years held the position of master mechanic at Scranton.

Mr. B. P. Flory has been appointed mechanical engineer of the Central Railroad of New Jersey to succeed Mr. G. W. Wildin. Mr. Flory is a native of Pennsylvania. He was born in Susquehanna in 1873 and was graduated from Cornell University in 1895. He has had experience in mining engineering in Montana and began railroad service with the Lehigh Valley in 1899 as inspector and was afterward draftsman, chief draftsman, and mechanical engineer of that road. In connection with the construction of the new shop at Sayre Mr. Flory was transferred to the office of the chief engineer in New York and leaves this position to accept the appointment on the Central Railroad of New Jersey.

Edward A. Phillips who was well and widely known as the editor of the *Railroad Car Journal* and afterward as general agent of the National Railway Publication Company, died in New York, February 26, after a brief illness. Mr. Phillips was born in England in 1863 and came to this country in 1888. After spending several years at sea and securing a master's certificate at an unusually early age, his first work in the United States was in connection with the publication department of Messrs. Thos. Cook & Son. In 1890 he took up railroad newspaper work and soon began the publication of the *Railroad Car Journal* as editor, which he continued up to the time of its absorption into another publication. He was an able writer and was thoroughly familiar with mechanical railroad subjects. He was devoted to his many friends and will be sadly missed.

Mr. T. S. Lloyd has been appointed general superintendent of motive power of the Chicago, Rock Island & Pacific. To accept this appointment he has resigned as superintendent of motive power of the Delaware, Lackawanna & Western where his work for the past four years has been a conspicuous success and has attracted general attention because of the remarkably fine condition to which the department has been brought out of the chaos which formerly existed on that road. Mr. Lloyd is a man of strong personality, positiveness in carefully formed opinions, executive ability and good business judgment. With these he combines a very wide experience and is admirably fitted to direct the important organization to which he has been called. He began as a machinist on the Toledo & Ohio Central and has served in the mechanical departments of Atlantic & Great Western, the Pittsburg, Fort Wayne & Chicago, and the Chesapeake & Ohio. He was for ten years master mechanic of the latter road at Richmond, Va.

Mr. F. N. Hibbits has resigned as assistant superintendent of motive power of the Union Pacific to accept the appointment as consulting engineer of the Southern Railway and its allied lines These include the Queen & Crescent system, the Central of Georgia, the Mobile & Ohio, and the Georgia Southern & Florida, a total mileage of nearly 12,000 miles. He will report to a committee of the mechanical officers of these roads, including Mr. Samuel Higgins, mechanical superintendent of the Southern Railway. Mr. Hibbits is 37 years of age and a graduate of Rose Polytechnic Institute. In 1886 he entered the service of the Cleveland, Columbus, Cincinnati & Indianapolis as machinist and was soon placed in charge of mechanical engineering work on that road. In 1891 he went to the New York, Lake Erie & Western as engineer of tests and in 1892 was made mechanical engineer. In 1894 he was appointed master mechanic of the Rochester division. He has also had experience in the operating department as trainmaster and as division superintendent. For about three years he has been with the Union Pacific as mechanical engineer and assistant superintendent of motive power.

Mr. George W. Wildin, whose appointment as assistant mechanical superintendent of the Erie Railroad was announced last month, has held the position of mechanical engineer of the Central Railroad of New Jersey for the past three years, where his work was specially successful because of his wide road experience. Mr. Wildin is 34 years of age. He is a graduate of the Agricultural and Mechanical College, Manhattan, Kan., and began railroad service as a draftsman in the mechanical department of the Atchison, Topeka & Santa Fe Railway at Topeka. He served in this capacity and as a locomotive fireman for four years and then entered the service of the Mexican Central as locomotive engineer. After this he was connected with the department of the chief engineer of that road. He then went to the Chicago & Alton as locomotive engineer and next served as machinist, locomotive engineer and mechanical engineer of the Plant System. From the latter position he went to the Central Railroad of New Jersey in the same capacity. Mr. Wildin thus combines technical preparation with a great deal of practical road experience, which render him a very valuable addition to the staff of the Erie Railroad. He is a member of the American Society of Mechanical Engineers, of the Master Mechanics', the Master Car Builders' Associations and is first vice-president of the Traveling Engineers' Association. It is only through a record of hard and effective work that a man of his age is called to a position of this importance.

Locomotive frames was the subject of a characteristically thoughtful and able address by Mr. S M. Vauclain before the New York Railroad Club March 18. After illustrating by lantern slides the progress in frame construction and frame splices, which accompanied the increasing size of locomotives, the speaker showed that the recent serious trouble from breakage was not due to lack of strength He believed it to be a result of water in the cylinders which did not find sufficient relief through piston valves or valves of the balanced type which permitted too little motion with reference to the balance plate to allow water to escape. It is doubtful if the general subject of frames has ever been so well summed up before and the development of frame splice construction so clearly traced. The speaker's arguments with reference to the necessity for the escape of water were clear and impressive. Cast steel as a material for frame construction was strongly advocated, because the material was nearly twice as strong as wrought iron and was more likely to be homogeneous than welds in wrought iron were sure to be sound. Judging from this address the report of the committee on this subject before the Master Mechanics' Association next June is likely to be exceedingly valuable. In the discussion, Mr. Deems said that he had seriously considered making locomotive frames of slab form out of ship plate material.

The well-known Modoc Soap Company has been succeeded by the Henry Roever Company, of Chester, Pa. The plant and buildings are up to date; the company has three sidings on its own grounds and its own wharf on the Delaware River, where steamers may load and unload merchandise. With a capital of $300,000 and a modern plant with improved manufacturing facilities, the company is prepared to meet all the requirements of the customers of the old concern. The two specialties in which our readers are interested are known as the "Improved Modoc Liquid Car Cleaner" and "Modoc Powdered Soap." The car cleaner is well known, and the powdered soap is made specially for shop use. The officers of the company are: Henry Roever, president and manager; William C. Sproul, vice-president; Josiah Smith, secretary and treasurer.

AN OBJECT LESSON IN FIREBOX SIDE SHEETS.

At the last convention of the Master Steam Boilermakers Association there was a novel exhibit presented for the purpose of demonstrating the effect on side sheets, of a narrow water space at and above the foundation ring of a firebox. Mr. John H. Smythe, formerly foreman boilermaker of the Chicago & Alton, arranged to illustrate the effects of overheating of the side sheets, by laying off a board to represent the locations of staybolts, in the side sheet by punched holes, and, into the punched holes in the board, placing punching or burrs from the firebox sheet in the relative positions occupied while in the firebox, as in Fig. 1. These sections of the sheet show the fire side and the effect is evident in the minute cracks, which are greatest in the part of the sheet enduring the most intense heat. Referring to this exhibit Mr. Smythe said in part:

"We had trouble with staybolts breaking from the start; and the engine has been out about forty days since we put in the new half side sheets, and have had no trouble with staybolts leaking. It is hard to say what makes the side sheets crack, but I attribute it largely to bad water. The Sante Fe made a very good test by putting in some water gauge cocks along the side at the hottest points, running the pipe of the first through the outside sheet to within ⅛ of an inch of the inside sheet, the second, within ¼ of an inch, and the third within ½-in.

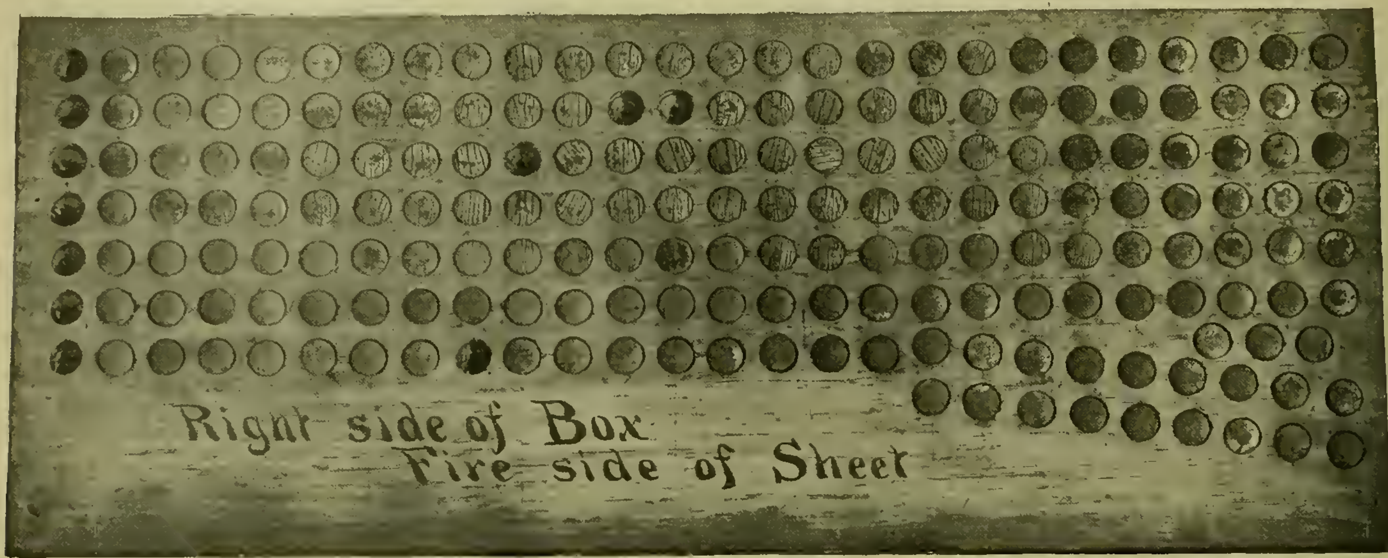


FIG. 1.—PUNCHINGS FROM FIREBOX SHEETS SHOWING CRACKS FROM OVERHEATING.

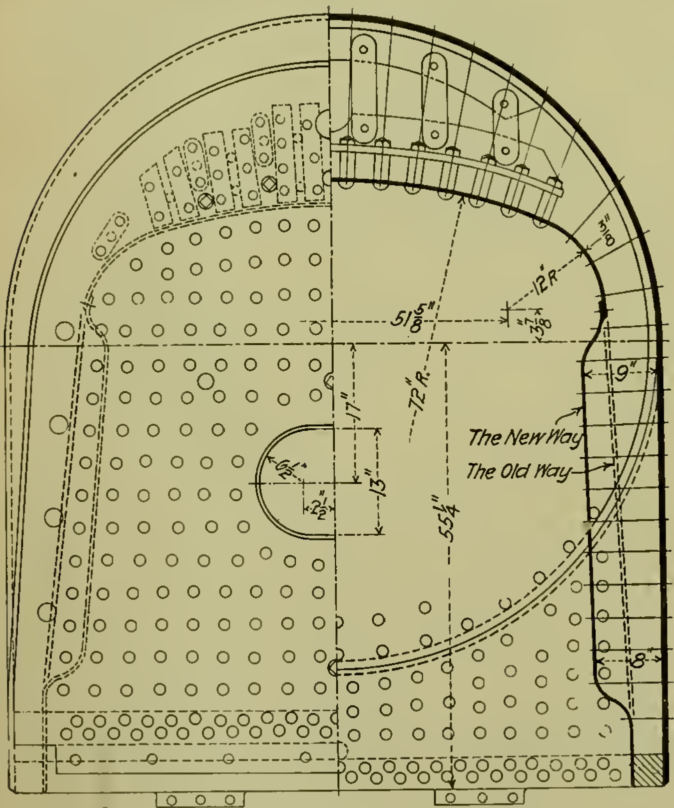


FIG. 2.—SMYTHE'S OFFSET SIDE SHEETS.

"I believe the result of this test was that the first one which was within ⅛-in. of the inside sheet, showed dry steam, the second wet steam, and the third water. This goes to show that the water boils away from the side sheets and I believe our water spaces are too narrow. In order to try to overcome this I have offset the half side sheet, as shown in the drawing, Fig. 2, making the water space 9 ins., also putting the flange of flue and door sheet in the water from top of side sheets down.

"I have at the present time five engines in the boiler shops for half side sheets and radial stays, all of the engines having been delivered to the company last August. You will notice I said that I had no trouble with engine 421 since putting in half side sheets, although she gave us trouble all the time before that, so I believe the offset side sheets will do the work. It will allow the side sheets to expand."

The advantages resulting from the wide water space around a firebox, are an increased volume of water through which to transmit the heat, and also a reduction of bending moment due to the longer staybolts; both of these factors are of the greatest importance in prolonging the life of a firebox, since with a wider space the circulation must be improved, thus doing away with the deadly steam film next the sheets, and with the larger staybolts, the stress due to expansion and contraction of side sheets, must be decreased. The use of side sheets curved at the top and bottom as indicated, is a novel method of construction, and one that ought to have a beneficial effect in taking care of the expansive forces. The shape makes possible a wide water space above the fire line, the widest we have any knowledge of, a construction for which we have contended as being one of the remedies for firebox troubles. In any event the results will be watched with much interest as they will be the outcome of a battle royal with bad water conditions. We beg to acknowledge courtesies extended by *Motive Power* for data contained in this article.

Mr. Samuel Higgins has resigned as mechanical superintendent of the Southern Railway, to become general manager of the New York, New Haven & Hartford Railroad, succeeding Mr. W. E. Chamberlain. Mr. Higgins was born in 1860, in San Francisco. He began railroad work with the New York, Lake Erie & Western, in 1881, as machinist apprentice. After serving as machinist, assistant foreman and general foreman at the Susquehanna shops, he was appointed engineer of motive power, in 1887. He served for two years as division master mechanic and in 1892, was appointed assistant superintendent of motive power. In 1894, he went to the Lehigh Valley Railroad as superintendent of motive power. In April, 1901, he was called to the Union Pacific as superintendent of motive power, and in June, 1902, he went to the Southern Railway as mechanical superintendent, the position which he now leaves. His present appointment is a recognition of his ability and wide experience and this selection of another successful motive power officer for a high operative position indicates the importance of motive power responsibilities and training for higher positions.

A great amount of attention is being given to the question of rapid change-gear appliances on lathes, both by lathe builders and by lathe users, and an ever increasing preference is being shown for such lathes over less modern types. It will therefore be of much interest to the machine tool trade in general, and to lathe users in particular, to learn that the question of patent rights for the manufacture of lathes equipped with possibly the most improved and most efficient of such appliances has just been effectually settled. The American Tool Works Company of Cincinnati have, through purchase, acquired manufacturing rights under the several patents which have been issued pertaining to such devices. This gives them the undisputed right to build absolutely without restriction and under thorough protection from infringement litigations, their improved new "American" engine lathe with quick changing mechanism for thread cutting and feeding. This lathe has previously been shown in these columns and its merits are already well known and its exceptional possibilities in the way of rapid production are recognized by progressive shop managers. The line of sizes in which this lathe is built ranges from 14 in. to 36 in., inclusive, and full information on any size will, we are confident, be cheerfully furnished by the makers.

The American Blower Company of Detroit, Michigan, are at present installing their "A B C" fan system of heating in the new shops of the Olds Gasoline Engine Works at Lansing, Michigan, which contract they secured because of the excellence of the layout submitted to the engineers of the building. The building is one story in height, being a steel frame structure. It consists of one division running east and west 130 by 438 feet; one division running north and south 62 by 346; one locker office and wash room building 36 by 141 feet, and one paint storage building 20 by 20 feet. The heating apparatus is arranged to provide for an addition 130 by 438 feet to the main portion of this building, and to maintain an average temperature of 65 degrees F. throughout the present structure, with the exception of the offices and paint shop, which are to be heated to 70 degrees. This apparatus consists of four units, each made up of an "A B C" sectional base heater, having a capacity of 3,250 lineal feet of one-inch pipe, to which is attached an "A B C" full housed steel plate fan. The fan located in the 62-foot wing is special, having a housing 100 inches high and a wheel 66 inches in diameter. The other three fans are regular 120-inch "A B C" fans, with wheels 70 inches in diameter. All of the fans are operated by independent motors. All of this heating apparatus is carried on girders which span the roof trusses in the wings, and is entirely above the bottom chords of same.

BOOKS AND PAMPHLETS.

Traveling Engineers' Association. Proceedings of the Eleventh Annual Convention. Edited by the secretary, W. O. Thompson, Oswego, N. Y. Bound in flexible leather; 240 pages.

The work of this association along the lines of improving the operation of locomotives is exceedingly important. Its discussions cover a wide range of subjects, and are participated in by men who actually do the things they talk about.

Association of Railway Superintendents of Bridges and Buildings. Proceedings of Thirteenth Annual Convention, October, 1903. Edited by the Secretary, S. F. Patterson, Boston & Maine Railroad, Concord, N. H.

This volume contains the reports, records and discussions of the convention held in Quebec, Canada, last October, and among the specially valuable reports are one on water purification for locomotive use, and one on methods and equipment for storing fuel oil for supplying locomotives. The latter report contains many drawings and photographs, and constitutes the most complete collection of information on this subject which is available.

The Indicator Hand Book. A practical manual for engineers. By C. N. Pickworth, editor of the *Mechanical World*. Part I. The Indicator: Its Construction and Application. Second edition. New York. D. Van Nostrand Co., 23 Murray street. Price, 3s. net.

This little book is an excellent guide to the application of the indicator, and of all the works on this subject we have seen none better in its field. It describes a number of the best instruments, presents the history of the indicator, discusses its errors, its attachment, various methods of making connections, describes reducing gear and errors therein, and gives good advice as to the care and use of these instruments. The ground covered by this book should be carefully studied by those who are called upon to use indicators in their work, whether in steam or gas-engine practice.

Proceedings of the Master Car and Locomotive Painter's Association. 34th Annual Convention, held in Chicago, September, 1903. Published for the association by the Railway Master Mechanic, Chicago, 1903.

This volume of 150 pages contains papers, reports and discussions of paints and painting from the standpoint of those who paint locomotives and cars. It is a valuable record each year, coming as it does from entirely disinterested people who are users of vast quantities of paints and varnishes for the most exacting service which these materials are called upon to perform. The value of the proceedings to those who are not members of the association would be greatly increased if the index was more complete and if the titles of the papers were set in large type in the form of headings. These annual volumes are exceedingly valuable in the literature on the use of paints, in fact their value is unique, because the opinions come from men whose responsibilities are entirely confined to this special subject.

Proceedings of the Eleventh Annual Meeting of the Society for the Promotion of Engineering Education. Held in Niagara Falls, N. Y., July, 1903, and joint session with the American Institute of Electrical Engineers. Edited by Calvin M. Woodward, C. Frank Allen and Clarence A. Waldo, committee New York Engineering News Publishing Company. 1903. Price per volume, $2.50; to members, $1.50; to libraries, $2.

This volume is the largest and in many ways the most interesting issued by this society. It contains a number of valuable papers. Those by the late Prof. R. H. Thurston; a report on "Technical Books for Public Libraries"; one on education for factory management; a paper by Arthur W. Ayer on engineering education from the standpoint of the practical engineer, and others, are exceedingly important contributions to the literature of modern education.

American Compound Locomotives. A practical explanation of the construction, operation and care of the compound locomotives in use on American railroads. By Fred H. Colvin. First edition, 1903. Derry-Collard Co., 256 Broadway, New York. Price $1.50.

This book is written especially for locomotive engineers, firemen and shop men who have to do with compound locomotives on American railroads. It is thoroughly practical and generally descriptive, being written with a view of rendering the descriptions perfectly clear. The engravings are excellent, ten of the different types of compounds being illustrated by "duotone" engravings, which we have never before seen in books of this kind. The author has taken special pains, by aid of sectional drawings, to indicate the operation of the valves and show the manner in which the steam gets into and out of the cylinders and passages. The book deals with a portion of the history of the compound, and also contains instructions for locating and remedying defects in operation. It fills a specific need, and it should result in assisting in the proper maintenance and efficient operation of compound locomotives.

The Crocker-Wheeler Company, Ampere, N. J., have recently issued a large number of interesting publications, including the following bulletins and pamphlets:

Bulletin No. 40, "Crane Motors, Form K."; Flyer No. 145, "Electric Drive for Machine Tools with Methods of Variable Speed Control"; Flyer No. 153, "Machine Tool Equipments, Band Saw Driven by a Direct Connected Motor"; Flyer No. 154, "Band Saw Setting and Filing Machine with Contained Motor Drive"; Flyer No. 155, "3-in. Bolt Cutter with Motor Drive"; Flyer No. 156, "Contained Motor Drive on a 30-in. Drill Press"; Flyer No. 157, "Motor Drive on a Four-Spindle Mud-Ring Drill"; Flyer No. 158, "Motor-Driven 24-in. Lathe"; Flyer No. 159, "Motor Driven Gap Lathe with 28- and 48-in. Swing"; Flyer No. 160, "Heavy Turret Lathe with Motor Drive"; Flyer No. 161, "Light Milling Machine with Motor Drive"; Flyer No. 162, "Heavy Milling Machine with motor Drive"; Flyer No. 163, "Motor Drive Applied to a Gear Shaper"; Flyer No. 164, "Horizontal Boring Machine with Motor Drive"; Flyer No. 165, "Motor Drive on a 51-in. Boring and Turning Mill"; Flyer No. 166, "No. 4 Single Punch, Equipped With Semi-Enclosed Motor"; Flyer No. 167, "Motor Drive on a Rotary Bevel Shear," and Flyer No. 168, "Motor-Driven Bending Rolls."

AMERICAN BLOWER COMPANY.—This company has issued a catalogue devoted to the application of their waste-heat drying system as applied to the drying of bricks. It is known as "Catalogue No. 15," and while the subject is of special interest to brickmakers, the details of the apparatus described will interest others who have occasion to use drying apparatus for kilns or other purposes. It is an exceedingly handsome catalogue and beautifully gotten up in every way.

The Brady Brass Company report an excellent condition of business and most gratifying results in the service of their "Cyprus Bronze Bearing Metals" in driving boxes, rods, tender and truck brasses and journal bearings for both passenger and freight equipment. This company has sold several million pounds of this metal in the past fifteen years, and in the interests of its customers it brings to bear an experience of thirty-two years in the manufacture of bearing metals. Mr. D. M. Brady is president of the company. The New York office is at 95 Liberty street.

POOR'S READY REFERENCE BOND LIST.—This edition, of January, 1904, contains all the important facts required by investors, bond experts, bankers, and others, relative to the bonded indebtedness, interest charges, etc., of the leading railroad systems of the United States. It is a supplement to *Poor's Manual of Railroads*, and is the third annual compilation of this department. All the bonds listed are carefully indexed, and the pamphlet is invaluable to those interested in bonds. It is published by Poor's Railroad Manual Company, 68 William street, New York.

EDISON STORAGE BATTERY FOR CAR LIGHTING.—The Gold Car Heating and Lighting Company has made an arrangement with Mr. Thomas A. Edison and his company for the exclusive sale in the United States of the Edison storage battery for car-lighting purposes. The railway car-heating business of the Gold Company has grown to a great extent, and the introduction of the new battery renders it necessary to move to larger quarters. They have taken a large suite of offices in the Whitehall building, 17 Battery place, New York, and have moved the Chicago branch and the New York office to that building.

HOLLOW STAYBOLTS.—The Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio, have received a letter from Supervising Inspector-General George Uhler, of the Department of Commerce and Labor, indicating that the committee on boilers and machinery has made a careful examination of papers, letters and reports of comparative tests of staybolts submitted to them. The report of the committee concludes as follows: "All the data contained therein is very instructive and interesting reading, and we are of the opinion that the Falls Hollow staybolt is safe and efficient for use in the construction of locomotive and marine boilers."

"JEFFREY SCREENS" is the title of a pamphlet by the Jeffrey Manufacturing Company, Columbus, Ohio, which should be examined by every one having occasion to use screens for any sort of material. This company finds it necessary to devote a department to this branch of their work, and by reason of a wide experience they are prepared to meet all sorts of requirements for screening machinery for ores, sand, rock, coal, or any kind of material for which screens are used. This pamphlet is known as "Catalogue No. 69." It is comprehensive, and is illustrated by half-tones and working drawings of screening machinery in service.

GRAPHITE.—The March number of the periodical bearing this title, which is published by the Joseph Dixon Crucible Company, is illustrated and printed in a way which compels notice. This number presents an imposing array of handsome engineering structures and buildings on prominent railroads and in large cities, indicating the appreciation of the Dixon graphite paints by use upon them. This number is a remarkably fine piece of work, showing that the architects of some of the finest buildings of the present day are protecting their steel and ornamental iron with these paints. The pictures of the new Hotel Astor, Keith's new Chestnut-street theater in Philadelphia, the new works of the Henry R. Worthington Company and others in this number constitute a convincing argument.

WOODWORKING MACHINERY.—The Jeffrey Manufacturing Company, Columbus, Ohio, have issued a new catalogue, "No. 57A," devoted to illustrated descriptions of machinery for saw mill, lumber and woodworking industries. The engravings are made from photographs of their machinery in actual use for elevating and conveying materials and finished product in the industries mentioned. This company finds it necessary to publish eighteen different catalogues in order to cover the wide range of its product. Any of these may be had on application. The pamphlet just received covers conveying machinery, pulleys, chains, link-belts, sheaves, shafting, hangers, ropes, sprockets, and many other details used in woodworking plants.

NOTES.

The Bettendorf Axle Company has found it necessary to establish an office in New York. Mr. G. N. Caleb is in charge and represents this company in the east with headquarters at 42 Broadway, New York.

Mr. Henry R. Dalton, Jr., has been elected president of the Baush Machine Tool Company, to succeed Mr. W. H. Baush who has resigned. Mr. C. J. Wetsell has been elected treasurer to fill the vacancy caused by the resignation of Mr. David Hunt, Jr. All communications should be addressed to the Baush Machine Tool Company, Springfield, Mass.

The Falls Hollow Staybolt Company of Cuyahoga Falls, Ohio, report the receipt of large orders of their hollow staybolt iron from Japan. These came through their agents, Messrs. Frazar & Company and the China & Japan Trading Company. This trade in Japan is increasing both with the railroads, marine boiler manufacturers and the government. This recognition of this material by so shrewd a nation as Japan is very pleasing to these staybolt people.

The American Nut and Bolt Fastener Company, 306 Frick Building, Pittsburgh, Pa., has elected the following officers: Mr. Milton Bartley, president and general manager; Mr. Frederick Bowery, vice-president; Mr. Barton Grubbs, secretary and treasurer; Mr. John C. Bowery, assistant secretary and treasurer. This company will have an exhibit at the St. Louis World's Fair. They now manufacture over 140 different sizes and designs of fasteners and in the year 1903 they equipped 18,000 cars with them, as well as supplying large quantities for other purposes.

The suit brought by the Pressed Steel Car Company against the Standard Steel Car Company and its president Mr. John M. Hansen, has been dismissed. It was brought to recover possession of drawings and patent rights for steel cars which were alleged to have been fraudulently taken by the defendant when he left the employ of the Pressed Steel Car Company to organize the new concern. Judge Joseph Buffington rendered the decision in the United States Circuit Court at Pittsburgh, March 7 and the Pressed Steel Car Company was ordered to pay the costs. It is stated that other suits are pending and that the one referred to may be appealed by the plaintiffs.

One of the interesting features of the new plant now being erected by the B. F. Sturtevant Co., at Hyde Park, Mass., is an elaborate testing plate for its engines. With an output of a thousand engines or more per year this is the essential climax of a careful system of manufacture and testing. The plate, or more properly the plates, will be supported upon a series of heavy parallel walls between which steam and exhaust pipes are carried so that at almost any point in the entire area of the floor measuring about 30 ft. by 60 ft. steam and exhaust connections may be made to any engine, and a transfer crane overhead will make it easy to locate or remove the engines. The same crane will transport them to the packing department, and thence load them directly upon cars which traverse the end of the building.

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL.

MAY, 1904.

CONTENTS.

RAILWAY SHOPS.

By R. H. Soule.

XIII.

THE LAYOUT.

After deciding on the floor areas and general features of the several departments which are to be included in the plant, their relative arrangement and track connections (collectively termed "the layout") have to be considered. In a general repair plant there are two groups of buildings, for locomotive work and car work respectively, and often some buildings common to both. A single building may, and generally does, contain more than a single department, and the relations between the departments largely influence the grouping of the buildings. The principal departments of the locomotive group are the erecting shop, the machine shop, the boiler shop, and, similarly, that the stock of bar iron is kept that under average conditions the amount of business interchanged between these five departments should justify favoring facility of intercommunication in the following order: (1) Erecting and machine; (2) erecting and boiler; (3) machine and smith; (4) boiler and smith; (5) machine and boiler; (6) erecting and smith; (7) machine and storehouse; erecting and storehouse; (9) boiler and storehouse; (10) smith and storehouse. It is assumed that the stock of boiler plate, although under storehouse jurisdiction, is kept at or near the boiler shop, the smith shop, and the storehouse. It is believed at or near the smith shop.

It seldom happens that the storehouse can be located equidistant from the locomotive group and the car group of buildings, and in the majority of plants the storehouse is made one of the locomotive group, it being felt that the best results can be obtained in that way. Therefore, with the storehouse eliminated from consideration, there remain, as the principal departments of the car plant, the passenger repair shop, the passenger paint shop, the cabinet shop, the upholstery shop, the freight repair shop (or yard) and the planing mill. The relative importance of the interchange of business between these six departments, as affecting their grouping may be taken to be about as follows: (1) Passenger repair and cabinet; (2) passenger repair and paint; (3) passenger repair and upholstery; (4) passenger paint and cabinet; (5) cabinet and upholstery; (6) passenger paint and upholstery; (7) freight repair and planing mill; (8) cabinet and planing mill; (9) passenger repair and planing mill; (10) passenger repair and freight repair; (11) passenger paint and freight repair; (12) cabinet and freight repair; (13) passenger paint and planing mill; (14) upholstery and freight repair; (15) upholstery and planing mill.

The following are some of the principal points to be borne in mind in connection with the general problem of the railway shop layout:

1. A longitudinal erecting shop is parallel to the base line of tracks, and does not require either a turntable, transfer table, or fan tail, for its approach.

2. A transverse erecting shop, if its stall tracks are to be parallel to the base line, must be approached either by a fan tail or by a transfer table.

3. A transverse erecting shop, if its stall tracks are to be at right angles to the base line, must be approached by a turntable.

4. Buildings should be so arranged that each may be extended by a large fraction of its original size. In the case of separate departments within the same building, permanent barriers between them should be avoided, so that the original assignment of space to each may be modified to suit altered conditions.

5. All buildings (or departments, or bays of buildings) which are to have traveling crane service, should, in order to get maximum results from the investment, be relatively long and narrow.

6. Each principal department should have yard room (which it can control) adjacent to it.

7. The track system should be so arranged that tracks between principal buildings should simply be running tracks, and not standing tracks on which strings of cars may be left

8. Outside tracks should not be so close to buildings that cars left standing on them will block off the light from any portion of the interior of a building.

9. Avoid placing 8-ft. turntables (for hand trucks) in running tracks which are to be used by locomotives, and, whenever possible, place such turntables under traveling cranes, facilitating their removal when pits have to be cleaned out.

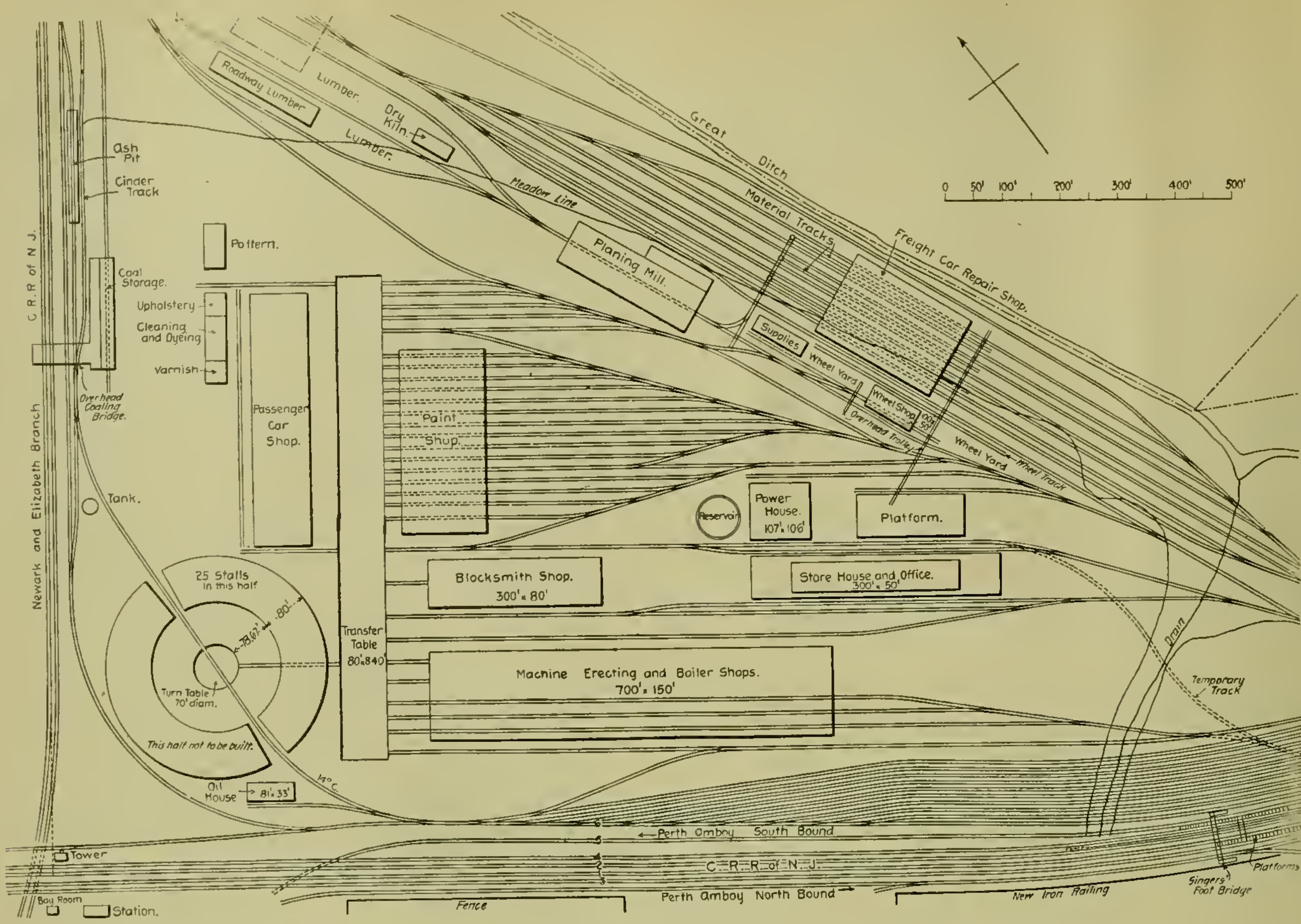
10. A yard crane should have a surface track parallel to and between runways, and connecting to tracks leading into buildings. Such a track will be very serviceable when the crane is either busy or out of service.

11. The roundhouse (if any) should be accessible from machine shop and boiler shop; accessibility from the smith shop is not so important.

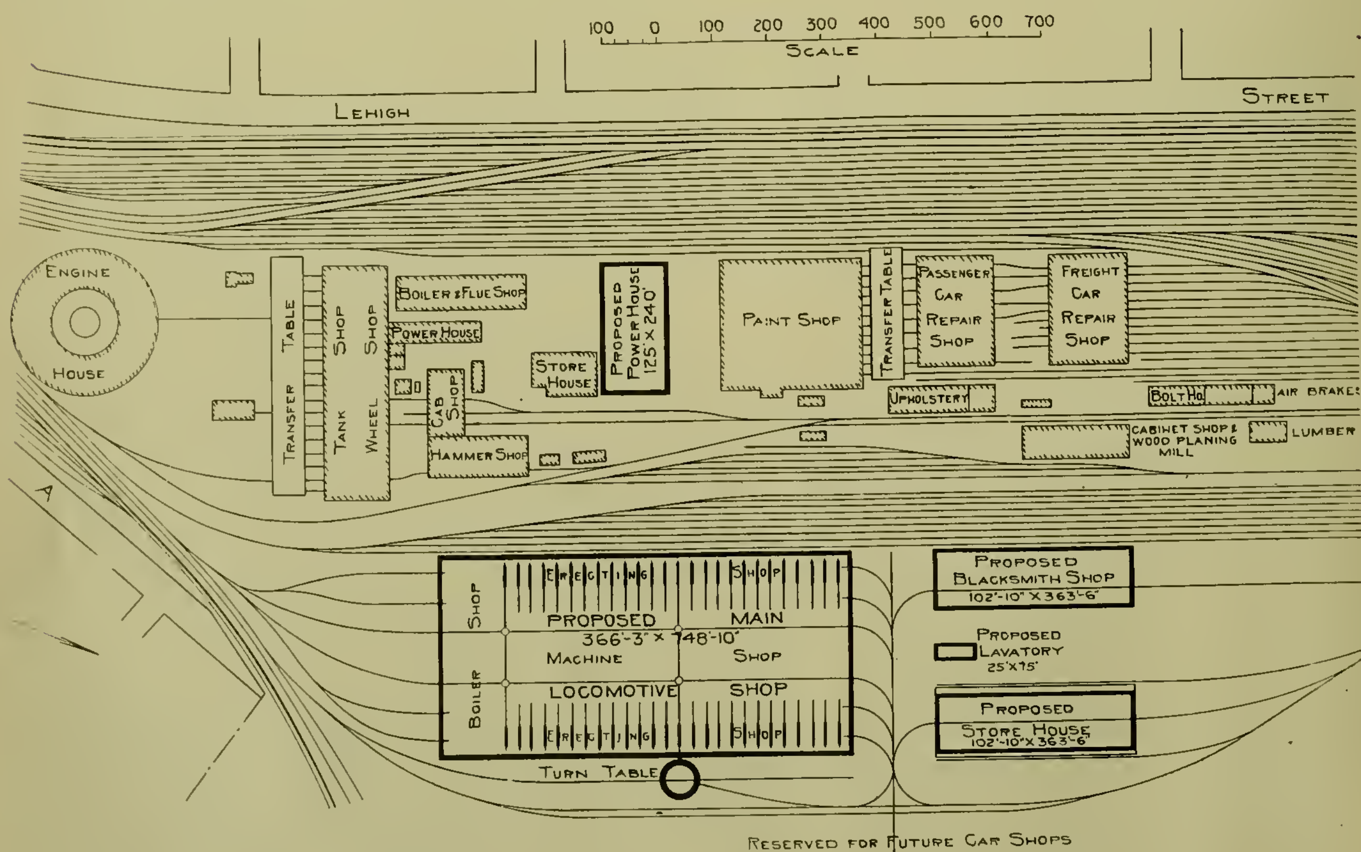
12. The oilhouse, when possible, should be between and easily accessible from the roundhouse and the storehouse.

13. If a transfer table is necessary (as it probably will be at the passenger car shop) it should preferably be located at one edge of the property so as to impede general yard traffic as little as possible.

14. If the shop group is in sight of the main passenger tracks, engines and cars awaiting repairs should be kept behind the buildings.



ELIZABETHPORT SHOPS, CENTRAL RAILROAD OF NEW JERSEY.

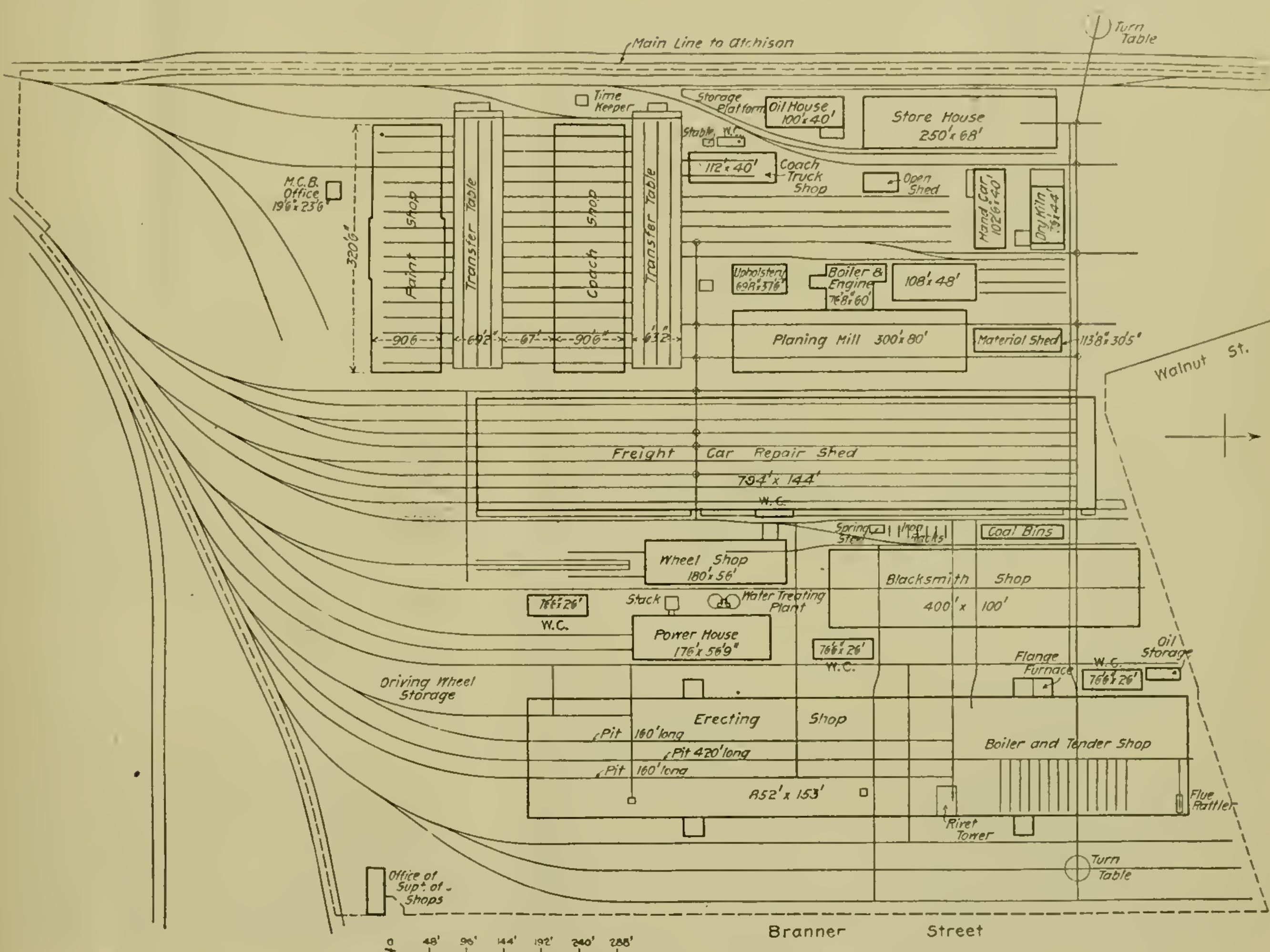


SAYRE SHOPS—LEHIGH VALLEY RAILROAD.

15. The original layout should include all yard accessories, such as scrap bins, lavatories, miscellaneous storage, lumber yard, etc.

16. The power plant should be central as regards power distribution, but should be isolated as a precaution against fire.

The relative merits of the longitudinal and the transverse erecting shop, considered from a construction and operating standpoint, have already been discussed, but the longitudinal shop lends itself more readily to the average layout conditions, and eliminates both the turntable and the transfer table (as regards the locomotive group of shops) from the problem, and these are generally realized to be obstacles in the way of simple and direct track connections. As regards the extensions of buildings it is well to group the original structures as near to one another as circumstances permit, and to reserve space for their extension outwardly from the general centre. The best evidence that transfer tables are apt to be an obstruction to traffic is that in several cases they have been installed and subsequently removed, as, for instance, at the New Haven, Conn., car shops of the N. Y., N. H. & H., and at the Juniata, Altoona, Pa., locomotive construction shops of the Pennsylvania Railroad.



TOPEKA SHOPS—ATCHISON, TOPEKA & SANTA FE RAILWAY.

Scrap bins have too often been left to chance and have been wedged in in cramped quarters after the buildings were completed and the plant put in operation; but discussion in the railway clubs and elsewhere during the last five years has focused attention on the problem and led to a better state of affairs, so that in some few cases (Collinwood, for instance,) the scrap storing, handling, and shipping facilities have been made part of the general scheme from the beginning, and installations worthy of the importance of this branch of current business have been put in. A power shear is a very useful adjunct, and machines for straightening bolts and rethreading them can usually be kept busy; practice tends towards keeping the scrap bins within easy reach of the smith shop, without, of course, sacrificing its relations to other departments from which it receives its principal contributions of scrap. Similarly, the smith shop foreman is often given a supervisory or advisory jurisdiction over the scrap platform, as being likely to be the best judge of what materials may be redeemed and used over (with or without having work done on them, as the case may be), what may be worked up into heavy forgings in the smith shop, and finally, what should be listed and reported for sale. If there is a traveling crane in the yard an effort should be made to so locate it or so locate the scrap bins as to make the crane of service in handling scrap; it is especially useful in unloading tangled wreckage as it comes in off the road, and may also be availed of in loading scrap for shipment, if certain other minor facilities are provided.

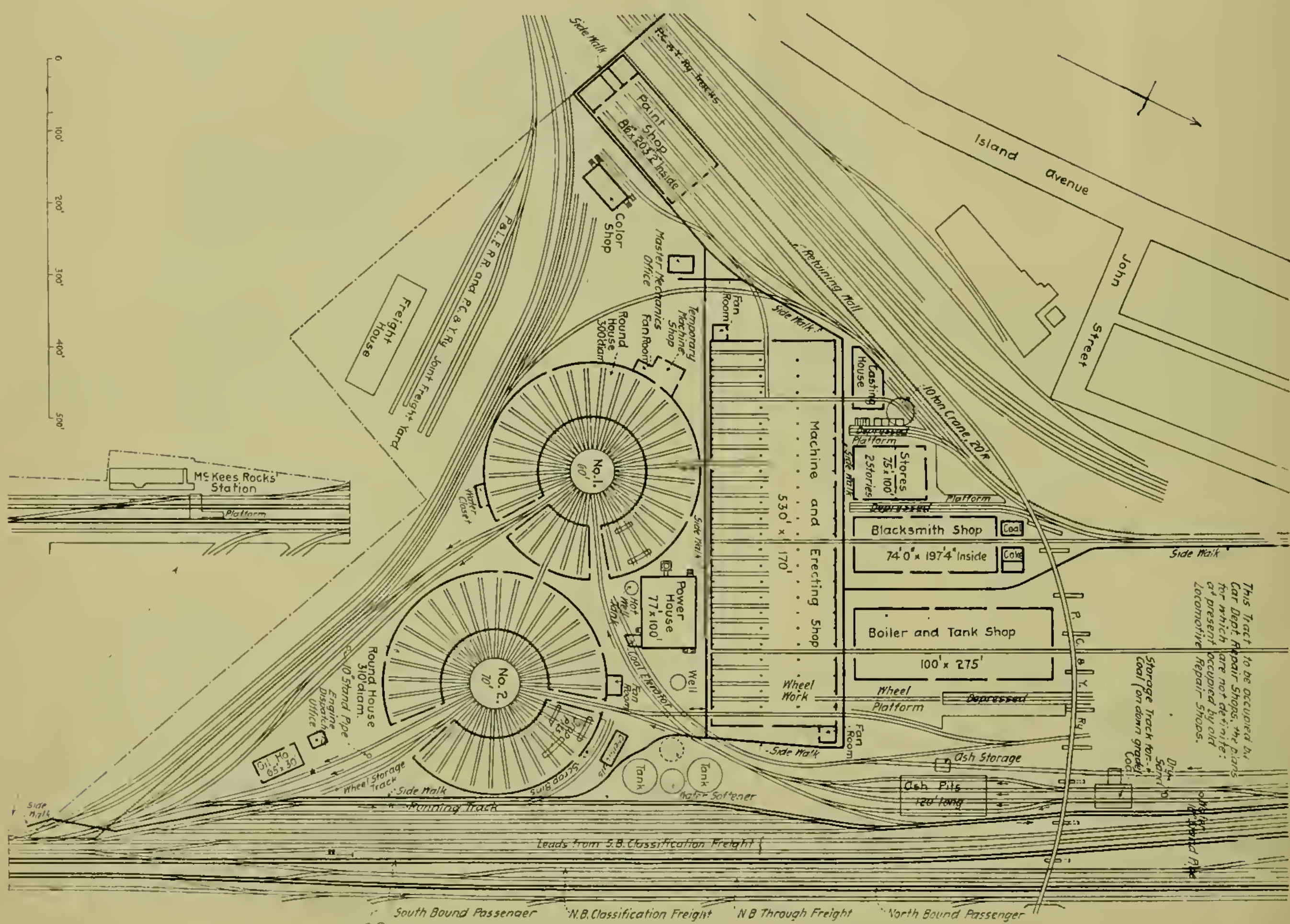
Opinion seems to be divided on the question whether water closet facilities can be maintained inside of shop buildings without becoming a nuisance, but as lavatories can be and urinals should be inside, the closets are often placed inside with them to secure concentration. The room containing these facilities should have independent ventilation to the outside atmosphere without any possibility of escape to the inside of the buildings, and this end is sometimes secured most readily by placing these accommodations on a gallery, or, as has been done in some cases, placing the lavatory and the urinals on the ground floor for convenient access, and the closets on a second floor over them, and open to the roof. If these accommodations are not to be inside the main buildings, they then become a part of the layout problem, and may be made one-story structures located as centrally as possible without forming obstructions to building extensions. On low riparian lands, where sewerage conditions are not favorable, water closets are often provided with a crematory feature.

In the course of time there will naturally gravitate to every large shop for storage a lot of old apparatus (machine tools, etc.), having some potential value, but for which no immediate use can be found. This accumulation can seldom be cared for in the regular storehouse, and is worthy of some special and separate provision, which ordinarily may be limited to an enclosed shed with a track running through it longitudinally along one side, a floor raised a few inches above ground level, and an overhead crane, of perhaps 2½ tons capacity, covering both track and floor and having sufficient headroom to permit the passage of box cars under it. As such a crane would be use only occasionally, it would not pay to have it electrically driven, but a hand crane would be sufficient. Such a storage shed, while well worthy of being considered and provided for in the original layout, may nevertheless be isolated from the other buildings and placed in any available spot.

tables located under the yard crane, while there are several more which are not covered by the yard crane. At this plant the drainage conditions are exceptionally favorable, and inasmuch as the snow fall is maximum, the practical results which may be realized from the use of this installation may be appealed to with confidence.

Layout plans of Elizabethport, N. J. (C. R. R. of N. J.), Sayre, Pa. (L. V.), Topeka, Kan. (A. T. & St. F.), and McKees Rocks, Pa. (P. & L. E.) are submitted herewith, as a basis of comment. Longitudinal erecting shops are used at Elizabethport and Topeka, transverse erecting shops at Sayre and McKees Rocks. Elizabethport and McKees Rocks are new plants throughout; Sayre and Topeka are each a combination of old shops and new shops.

Elizabethport presented a peculiar problem, as the available land took the shape of a right angled triangle. As the



MC KEES ROCKS SHOPS—PITTSBURGH & LAKE ERIE RAILROAD.

The use of 8-ft. turntables outside of buildings is objected to by many and for various reasons: First and most important, because they must be excluded from all tracks over which locomotives are likely to pass, and, second, because their pits are likely to at times fill up with dirt, or be frozen up, and the turntables thus become inoperative. On the other hand, they permit of much more direct truck track connections than any system of switches possibly can, and trucks will make better time over them than over switch connections, as in the latter case the truck must be left while the switch is being turned in more than half the movements. Further, if the pit masonry is good and heavy, carried well below the frost line, and the pit provided with ample drainage, the time the turntable will be out of service will be a very small fraction of working hours, if any. Those 8-ft. turntables, which are under a yard crane, are easily lifted out when there is work to be done in the pits, and at the new Montreal, Can., Angus shop plant of the Canadian Pacific, there are 17, 8-ft. turn-

roundhouse was to serve both the main line and the two diverging branches (only one being shown in the plan) the rectangular corner of the property was naturally the preferred location for it, and this fixed the oilhouse as adjacent to it. The erecting and machine shops were obviously to be kept as close as possible to the roundhouse, as in this case the roundhouse has no machine shop annex of its own. Other considerations suggested that the transfer table be interposed between the roundhouse and the main shop, but this somewhat hinders foot traffic between the two, and also leaves the boiler shop, which always has very intimate relations with the roundhouse, rather far away from it. The smith shop falls into place nicely as regards the main shop building, and has very good connections with the passenger shop, freight shop, and storehouse. The storehouse is somewhat out of the centre of gravity, but has good track connections and shipping facilities; the power house is centrally located as regards power consumption; the transfer table pit is one of the largest in the country, others are longer and narrower, but none has a greater ground area. The passenger car buildings are naturally grouped about the transfer table, the cabinet shop, for convenience, being located in one end of the passenger repair shop, rather than at the more remote planing mill. The paint shop stall tracks are reached from the transfer table only, the yard tracks on the opposite side of the building not running into it. The freight repair facilities include a building and have the planing mill close at hand, the cabinet shop being elsewhere, as is also the case at the new shops of the Pennsylvania at Wilmington, Del. It can be said of Elizabethport that it is possible to extend each individual building in a large ratio.

Sayre was a problem where a very large increase of locomotive repair facilities was imperative. Efforts were made to provide additional structures within the limits of the original shop property, but, as this proved to be impossible without undue congestion and forbidding all future extensions, additional and adjacent property was acquired. Four new buildings house the erecting shop, machine shop, boiler shop, smith shop, storehouse, and power plant, and the work still remaining in the old buildings had to be redistributed. The new main building has track connections into each of its several crane served bays from both ends of the building; those at one end can evidently be used either by locomotives or by hand trucks; those at the other end by hand trucks only. The two erecting shops being of the transverse type, with the long side of the building placed parallel to the track base line, access by turntable was necessary, and the engines after being taken in are lifted over one another to be placed in the repair stalls. The use of 8-ft. turntables outside of buildings has been avoided, and a system of curves and switches substituted by which hand trucks may pass between the three buildings and the six bays of the main building; the storehouse being over 100 ft. wide, the central through-track will be very serviceable in the way of placing road cars in the centre of the floor space for loading and unloading, and not less so in making it possible to run hand trucks in from the shop side as well. It will be noticed that a large lavatory building is to be provided in a space between buildings, but it is not known whether other lavatories are to be provided inside some of the buildings as well.

Topeka was also a problem of enlargement, the available land being across the main tracks from the original shop location. On account of the peculiar shape of the property, the several longitudinal buildings have track connections from one end only, and in order to avoid the necessity of keeping the centre track of the erecting shop always open through to the boiler and tender shop, a turntable is introduced by means of which tenders may be brought into the boiler and tender shop direct, and it naturally follows that the tenders or their frames or tanks when lifted into working position are stood transversely to the length of the building. The exigencies of the particular case made it necessary to have the power house long and narrow instead of the more prevalent type of a building nearly square, which is usually preferred, where possible, as it minimizes pipe connections and presents some other advantages. The smith shop, while favorably located in reference to those other departments which it principally serves, apparently cannot be extended. It will be noticed that the wheel shop has a depressed track adjacent to it to facilitate loading and unloading mounted wheels. The freight car repair shed is a fine example of liberal provision for this class of work, and it covers nearly the whole of the freight repair yard. In the passenger car group of buildings the unusual feature is the use of two transfer tables where one would seem to have answered for the coach shop and paint shop, but possibly the second one is intended to give access to the planing mill, the coach truck shop, and the intermediate yard tracks. Owing to the peculiar conditions of this layout, several cross connecting tracks are required, and it is understood that some of them are provided with pneumatic jack turntables at crossings, which cause no break (other than frogs) in the track rails.

McKees Rocks is a very interesting layout in many particulars. The first thing that attracts attention is that the roundhouse accommodations are unusually liberal in proportion to the size of the shop; next it is observed that the entire available property is occupied from the outset, there being no chance for the expansion of any building in any direction. This probably results from the fact that level tracts of land are very scarce at or near Pittsburg (McKees Rocks being only four miles out) which traffic conditions fix as the natural and preferred shop location. To secure the results aimed at, the distance between the main building is reduced to 25 ft. in several instances, while in a few instances it is even less than that. This ought to be taken as a valuable precedent, as it is always advisable to keep shop buildings as close together as possible, and with modern steel and brick construction and improved fire precautions it is certainly practicable to relax somewhat from the rigid conditions imposed by insurance companies in the days when wood was more largely used in building construction and the modern concentrated shop power plant had not been evolved, the latter being almost always equipped with large and powerful underwriters fire pumps, with steam up and skilled attendants on hand at all times. Other noticeable features are that each roundhouse has two sets of approach tracks, that the ash pits cover four tracks, that the oilhouse is located with reference to the roundhouse rather than the storehouse, that there are three depressed tracks, (one for handling mounted wheels and two alongside of the storehouse) and that the passenger car paint shop is of the longitudinal type.

(*To be continued.*)

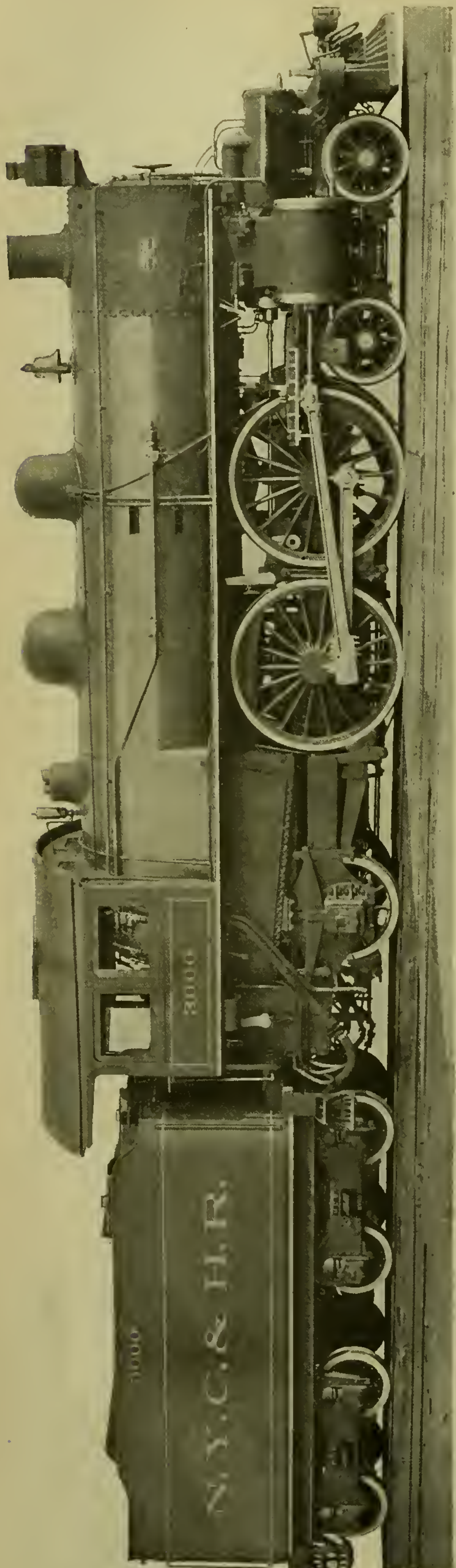
Water Purification—Practical experience has shown that the use of soft water has greatly reduced the amount of boiler repairs. It is an established fact that boilers using soft water give very little trouble from leaky flues. A superintendent of motive power has stated that since the installation of 17 water-softening plants on a busy division of his road, 12 boiler-makers are now required to keep up the boiler repairs where 23 were needed before the plants were installed. The chief engineer of another railroad that has 10 water-softening plants in operation on one division has stated that these plants are removing 2,790 lbs. of incrusting solids from the water per day, and that the saving in boiler repairs alone warrants the expenditure of the amount necessary to treat the waters. Another railroad has recently completed new repair shops that are strictly modern in every respect. In designing the boiler shop the floor space was made considerably less than the average for repair shops of similar capacity. This road has installed 10 water-softening plants, and has found from practical experience with them that the repairs to boilers were so much decreased that it would not be necessary, in order to keep up their boilers, to build a boiler shop of the usual capacity.—*Report to American Railway Engineering and Maintenance of Way Association.*

Mr. Thomas Roope, heretofore superintendent of motive power of the Atchison Topeka & Santa Fe Railway at Topeka, Kansas, has been appointed superintendent of motive power of the Western lines with headquarters at the same place.

Mr. T. N. Gilmore, heretofore master mechanic of the Terminal Railroad Association of St. Louis, has been appointed assistant to the general superintendent of motive power of the Chicago, Rock Island & Pacific Railway, with headquarters in Chicago.

Mr. N. M. Boyden has been appointed master mechanic of the Southern Railway with headquarters at Selma, Ala. He is promoted from the position of foreman of locomotive repairs.

Two Hundred and Thirty Miles Without A Stop.—In connection with the mail service from the United States, the London & Southwestern Railway is preparing to run trains from Plymouth to London, 230 miles, without an intermediate stop. The time of the train is to be 4½ hours, the rate being 51 miles per hour.



FOUR-CYLINDER, BALANCED, DIVIDED COMPOUND LOCOMOTIVE—4-4-2 TYPE.—NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

J. F. DEEMS, *General Superintendent Motive Power.* AMERICAN LOCOMOTIVE COMPANY, SCHENECTADY WORKS, *Builders.*

COLE'S 4-CYLINDER BALANCED COMPOUND LOCOMOTIVE.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

4-4-2 TYPE.

Through the courtesy of Mr. J. F. Deems, general superintendent of motive power, and the American Locomotive Company, this remarkably interesting locomotive is illustrated by a photograph and a more extended description will follow.

This locomotive represents a careful effort to provide as many of the essential elements of the famous De Glehn four-cylinder compound as appeared to the designer advisable to introduce into an American locomotive design at this time. The important elements are four cylinders for compound working, so arranged that their forces, which constitute a disturbing element in the ordinary construction of locomotives, oppose and neutralize each other to produce a balanced engine. The work is divided among four cylinders in such a way that each part has less duty to perform than in the usual construction, and furthermore this engine is arranged to divide the cylinder stresses between two driving axles, instead of concentrating them all upon the crank axle. It seems fitting to remark that this is one of the most promising locomotive designs for American conditions and readers of this journal are urged to watch this development with the greatest care.

In accordance with the position this journal has taken in advocating thorough trials of the principles of the four-cylinder compound and the division and balancing of the cylinder effects Mr. Cole's design is illustrated with pleasure and even gratification. Its appearance marks further evidence of faith in the principles so successfully applied in the De Glehn compounds in Europe. Mr. Cole's design employs but one valve motion on each side of the engine and thus stops short of De Glehn's complete idea. The advent of a balanced and divided compound by the American Locomotive Company together with the ready acceptance of 4-cylinder balanced compounds built by the Baldwin Locomotive Works, certainly seems significant of a new era in American locomotive design.

In this journal for April, 1903, page 145, Mr. Cole's arrangement of cylinders was described and we shall present the details of construction and a description of the design in our next issue. This locomotive will form part of the exhibit of the New York Central Railroad at St. Louis. The leading dimensions are given in the following table:

FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE.
COLE SYSTEM.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

GENERAL DIMENSIONS.	
Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal
Weight in working order	200,000 lbs.
Weight on drivers	110,000 lbs.
Weight engine and tender in working order	321,600 lbs.
Wheel base, driving	7 ft.
Wheel base, rigid	16 ft. 6 ins.
Wheel base, total	27 ft. 9 ins.
Wheel base, total, engine and tender	53 ft. 8 ins.
CYLINDERS.	
Diameter of cylinders	15½ ins. and 26 ins.
Stroke of piston	26 ins.
Horizontal thickness of piston: Low pressure, outside, 5¼ ins.; high pressure, inside, 6¼ ins.	
Diameter of piston rod	3 ins.
Kind of piston packing	Cast-iron rings
Kind of piston-rod packing	U. S. metallic, with Gibbs vibrating cup
VALVES.	
Kind of slide valves	Piston type
Greatest travel of slide valves	6 ins.
Outside lap of slide valves	1 in.
Inside clear of slide valves	High pressure, ¼ in.; low pressure, ⅜ in.
Lead of valves in full gear: ¼-in. lead forward motion when cutting off at 11 ins. of the stroke	
Kind of valve-stem packing	U. S. metallic
WHEELS, ETC.	
Number of driving wheels	4
Diameter of driving wheels outside of tire	79 ins.
Material of driving-wheel centers	Cast steel
Thickness of tire	3½ ins.
Driving box material	Cast steel
Diameter and length of driving journals	10 ins. diameter x 12 ins.
Diameter and length of main crankpin journals: (Back side, 6¾ x 4 ins.)	Back, 6 ins. diameter x 6 ins.
Diameter and length of side-rod crankpin journals:	Front, 5 ins. diameter x 3¼ ins.
Engine truck, kind	Four-wheel swing cen. bear, spring centering device railroad company style

Engine-truck journals	6½ ins. diameter x 12 ins.
Diameter of engine-truck wheels	36 ins.
Kind of engine-truck wheels	Krupp No. 3 cast-iron spoke, 3⅛ ins.
Trailing truck rigid, with outsire journals	8 x 14 ins.
Trailing-track wheels, diameter	50 ins.

BOILER.

Style	Straight top, radial stay
Outside diameter of first ring	72¼ ins.
Working pressure	220 lbs.
Material of barrel and outside of firebox	Coatsville (Worth Bros.) steel
Thickness of plates in barrel and outside of firebox	13-16, 9-16, ⅝ in.
Firebox, length	96⅛ ins.
Firebox, width	75¼ ins.
Firebox, depth	Front, 80¼ ins.; back, 69 ins.
Firebox, material	Carbon steel
Firebox plates, thickness: Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube sheet, ½ in.	
Firebox, water space: Front, 4 and 5 ins.; sides, 3½ and 5½ ins.; back, 3½ and 4½ ins.	
Firebox, crown staying	Radial
Firebox, staybolts	Taylor iron 1 in. diameter U. S.
Tubes, number	390
Tubes, diameter	2 ins.
Tubes, length over tube sheets	16 ft.
Fire brick, supported on	Water tubes
Heating surface, tubes	3,248.1 sq. ft.
Heating surface, water tubes	23 sq. ft.
Heating surface, firebox	175 sq. ft.
Heating surface, total	3,446.1 sq. ft.
Grate surface	50.3 sq. ft.
Exhaust nozzles	5¾ ins., 5⅝ ins., 5⅞ ins. diameter
Smokestack, inside diameter	18 ins.
Smokestack, top above rail	14 ft. 8 ins.

TENDER.

Weight, empty	51,600 lbs.
Wheels, number	8
Wheels, diameter	36 ins.
Journals, diameter and length	5½ ins. diameter x 10 ins.
Wheel base	16 ft. 9½ ins.
Tender frame	10-in. channels
Tender trucks	Fox pressed-steel frames and bolsters
Water capacity	6 000 U. S. gals.
Coal capacity	10 tons

of 70,000 lbs. when running as a compound. Many points of interest in the design must be left for further consideration in another article. This locomotive is believed to be the most interesting and significant development in the construction of very heavy units and a careful study leads to the conclusion that it must be successful in principle, the only uncertainties being in minor details. It is well that the Mallet type should be tried in this country and the boldness of Mr. Muhlfeld and the builders in attacking the problem on so large a scale is to be commended. It is believed that if this locomotive is successful, and there is every reason to believe it will be, it will mark an important step in the further development of the very large freight locomotive.

This boiler weighs 117,000 lbs. with water, but without the exterior fittings. The weight of the water alone is 33,000 lbs. and that of the tubes 27,000 lbs., the weight of the shell and fire-box without tubes being 57,000 lbs. The shell plates are 1 in. thick, the roof sheet ⅝ in., the front tube sheet ¾ in., the back head ⅝ in. and the throat sheet 1 in. The horizontal seams are butt jointed, sextuple riveted, with 1¼-in. rivets, the joints being designed for 70 per cent efficiency. The circumferential seams are double riveted with 1¼ in. rivets, the joints having an efficiency of 50 per cent. The working pressure is to be 235 lbs. per sq. in. The fire-box is 108 in. long by 96 in. wide; 80 in. deep at the front end and 72 in. at the back end. The fire-box plates are of the following thickness: sides ⅜ in., crown 7-16 in., tube sheet ½ in., door sheet ⅜ in.

THE LARGEST LOCOMOTIVE BOILER IN THE WORLD. BUILT BY THE AMERICAN LOCOMOTIVE COMPANY.
MALLET COMPOUND LOCOMOTIVE, BALTIMORE & OHIO RAILROAD.

THE LARGEST OF LOCOMOTIVE BOILERS.

For Mallet Compound Locomotive—Baltimore & Ohio R. R.

This photograph illustrates the enormous boiler of the compound locomotive of the Mallet type which is being built by the American Locomotive Company at Schenectady for the Baltimore & Ohio Railroad. It is the largest boiler ever constructed for a locomotive, and because of the interesting character of the design a number of the details of construction will be presented in this journal when the work is finished.

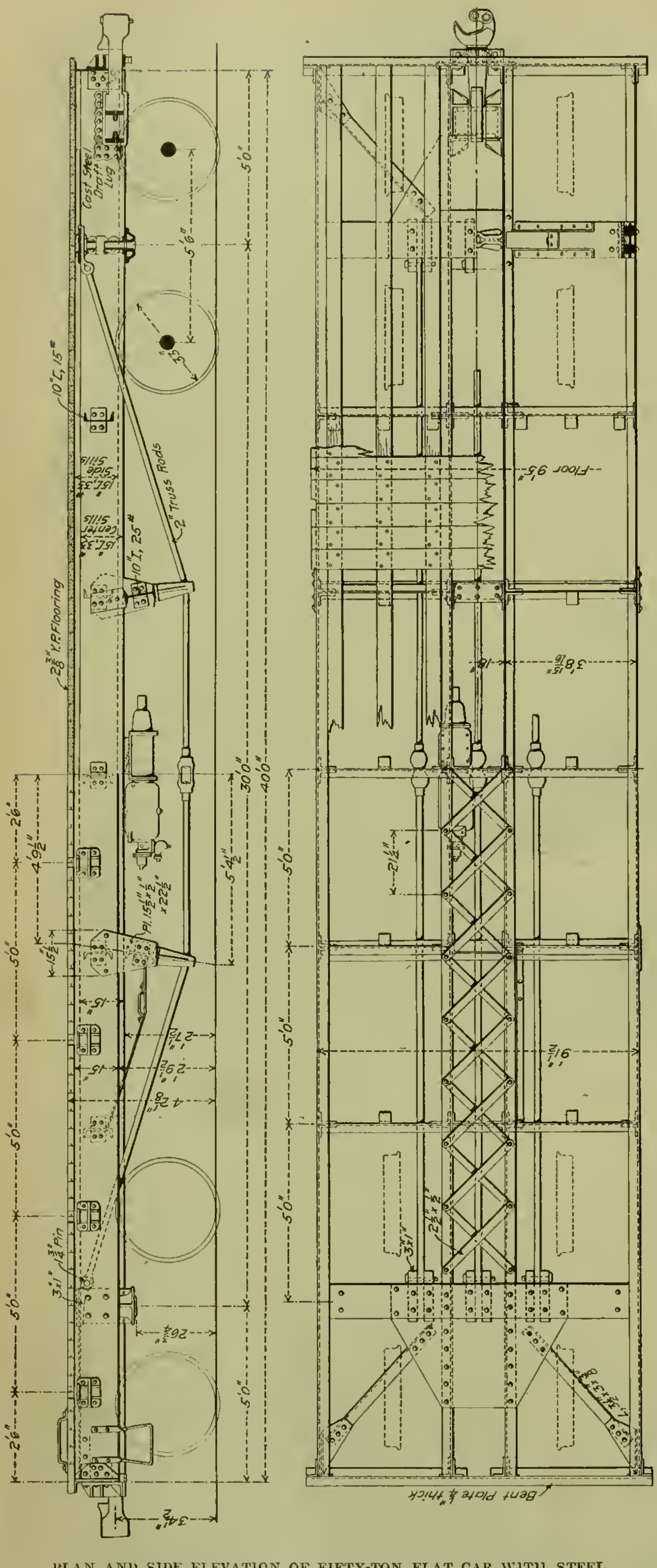
In many ways this is the most remarkable locomotive ever constructed. Its total weight will be over 300,000 lbs., all of which is on the driving wheels. It will replace two heavy consolidation locomotives in pushing service over a hilly and very crooked track. It is built on the principle that where the grades are heavy the shortest wheel base is required and also embodies the principle of dividing the stresses produced in furnishing a draw-bar pull of 85,000 lbs. (in starting) among double the number of parts of running gear which have heretofore been applied in the construction of very large American locomotives. This engine is expected to exert a tractive effort

The mud ring is 6 in. wide in front and 5 in. wide at the sides and back.

This boiler provides 5,372 sq. ft. of heating surface in the tubes; 219 sq. ft. in the firebox, making a total of 5,591 sq. ft., which is 201 more square feet than the heating surface of the big Santa Fe locomotives illustrated in this journal in June, 1902, page 192. The Baltimore & Ohio boiler has 72.25 sq. ft. of grate area. It is 38 ft. 5 in. long from the front to the firebox door, and the diameter at the third ring is 88 in. Its enormous size is appreciated from the figure of the man standing beside it.

This photograph and information are presented through the courtesy of Mr. J. E. Muhlfeld, General Superintendent Motive Power, Baltimore & Ohio Railroad. The locomotive will be tested on the grades where it is to work on the Baltimore & Ohio, and will then be sent to the St. Louis Exposition to form part of the exhibit of that road.

John Reilly, president of the United States Metallic Packing Company died April 19, at the age of 69 years. He was connected with the Pennsylvania Railroad for thirty-one years and had been at the head of the United States Metallic Packing Company for fifteen years. He was held in high esteem by his associates, subordinates and friends.

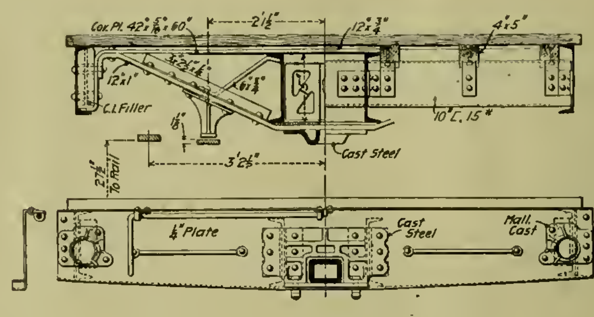


PLAN AND SIDE ELEVATION OF FIFTY-TON FLAT CAR WITH STEEL UNDERFRAME AND TRUSS RODS.
BUILT BY THE MIDDLETOWN CAR WORKS.

100,000-POUND STEEL UNDERFRAME FLAT CAR.

The Standard Steel Works of Philadelphia have received a 40-ft. steel underframe flat car of 50 tons capacity from the Middletown Car Works, Middletown, Pa., built to the design of Mr. Geo. I. King, vice-president and general manager of the car works.

The underframe is in general similar in construction to that used by this company in other cars of this and also the box type. It has the unusual feature of truss rods, three in number, which, as shown in the engravings, extend from bolster to bolster, as shown in the plan. All of these truss rods are near the center of the car, one of them being immediately under the center line. The car has the following general dimensions:



CROSS-SECTION AND END ELEVATION.

Length over end sills	40 ft.
Center to center of trucks	30 ft.
Width over side sills	9 ft. 1½ ins.
Width over flooring	9 ft. 5 ins.
Height from top of rail to top of floor	4 ft. 2⅛ ins.
Wheel face of truck	5 ft. 6 ins.
Weight	37,840 lbs.

The center sills are 15 ins., 33 lbs. channels with the flanges turned outward. The side sills are 15 ins., 33 lbs. channels with the flanges turned inward. The bolsters are 1 by 12-in. plates for the lower members, and ¾ by 12-in. plates for the upper members. These have large gusset plates extending over the center sills towards the ends of the car, and to them are secured the corner bracing angles. The end sills are of bent plate, ¼ in. thick. The needle beams are 10-in. 25-lb. I-beams.

The idea in supplying this car with 2-in. truss rods is to permit of constructing the car to withstand compression and pulling stresses, as a column, and yet without making the center sills sufficiently heavy to withstand heavy service shocks without support. The truss rods are used to secure the necessary strength, and yet permit of employing relatively light center sills. The drawings show the location of the six 4 by 5 in. nailing strips for the flooring.

Mr. A. E. Mitchell has resigned as superintendent of motive power of the Northern Pacific Railway to succeed Mr. H. D. Taylor, as superintendent of motive power of the Lehigh Valley. Mr. Mitchell is a graduate of the Maine State College and began his experience as an apprentice at the Baldwin Locomotive Works. His first railroad service was in the test department of the Pennsylvania Railroad in 1877. He has had manufacturing experience, has been signal engineer of the New York, Lake Erie & Western, mechanical engineer of the Chicago & Erie and in 1892 was made superintendent of motive power of the Erie. Three years ago he went to the Chicago, Milwaukee & St. Paul as assistant superintendent of motive power and two years ago took charge of the motive power department of the Northern Pacific.

Mr. H. D. Taylor has resigned as superintendent of motive power of the Lehigh Valley Railroad.

Missouri Pacific New Shops—It is announced that the new main shops of this road, which will cost about $1,000,000, will be located at Sedalia, Mo.

NEW LOCOMOTIVE AND CAR SHOPS.

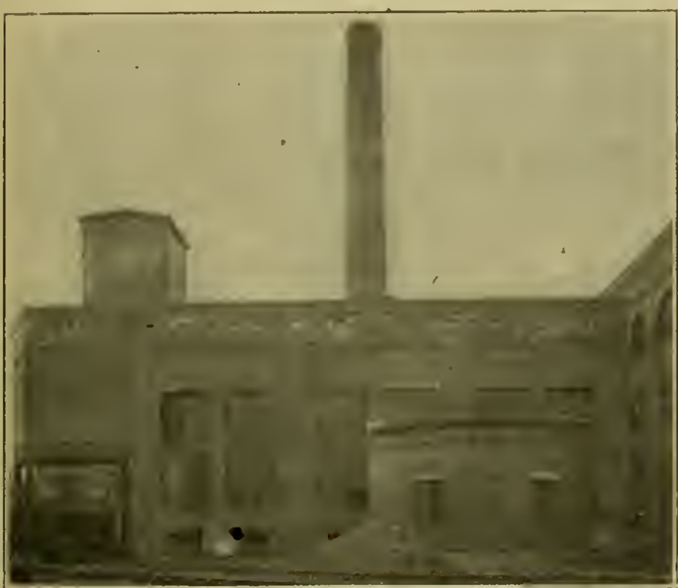
McKEES ROCKS, PA.

PITTSBURG & LAKE ERIE RAILROAD.

V.

THE POWER PLANT.

The power plant is the heart of the shop installation at McKees Rocks. In it is generated all power that is used in the shops, whether in the form of compressed air, steam for the hammers, or electricity for the motors and electric lighting. The desirability of generating the power for all these various uses at a central point and then distributing it to points of consumption is emphasized by the thorough and substantial character of the design of this plant. No more complete or better equipped power plant has ever been installed for use in connection with a railroad repair shop.



EXTERIOR OF POWER HOUSE, SHOWING COAL CAR OVER UNLOADING HOPPER AND ASH STORAGE ABOVE. WELL HOUSE IN FOREGROUND AT RIGHT.

As was pointed out in the initial article of this series (November, 1903, page 398), while the power plant is situated some distance to the south of the geographical centre of the shop layout, it lies very close to the centre of power consumption of the entire shop layout, including both locomotive department and the proposed car department shops, which is the governing factor in power transmission. A glance at the layout drawing of the McKees Rocks shops, in the above-mentioned article, will show, furthermore, that its location is most convenient for the operation of the water-supply system and the heating system for the shops, and also that easy access for cars to the coal and ash handling apparatus is here provided for by a side track connection.

The power house is a substantial steel and brick building, 75 ft. x 100 ft. in size inside, with a clear vertical height of 27 ft. beneath the roof trusses. It is divided by a division wall into a boiler room, 38 ft. wide, on the south side and the engine room, 34 ft. wide, on the north. There is a spacious basement, having 10 ft. of clear height beneath the floors, surrounding the boiler and engine foundations and giving easy access to the auxiliary machinery and piping systems. In the basement is also located a very convenient and well appointed bathroom and lavatory for the convenience of the attendants.

The important details of the building are well shown in the accompanying cross section and plan views of the plant, which also show the arrangement of apparatus. The external views will show the appearance of the power house. The construction indicates a liberal use of concrete in foundations and floors, tending to render the plant fireproof. Both the wall and the engine foundations are of very substantial construction. The engine room roof is supported by steel trusses resting upon wall columns ending in heavy brackets at the top, as shown in the cross section; the boiler room roof trusses extend only from the division wall to the row of columns placed in line with the boiler fronts to support the coal storage bins, the remainder of the span being covered by a separate narrow roof over the coal bins. The wall columns in the engine room are enlarged to a height of 18 ft. above the floor to carry the runways for the traveling crane, which is a 10-ton hand-operated traveling crane built by Maris Bros., of Philadelphia, Pa. This crane is constructed of 4-ft. plate girders and has a span between crane tracks of 32 ft.

The steam generating equipment of the plant consists of six Babcock & Wilcox vertical header water-tube boilers, each of 264 h. p. rated capacity at 150 lbs. steam pressure. They are installed in three batteries of two boilers each and are conveniently arranged with intervening spaces for access. The estimated maximum load, including that required by the locomotive washing out plant, was 1,500 boiler horse power. It was found that this was approximately right, though at the peak of the load on cold days during last winter the load was above that. Yet four boilers were found sufficient, and thus there were two boilers in reserve.

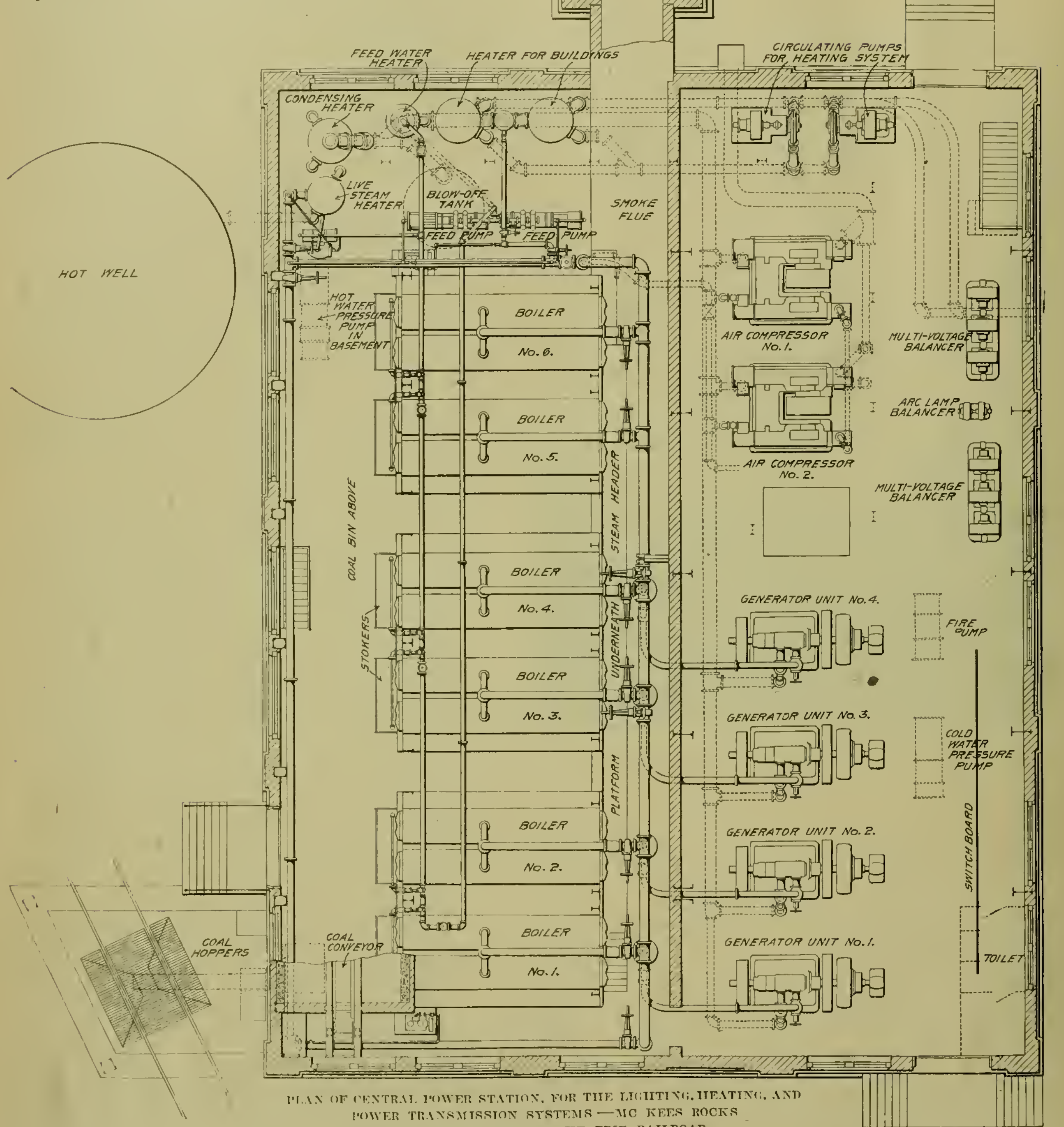
These boilers involve the latest improvements and best approved construction of the Babcock & Wilcox Company including recent improvements in pressed steel headers and steam drum flanges and fittings.

Each boiler is equipped with a Roney mechanical stoker for automatic firing. Each stoker is 100 ins. wide and is 20 grates deep. Coal is delivered into the stoker hoppers directly from chutes leading from the overhead coal bins, and the stokers are driven by a 4½ by 4-in. Westinghouse standard stoker engine. Natural draft is supplied for the fires by a Custodis brick stack, located outside the boiler room, as shown on the plan drawing, and connected to the various boilers by a breeching of structural steel and fire-brick construction. The stack is 135 ft. high above the grates and is 8 ft. in diameter inside. The flue connections are well provided with dampers for regulating the draught or cutting a boiler out for repairs.

The coal and ash handling equipment of the plant is very complete. As may be seen from the layout plan (November issue, 1903, page 396), coal is delivered to the power plant by a spur track, leading past one corner of the boiler room. This track passes over a receiving hopper, into which the coal may be dumped directly from hopper cars. The coal thence passes through a proper grating and is hoisted by an endless-chain bucket conveyor, of the Heyl and Patterson type, to the top of the building. From here it is dumped onto a horizontal conveyor, which deposits at the points desired in the storage bins located in the upper part of the boiler room and arranged to feed into the stoker hoppers directly by chutes. The hoisting mechanism is operated by a 10-h. p. Crocker-Wheeler motor in the basement and the horizontal conveyor by a 7½-h. p. motor of similar make; the actual power required by the two conveyors when running is, however, about 7½ and 4 h. p. respectively. The capacity of this hoisting and conveying equipment is 40 tons per hour, the total storage capacity of the coal bunkers being 200 tons.

The ashes are handled by the same hoisting conveyor as is used for the coal, a storage pocket for the same having been arranged upon an elevated structure above the coal receiving track. In this way, when a carload of coal has been dumped into the receiving hopper below, the car may be utilized for removing the ashes without further shifting—they are merely dumped from the hopper above. The ashes are handled from the ash-pits beneath the boilers by special wheelbarrows and then dumped into the hoisting conveyor, which may be arranged to deliver at the top into the ash hopper side. The complete arrangement of this coal and ash handling system of conveyors is clearly shown by the cross-section drawing of the plant. The vertical hoisting conveyor is located just outside the south-east corner of the boiler room; the chutes used to direct either coal or ashes into it, as well as the motor driving it, being shown in the basement. At the top are located the deflecting chutes for delivering either into the ash bin or into the coal storage system.

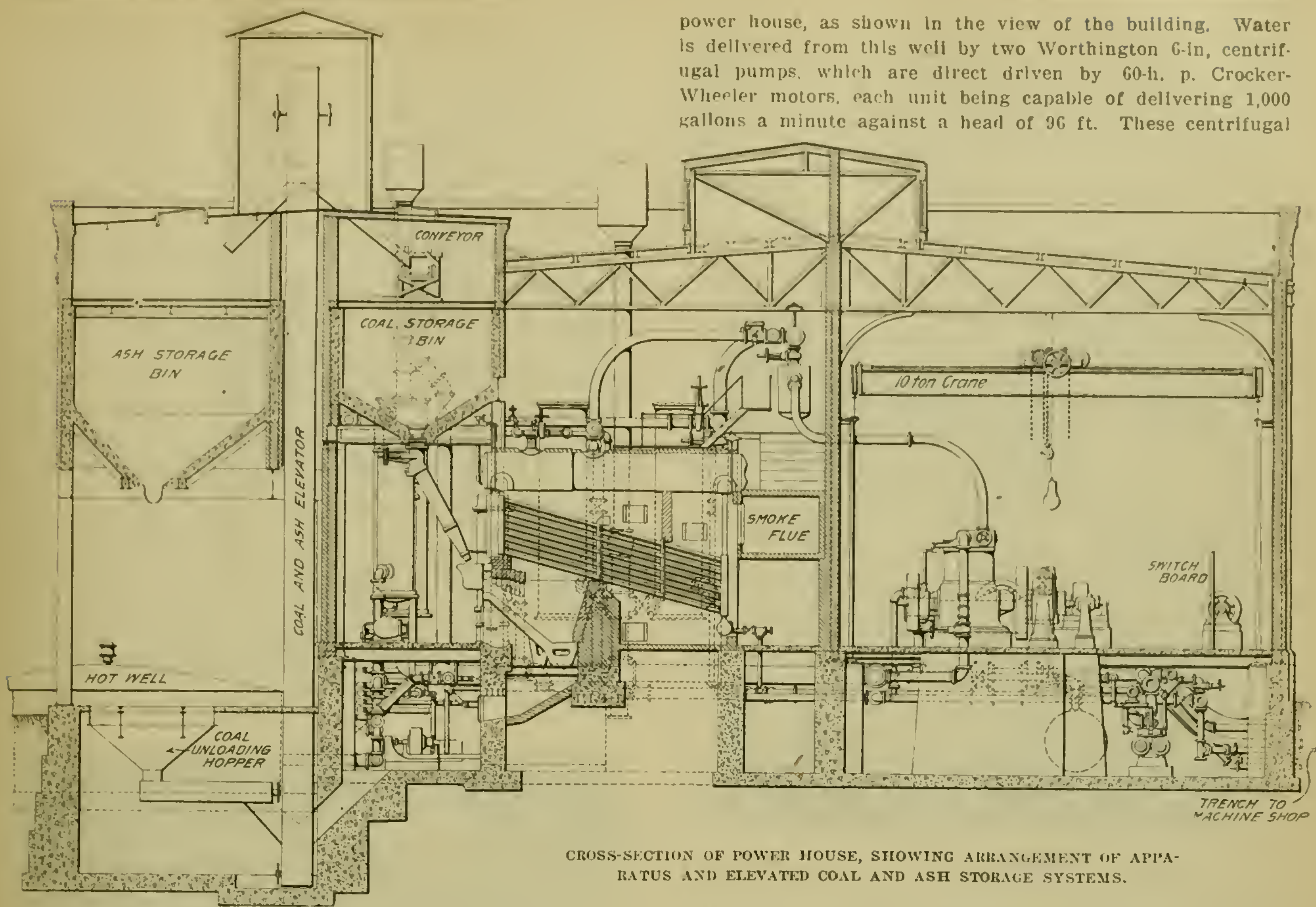
The construction of both the ash storage bin and the coal



PLAN OF CENTRAL POWER STATION, FOR THE LIGHTING, HEATING, AND POWER TRANSMISSION SYSTEMS.—MC KEES ROCKS SHOPS, PITTSBURGH & LAKE ERIE RAILROAD.

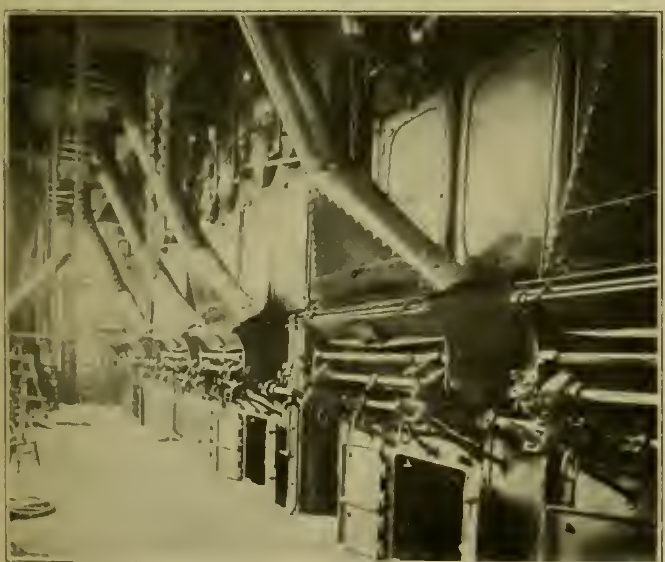
storage hoppers is well shown in the cross-section. The ash bin is of concrete upon steel framework, with the lowest point of the hopper 16 ft. above rail level. The coal hoppers, six in number, are of similar construction, with their outlets 12 ft. above the boiler room floor. The coal outlets are controlled by special gate valves operated from the floor by chains passing over the wheels. The coal is distributed to the various pockets by the horizontal conveyor shown, which may be arranged to dump at any point. A protection for the top of the hoisting conveyor is provided for by a small enclosure above the roof; this is well shown in the exterior view of the power plant.

A very complete system of boiler room auxiliaries has been installed in the plant. The boilers are fed by two outside-packed Worthington pumps, with "pot valves," having 9-in. steam cylinders, 5-in. water cylinders and a common 10-in. stroke. Water is delivered from these pumps to the boilers through a Goubert hot water heater of 1,000 h. p. rated capacity. The main feed line to boilers is of brass pipe and fittings throughout, and to further minimize any danger from interruption of feed water supply the feed line forms a loop so that any section may cut out. In addition to the boiler feed pumps, there is a large 16-in. by 10¼-in. by 10-in. stroke Worthington fire-pump in the engine room basement, which is



CROSS-SECTION OF POWER HOUSE, SHOWING ARRANGEMENT OF APPARATUS AND ELEVATED COAL AND ASH STORAGE SYSTEMS.

capable of throwing four 1⅛-in. fire-streams. This is connected to a system of high pressure fire-mains, leading to hydrants, located at convenient positions on the shop grounds. There is also a low-pressure water pump for supplying water to the lavatories and other low-pressure water



BOILER ROOM, SHOWING COAL CHUTES FROM STORAGE HOPPERS ABOVE. BABCOCK AND WILCOX BOILERS.

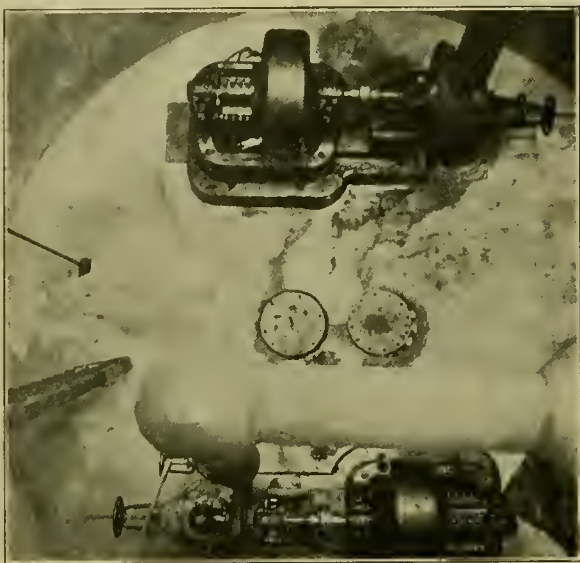
service through the shop buildings. The latter pump, which was built by the Warren steam Pump Company is an 8 in. by 6-in. by 12-in. stroke pump of 300 gallons per minute capacity. A superheater drip discharge pump, 6 by 4 by 6 in. in size, automatically controlled, complete the auxiliary equipment.

Water is supplied to the plant from a large well outside the power house, as shown in the view of the building. Water is delivered from this well by two Worthington 6-in. centrifugal pumps, which are direct driven by 60-h. p. Crocker-Wheeler motors, each unit being capable of delivering 1,000 gallons a minute against a head of 96 ft. These centrifugal pumps are located down in the well pit at a level above the water, as shown in the accompanying engraving from a photograph taken looking vertically downward upon them; this is a remarkable photograph, corresponding as it does to a plan drawing, and it was taken under great difficulties by Mr. R. T. McMasters, of the engineering department of the system.

FEED WATER HEATERS AND BOILER-FEED PUMPS IN BOILER ROOM. STOKER ENGINE AT RIGHT.

The space in the well is large enough to accommodate two additional pumping units. These pumps deliver the water to the top of the Kennicott water softener near by, which has been described in recent issues of this journal, where it is chemically treated and then flows by gravity to the various pumps in the power plant. There are, of course, the necessary by-pass connections, so that raw water may be delivered di rect from the well to the pumps, if desired, or in emergency.

In addition to the boiler auxiliary pumps there is installed in the power plant a complete equipment of steam pumps, including a cold-water pressure pump, a hot-water pressure pump, a high pressure testing pump, etc., for use in connection with the new system of boiler washing and testing, which is being installed at the McKees Rocks roundhouse and shops. The hot and cold water pressure pumps are both compound steam pumps, with cylinders 12-ins. and 18 ins. by 12 ins., with common 18-in. stroke, and each has a capacity of about 1,000 gallons per minute. The high pressure pump for testing of locomotive boilers has cylinders of 6 and 2½ ins. diameter by



PLAN VIEW OF MOTOR-DRIVEN CENTRIFUGAL WATER-SUPPLY PUMPS, IN WELL PIT.—VIEW TAKEN LOOKING VERTICALLY DOWNWARD.

6 ins. stroke, and has a capacity of 30 gallons per minute against a pressure of 300 lbs. The latter pumps were all supplied by the Warren Steam Pump Company. The piping for the pumps is carefully arranged, so that nearly any pump can be quickly connected up for any service; in this way a complete interruption of any of the different services is almost impossible.

The arrangement of the apparatus in the engine room, as well as in the boiler room, is indicated in the plan drawing. The electrical generating units and the air compressors form the principal part of the engine room equipment, but there are also the two motor-driven centrifugal pumps for the heating system, at one end, and the three balancer units for the 4-wire multiple voltage system and the arc lighting system, at the side, next to the switchboard. The centrifugal hot-water pumps at the west end, together with the two large water heaters at the west end of the boiler room, will be referred to in the following article of this series in connection with the shop heating system, which is operated on the hot-water-recirculating system; the heaters are used to heat the circulating water for the radiators while the centrifugal pumps serve to force the water through the heating pipe system.

The two air compressors are located between the centrifugal pumps and the main engines, as shown in the foreground in the engine room view. These are the well-known "Imperial" type of air compressors, built by the Rand Drill Company, and supply compressed air for the various uses about the roundhouse and shops. Each machine has a capacity of compressing 1,000 cu. ft. of free air per minute to a pressure of 100 lbs. per sq. in.

The electrical generating units, of which there are four, consist of standard Westinghouse single-acting non-condensing compound engines, direct-connected to Westinghouse dynamos of the multipolar engine type, with outboard bearings. The engines have cylinders 14 and 24 ins. in diameter with a 14-in. stroke and operate at a normal speed of 280 rev. per min. Their rated capacity at this speed and with the normal steam pressure of 150 lbs. is 250 h. p. These engines are equipped with the usual centrifugal type of shaft governor, and are designed with particular care with reference to speed regulations; they all have similar characteristics in this respect, so that the power delivered is proportional to the load.

The engines are conveniently equipped with an elevated platform, permitting access to the throttle valves and valve gear, this platform leading from one engine to another. Practically the entire operation of the engines is controlled from these points. The arrangement of the generating units is well shown in the engine room view presented herewith.

The generators are direct-current multipolar machines of the direct-connected engine type and each has a capacity of 150 kilowatts at a voltage of 240 volts. These generators are over-compounded sufficiently to maintain the voltage throughout the entire range of load and overload, and each machine is guaranteed to be capable of carrying an overload of 50 per cent. above its rated capacity for one hour immediately following a 24-hour full load test and overloads of 75 per cent of short intervals. All the generators feed to common bus bars on the switchboard, which causes the total load delivered to be shared equally among all the machines in service.

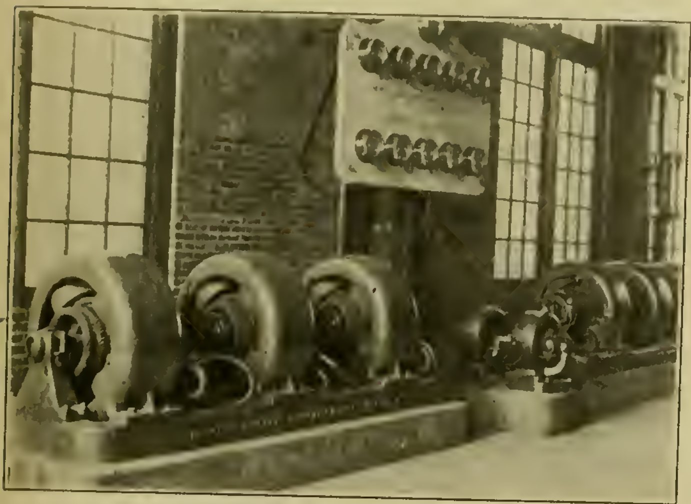
In the design of the electric generating equipment, it was estimated that, at the "peak" of the load, which will come in the winter months, when, in addition to the usual motor load, all the lighting will be in service, all four of the generators will be required in service. During the past winter never more than three units were in use at one time. But as this "peak" will last for only a few hours at a time on each dark winter day there will be obviously ample opportunity to keep

ENGINE ROOM VIEW, SHOWING STEAM PIPING ARRANGEMENT. RAND AIR COMPRESSORS AT RIGHT.

the machine in good repair. In fact, on the average, only from two to three machines will be kept in service, varying according to the load, which will practically leave one unit free, for repairs and the necessary attention to be given it at leisure. Space has been left in the engine room, however, for an additional generating unit to be installed, if required by growth of the load.

A large 18-panel switchboard is used for controlling the current from the generating units and also that for the various distribution circuits. The board is beautifully constructed of 2-in. blue Vermont marble, mounted upon a substantial angle iron frame and located 5 ft. from the wall, so as to permit ease of access to the connections at the rear. An excellent view of this board is presented in an accompanying half-tone. The fittings upon the switchboard were designed for neatness of appearance and the marble was carefully selected for freedom from metallic strata. The board was built by the H. Krantz Manufacturing Company; it is 7½ ft. high by 32 ft. 8 ins. long.

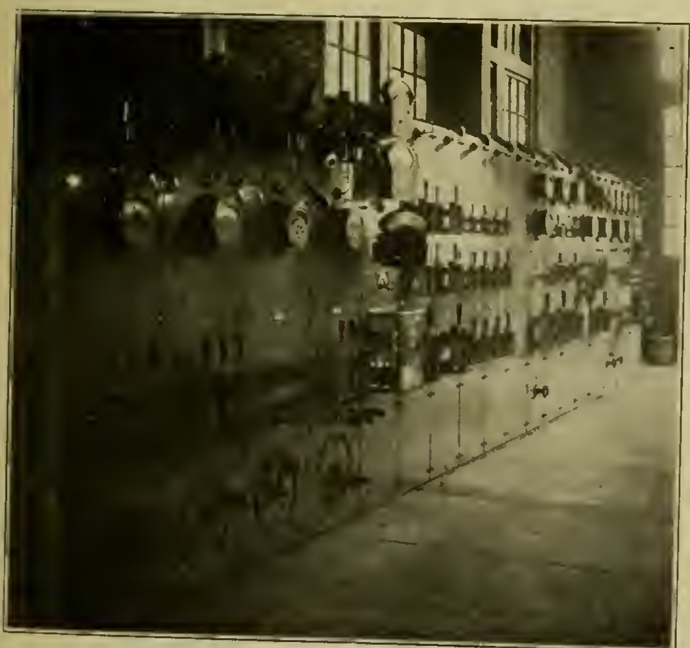
The four panels at the left end of the switchboard contain the necessary apparatus for controlling the generating units, one being used for each machine. The fifth panel contains the indicating and recording ammeters and other apparatus for a total load panel. The remaining 13 panels are for the distribution circuits as follows: Panels 6, 7, 8 and 9 control four principal power circuits, which deliver current to the constant speed motors and to the incandescent light circuits, the tenth panel being held in reserve for extensions. Panels 11, 12 and 13 are used for the arc lighting system, the eleventh being used to control the circuits for the arc-light system balancer unit. The remaining panels are devoted to the multiple voltage circuits; panel 14 is the power-controlling panel for the multiple-voltage, variable-speed motors; the following



DUPLICATE BALANCERS FOR THE MULTIPLE-VOLTAGE SYSTEM AND SMALL COMPENSATING BALANCER FOR THE ARC LIGHTING SYSTEM.

three panels control the Crocker-Wheeler balancer units for this system, and the last panel controls the 4-wire multiple voltage feeders.

In the illustration which shows the beautiful marble pressure-gauge board in the engine room, may also be seen two of the three-unit rotary transformers, which are used as balancers for the 4-wire multiple-voltage distribution system. As is



THE SWITCHBOARD, CONTROLLING ALL POWER AND LIGHTING DISTRIBUTION CIRCUITS.

well known, the balancers are used for the purpose of generating the intermediate, or "low" voltages, which are interposed between the two main voltages that are generated by the main dynamos. The principle of the multiple voltage system is generally well understood, but for further details we would refer our readers to the extended description of this system of variable-speed electric driving, which appeared in connection with the series of articles describing the Collinwood shops of the L. S. & M. S. Ry. The characteristic features of the multiple voltage system were referred to in detail in that series on pages 23 and 24 of our January, 1903, issue. The different voltages made available by this system are 40, 80, 120, 160, 200 and 240 volts, as is the case at the Collinwood installation. These balancers were installed in duplicate on account of the importance of maintaining uninterrupted service for the machine tool driving. Each balancer has a capacity of 35 kw.

In addition to the two balancer units may also be seen a small two-unit rotary transformer, or balancer, which is used in connection with the arc-lighting system. The arc lights which are used in the shop and yard lighting system are operated at 120 volts; inasmuch as the main generator voltage is 240 volts, this necessitated the operation of the arc lights upon the 3-wire system. The balancer serves the purpose of equalizing the division of load upon the two sides of the system, which it does automatically; if the load is equally divided it has no work to do, and is only called into operation when the load becomes out of balance. The capacity of this balancer is only 3½ kilowatts; this seems small, in view of the fact that the arc lamps require a total of 150 kilowatts, but it is found that the lamps balance each other very closely on the two sides of the circuits. It has been found that the unbalanced load rarely becomes more than 7½ amperes. The arc lamps used are the Adams-Bagnall 120-volt lamps, of the long-burning enclosed-arc type; the incandescent lamps operate directly upon the main 240-volt circuits.

This interesting plant was designed by the engineering firm of Westinghouse, Church, Kerr & Company, New York, under the supervision of the engineering department of the Pittsburgh & Lake Erie. We are greatly indebted to Mr. A. R. Raymer, Assistant Chief Engineer, and to Mr. G. M. Campbell, Electrical Engineer, for this information.

Master Car Builders' Drop Testing Machine.—This machine, which for some time has been in process of erection, is now completed and ready for use. It will be remembered that, by direction of the association, this machine has been installed at the laboratory of Purdue University, Lafayette, Ind., where it will be operated under conditions similar to those prevailing in connection with the Master Car Builders' brake shoe testing machine and the Master Car Builders' air brake testing rack. The conditions are such that the machine may be used not only by committees of the Master Car Builders' Association, but also by individual railway companies and manufacturers as well. The machine has already been described in detail in the proceedings of the association for 1903. It is especially designed to test couplers, draft gears, axles, rails and bolsters. Parties interested in making use of the machine should communicate with Prof. W. F. M. Goss, Dean of the Schools of Engineering, Purdue University, Lafayette, Ind.

Railway Storekeepers' Association.—This new organization, which was started last February, promises to be an important one in improving the administration of store departments of railroads and in the handling of supplies. The organization is one which should secure the interest and co-operation of motive power officials because of the importance of proper handling of material, which has a very definite bearing upon the cost of work in locomotive shops. The association is quite new, and it promises to become valuable in introducing commercial principles into this department. Mr. J. P. Murphy, general storekeeper of the Lake Shore & Michigan Central Railway, Collinwood, Ohio, is the president, and the first annual meeting for the consideration of business will be held in Chicago during the current month.

High Speed Locomotive—The three-cylinder locomotive designed and built by Henschel & Son, Cassell, Germany, in a trial run between Gottingen and Bovenden, made a speed of 78.74 miles per hour, on straight track. It is to be tried on the experimental track between Marienfeld and Zossen, where the famous electric locomotive tests have been made. This is known as the Wittfeld locomotive, from its designer, who is connected with this firm of builders.

APPRENTICE SCHOOLS ON ENGLISH RAILWAYS.

Editorial Correspondence.

London, England.

America has much to learn from England with respect to apprenticeship in the mechanical trades. England is not only well supplied with apprentices, but with facilities for educating them outside of the shops. I spent some time in looking over the situation of apprentices on the railroads and was surprised, not only by the numbers of apprentices, but with the fact that systematic educational methods have been in operation for fifty and more years on the leading English roads. It may be said that every important road has its *Mechanics Institute*, whereby the boys may acquire advancement mentally to correspond with their progress in mechanical skill. Some of these institutions would take high rank among our technical schools, although they do not aspire to the grade of engineering colleges.

Some of the English roads have faithfully provided apprentice school instruction for years and for generations, and this is one reason why there is no lack of skilled mechanics in every trade. The efforts of the railroads are worthy of special comment.

There are usually three grades of apprenticeship in the motive power departments.

1. Pupils—Who are sons of influential men and pay for the privilege of studying railroad work. The superintendent of motive power usually receives the premiums paid by these pupils, as one of his perquisites. The pupils do as much or as little work as they choose.

2. Premium Apprentices—Who are also sons of well-to-do parents and pay for the shop privileges. They often receive wages which offset the premiums they pay. These are generally technical school graduates and in the shop they are practically the same as our "special" apprentices.

3. Workmen's Apprentices—These are sons of the workmen and they form the largest class of apprentices. These boys apply for apprenticeship in large numbers and this constitutes the recruiting source for shop men. They are allowed to learn the trade of their fathers and are not, as a rule, allowed to take up any other trade, but they are carefully taught in the shops and finish as good mechanics.

Because the workmen's apprentices are the recruits for the shops this class is the most important in my investigation. Locomotive engineers and firemen are usually taken from the shops, therefore the road service of the department is also recruited through this form of apprenticeship.

In England there is no lack of the best mechanics, because there are plenty of boys who wish to learn trades and the trades unions are not restricting the numbers of apprentices, as they are in this country.

The pupil system, while quite general in England, places a lot of privileged characters in the shops and is not to be commended. The premium apprentice may be left to be dealt with at another time. The regular or workman apprentice is the important one and he is well provided for on English roads. The following observations concern this class:

Great Eastern Railway—For 52 years this road has conducted and provided a Mechanics' Institute for apprentices, with evening classes for all who desire to take advantage of them. Mr. Holden believes in giving the ordinary apprentice a chance. He does not entirely approve of night schools for boys who work hard all day. Those who have served three years and have regularly attended the evening classes, may, by approval of the Mechanics' Institute committee, be allowed leave of absence with pay for two or more winters in order to attend higher technical schools. These students report to the locomotive superintendent every month and they are provided with facilities for visiting the works of other companies. One such visit is made every month during the winter. This part of the scheme has not been long in use, but thus far has worked well. Annual prizes are awarded for proficiency at the Mechanics' Institute and the distribution of the prizes is made a notable occasion and is attended by Lord Claude Hamilton, chairman of the board of directors who, last year, distributed the prizes. At the ceremony last year Mr. Choate, United States Ambassador in an address said: "These Mechanics' Institutes are the best hope of the people of England." The library of the Institute of this road contains 9,000 volumes.

London & Southwestern—Mr. Dugald Drummond, chief of the locomotive department of the London & Southwestern, has put into practice a scheme for day classes for apprentices at a technical college, near the Nine Elms works in London. Competent teachers are provided by the company and the apprentices may spend one hour a day, three days a week, from 8 to 9 a. m. at the school, which forms part of the day's work, without loss of pay. Preliminary examinations are required, and at the end of three months in each term, progress examinations are taken. Those who pass all examinations satisfactorily are allowed to attend the engineering colleges during the winter months to secure a higher education and the time so spent is accounted as part of the apprentice course. Those who successfully pass the college examinations are allowed to work in the laboratory or drawing office during the summer months. The first calls for promotions are made from the apprentices who have shown ability, both in the shop and the school. Mr. Drummond has made the following standing offer: "Any lad whose parents have not the means to keep him sufficiently long at school to give him an education, such as would qualify him to pass the preliminary examinations, will call upon me and I shall endeavor to make such arrangements as will enable him to require the necessary knowledge to do so."

This road does not conduct the school, but it does provide the salaries of the teachers and bears all the expense which would ordinarily fall upon the students.

Great Western Railway—This road has for thirteen years provided a series of evening classes for apprentices and shop men. They now have a large library and reading room at Swindon, and have turned the technical school over to the town, but retain control of the instruction through the officers of the locomotive department. This road has about 12,000 men in the shops at Swindon. The best apprentices are allowed to attend day classes at the technical school and are allowed full pay for the time so spent, and the school fees are also paid by the road. These candidates must be registered apprentices, between 17 and 18 years of age, they must have spent at least one year in the works and must have regularly attended at least one session in the preparatory evening classes in the technical school. Thirty such day students are provided for and they take three years' courses. They study practical mathematics, practical mechanics, geometrical and machine drawing, heat, electricity and chemistry. The students who distinguish themselves are allowed during the last year to spend part of their time in the drawing office and chemical laboratory of the road. The whole plan is at all times under the control of the head of the locomotive department. The regular evening classes at the school have been arranged with special reference to the needs of railroad shop apprentices and are divided into two grades, the preliminary and the engineering. The laboratory equipment of the school is extensive and excellent.

London & Northwestern—At Crewe a well equipped Mechanics' Institute has been maintained for 58 years. For 32 years Mr. F. W. Webb presided over it. In 1847 the cost was $1,000 for the year. In 1903 it was $15,000, not including the cost of the buildings and equipments furnished by the company. The Institute is a high grade technical high school and prepares for college and higher technical schools. It has well-equipped laboratories and is an impressive establishment. It has a library of 11,200 volumes. Small fees are charged for tuition in the various classes and the road makes up the deficiency in operating expenses. Last year students received 255 certificates from the board of education for graduates. This school has furnished 51 Whitworth scholars by competitive examination. It is doing a remarkable work. This road has

1,077 apprentices at Crewe and 8,000 workmen. The reports of the Mechanics' Institute are exceedingly interesting and far ahead of anything we have in this country. This school has taken more Whitworth scholarships than any other one institution in England. Seven scholarships are provided by the Government at the Royal College of Science at London and Dublin. These are awarded by competition and the successful candidates are prepared to compete for Whitworth scholarships. This school work is not in any way compulsory. The newest development is an electric laboratory in which 36 pupils may work at the same time. It is equipped for railway electric work exclusively, and is used Wednesday afternoons, under an instructor, provided by the company.

Lancashire & Yorkshire—This road has a large Mechanics' Institute in connection with the Horwich shops, which are among the best shops in England. The classes are taught by men who actually work in the shops. Metallurgy is taught by the superintendent of the steel foundry. Chemistry is taught by the chemist of the road and drafting by the draftsmen. The result is that though attendance is purely voluntary, the establishment is completely filled every winter evening. They have their own young men to take up their electrical work of their new electric lines now in service.

Night schools are not approved by the most progressive railroad men in England. They do not believe in night classes for growing lads after a full day's work and they are unquestionably correct.

Other railroads have these apprentice schools but I mention only those which I investigated personally. I have printed matter in my possession concerning all of these, and it constitutes an interesting record of an effort to "give the workman's son a chance."

Manufacturing Concerns—Such concerns as Yarrow & Company; Richardsons, Westgarth & Company; Palmer's Shipbuilding & Iron Company; William Denny & Company and Andrew Barclay Sons & Company, provide very comprehensive schemes for apprentice education by evening classes and encourage efforts by means of prizes awarded annually. The details of these plans are very interesting. Mr. Yarrow has, at his own expense, sent a representative educator to the United States, who thoroughly investigated technical school developments for the purpose of aiding him in providing for his own apprentices. This indicates the high place the subject holds in the minds of the leaders in engineering work in England. Mr. Yarrow believes that a concern employing 4,000 or 5,000 men can successfully inaugurate and conduct its own schools with the very best of teachers. This is a suggestion to the big American railroads. Smaller concerns should depend on the existing school facilities.

British Admiralty—For over 40 years the British admiralty has followed a plan for apprenticeship whereby the winter months are spent in college and the summer months in the work shops. "This method has produced a famous roll of chief constructors." The same plan is followed by the Scotch universities; the students study in the winter and work in the summer.

Sandwich System—In England the belief is growing among employers of men that school work and shop training must go hand in hand. The boys must turn from one to the other every day. This is called the "sandwich" system and it is admirably applied so that the shop boys may advance in studies and mechanical proficiency at the same time.

Provide for Workmen's Sons—Mr. J. A. F. Aspinall, general manager of the Lancashire & Yorkshire Railway, says, "Consideration ought to be given to the rank and file of the workshop, those who were not born with a silver spoon in their mouths, and who ought to be able to get on and advance themselves if they have sufficient brains, and ought to have facilities for rising to the top. From this class the most distinguished men in England have sprung." Aspinall, Drummond and Yarrow are firm advocates of thoroughly educating the workmen's sons.

Social Limitation—Exceptions—Mr. W. H. Maw believes that "Care must be taken that every facility to rise be given to the best man, irrespective of social position. Such men will be most frequently found among those not endowed with wealth who in consequence had inherited the instinct for work, and by example and necessity will be more ready to go through the drugery of learning their profession than those who were what is termed 'socially above them."

In spite of frequent expressions in favor of aiding the rank and file, it is, because of social distinction, very difficult for a shop boy to rise and become a "gentleman." I must say, however, that some of the finest and broadest-minded men I met in England have come from the ranks to the highest positions, and these very men owe this advancement to the Mechanics' Institutes.

Necessity for Schools—Mr. Hugh Reid of the Hyde Park Locomotive Works, says: "Every engineering firm, if working on sound commercial lines, must look to the education of its apprentices, more particularly from its bearing upon its own business, present and future. The more a business is removed from the purely manufacturing processes, and where new designs and developments are constantly required, so correspondingly will a larger number of highly trained workmen be required. Also in works far removed from or very close to large centers of population, highly trained men may in the one case be very difficult to obtain and in the other, very difficult to retain."

This means that for self preservation school instruction must absolutely be provided for apprentices and that it must be done by and under the control of the employers. In the United States the methods described will not answer. Our conditions require methods specially adapted to a relatively new country and to railroads which lack the traditions of these in England As a result of these observations I have formulated a plan which when developed will be ready for the consideration of American railway officials. It is necessary to provide a system which while under centralized direction and control will meet the needs of railroads having many centers of mechanical work. The English methods do not provide for this.

I trust that this general discussion of the subject may awaken and incite interest in this tremendously important matter, than which there is nothing more vital in the entire labor problem. G. M. B.

(To be Continued.)

The oil-burning engine district on the Santa Fe has been extended from Seligman to Winslow, Arizona, a distance of 143 miles. Coal-burners are not used any more in California or Western Arizona. Instead of storing oil in steel tanks at division points, the Santa Fe has built circular pits in the ground, banked up high, with a depth of about 20 feet, and roofed over. The oil thus stored is pumped into small delivery tanks and there run into the engines by gravity. The largest of these pits are at Seligman and Flagstaff—one for each place, each holding 50,000 barrels. At Ash Fork there are two pits, each holding 25,000 barrels; at Williams one and at Winslow one, each holding 25,000 barrels. There is little loss by leakage. The earthpits cost less than steel tanks and hold more oil. The fire hazard is greatly reduced.

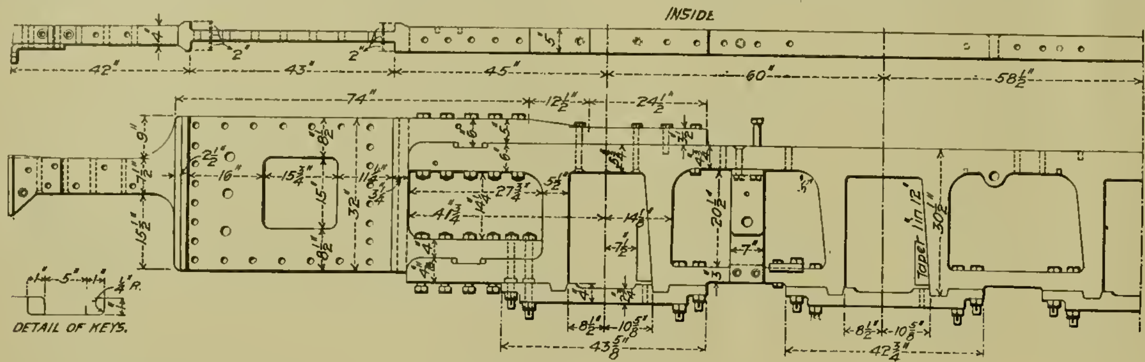
"Since the use of soft water decreases the time necessary for keeping locomotives out of service for boiler repairs, and for washing out, the number of locomotives required to operate a line should be decreased. Your committee has found published statistics covering a period of time on a division of a railroad that recently was equipped with water-softening plants. These statistics show that the number of locomotives in service was 9 per cent. less, the ton mileage 11 per cent. more, and the pounds of coal consumed per 1,000 ton miles was 5 per cent. less than during the same period before the division was equipped with the water-softening plants."—*From a committee report on water softening, to the Engineering and Maintenance of Way Association.*

SOME DETAILS OF A VERY HEAVY LOCOMOTIVE.

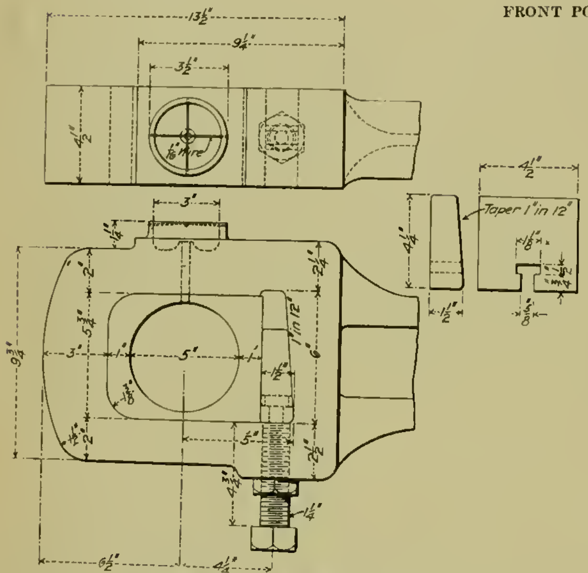
ATCHISON, TOPEKA & SANTA FE RAILWAY.

2-10-2 (SANTA FE) TYPE.

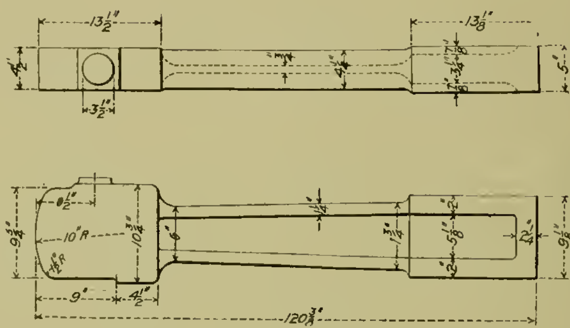
In this journal for October and November, 1903 (pages 372 and 399) descriptions of the very powerful freight locomotives built by the Baldwin Locomotive Works for the Santa Fe Railway were presented. Because of its size and enormous draw-bar pull in starting (69,500 lbs.) some of the details of the running gear will be interesting because they show the large sizes of the parts which are necessary in such an enormous locomotive. While the exact weights of the parts of this engine are not now available, those of some of the principal parts of the 2-10-0 engine illustrated on page 192 of our June number, 1902, will indicate in a general way the corresponding figures for the 2-10-2 type which is very nearly the same size. These weights are given in the accompanying table. The reciprocating weights, including the portion of the weight of the main rod, for one side amount, approximately, to 1,800 lbs.



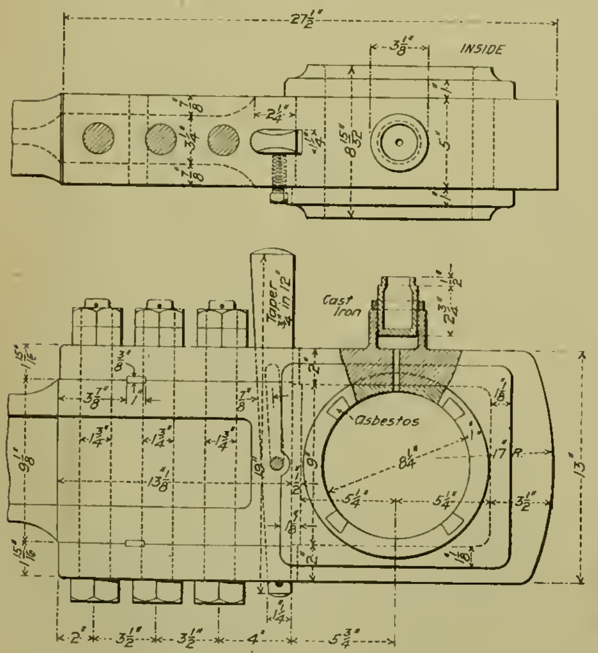
FRONT PORTION OF FRAMES.



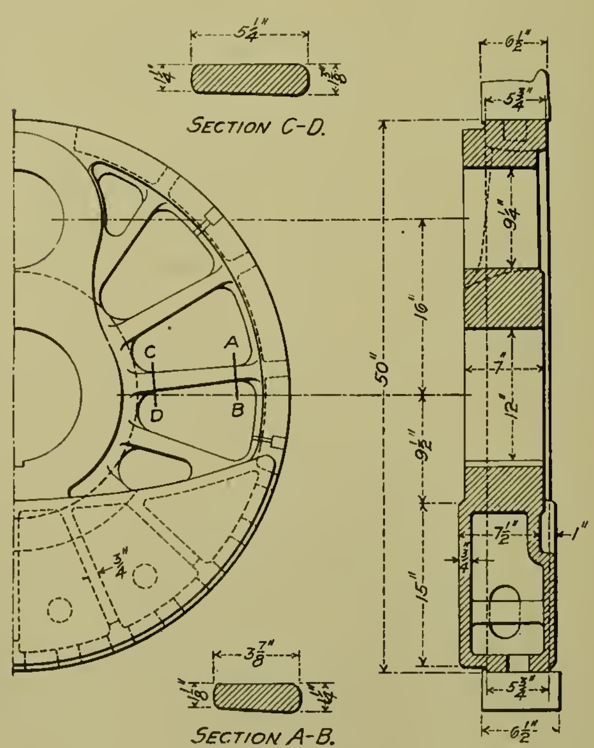
FRONT END OF MAIN ROD.



MAIN ROD.



BACK END OF MAIN ROD.



DRIVING WHEEL.

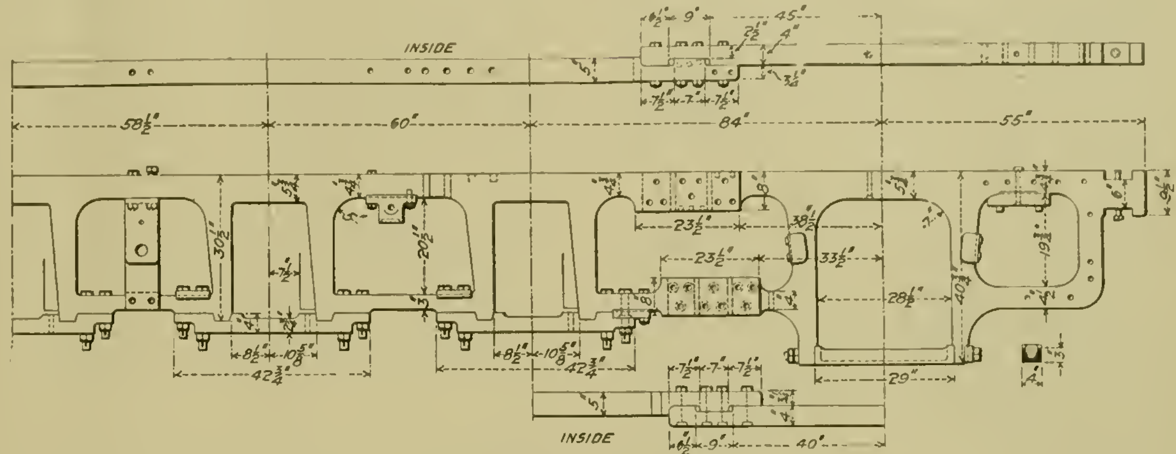
DETAILS OF THE HEAVIEST LOCOMOTIVE EVER BUILT.

WEIGHTS OF PARTS OF HEAVY DECAPOD LOCOMOTIVE.

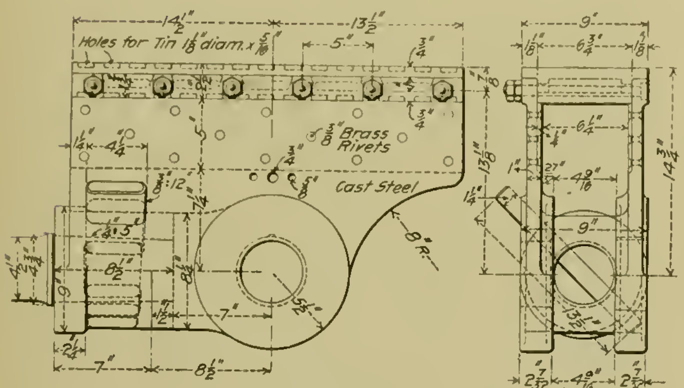
(See AMERICAN ENGINEER, June, 1902, page 192.)

	Pounds.
Weight in working order	267,800
Driving wheels and axle, front and back pairs	7,475
Driving wheels and axle, intermediate, front and back	8,055
Driving wheels and axle, main pair	9,375
Driving box, main, each	512
Driving box, others, each	444
Engine trucks, without wheels, axles or boxes	4,500
Engine truck wheels, one pair and axle	2,080
Equalizer beam	160
Frames, each	8,400
Foot plate	910
Boiler, without tubes	43,000
Cab, steel	2,690
Axle, main driving	1,875
Axles, other driving	1,520
Crosshead	431
Pistons and rod	1,075
Main rods, each	1,030
Side rods for each side	1,370
Cylinders, for one side, without saddle	10,160
Saddle	7,100

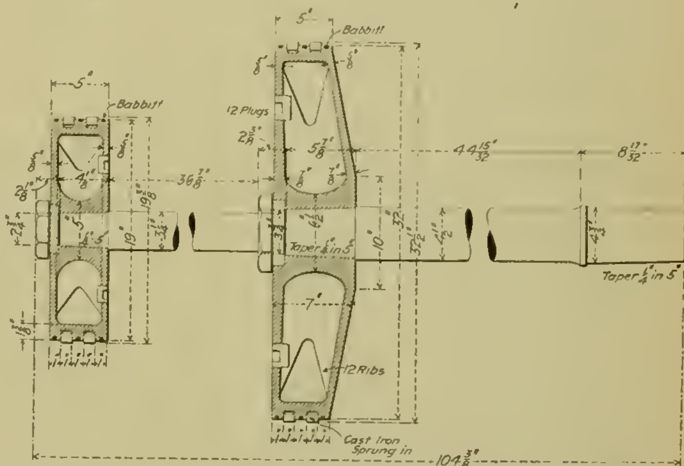
This selection of details for illustration sufficiently indicates the difficulty in designing a very large locomotive. For example a glance at the main crank pin with its 8¼ by 8½ in. main rod bearing conveys at once the impression of the power which must be provided for when 19 and 32 in. cylinders are used. The drawing of the main driving wheel shows that there is insufficient room for the counterbalance required by the prevailing rules. Guides 4 by 9 in. in section are required for the



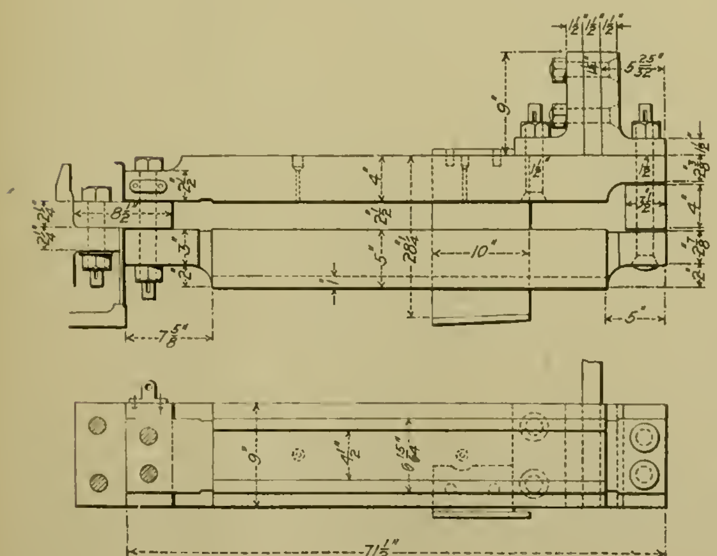
REAR PORTION OF FRAMES.



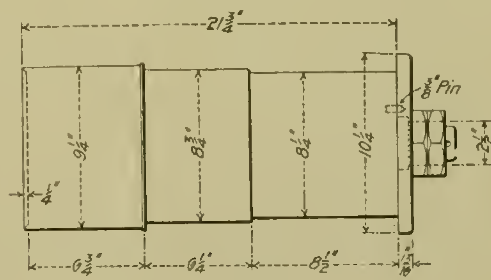
CROSSHEAD.



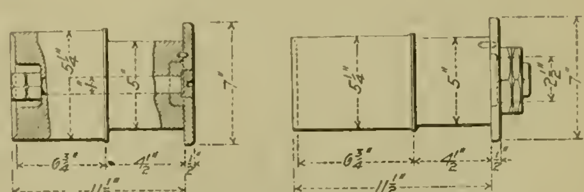
PISTONS AND PISTON ROD.



GUIDES.



MAIN PIN.



PIN FOR FORWARD DRIVERS. *PINS FOR 2ND., 4TH. AND 5TH. PAIRS OF DRIVERS.*

CRANK PINS.

DETAILS OF THE HEAVIEST LOCOMOTIVE EVER BUILT.

crosshead stresses and the bearing area of the crosshead is 252 sq in. A 32-in. piston is a large member and the two pistons and piston rod are shown assembled. Drawings of the main rod and the frames complete the selections.

A locomotive of this size presents many problems in detail design which have been treated in a most creditable manner which is worthy of careful study by the reader, for in this case forces are provided for which locomotive designers have never before been called upon to meet. In looking over these details as the drawings were lying on the writer's desk, a well-known railroad officer remarked that he thought the time had come when the problem of the big locomotive should be approached in a new way, a way which would divide the stresses in the running gear among a large number of parts and that while this would increase the expense of construction, it would lead to a lightening of the parts, a distribution of the wear over a larger number of surfaces and to greater convenience in the shop. In fact, he thought that locomotives had gone as far as they ought in the matter of size.

Before leaving the subject, attention should be directed to the frame splices of this engine and to the depth of the frames, 32 in., at the cylinders. In the depth of the frames at this point, the method of securing the cylinders to the frames by long keys, planed together, and the key construction of the frame splices, the practice shown in connection with the 2-8-0 and other classes of Pennsylvania engines has been followed. (See AMERICAN ENGINEER, June, 1899, page 181). In the large Santa Fe engine, it is noteworthy that at the front frame splices a cross sectional area of nearly 98 sq. in. has been provided. These frames have never given the slightest trouble on the road.

These drawings have been received through the courtesy of the officers of the Atchison, Topeka & Santa Fe Railway and the Baldwin Locomotive Works.

MAINTENANCE OF METALLIC PACKING ON LOCOMOTIVES.

By P. A. C. KING.

It is a well-known fact that there are about as many metallic packings on locomotives at the present time leaking steam as there are correctly performing the duty originally intended, and this is due to a large number of causes. The packing manufacturer has often been called upon to produce a fool-proof packing. Now, as soon as we can produce a crank pin bearing which will never require attention or a triple valve that can be put together with a shovel, about that time we may expect a packing, either fibrous or metallic, which will be fool proof, and by the way, it is well to bear in mind that fibrous packings require better attention and greater care in application than any of the metallic packings.

It has often occurred to the writer that it is a pity that packing leakages will not tie up railroads, like broken frames or broken axles or disarranged air brakes, for then the packing would receive the consideration to which it is entitled.

Why is it that metallic packings applied to steamships and stationary engines are steam tight, and when the same are applied to locomotives, they leak steam? The writer thinks the difference is just here: It is impossible to successfully run a marine engine with leaky packings—steam will blow down on the heads of the oilers and the engineers would be compelled to shut down. They are, therefore, particularly careful to see that the packings are in first-class condition and correctly repaired before they leave port, and that by a man who knows his business. While the leaky packing on a locomotive generally does not do any damage immediately, particularly to those running the locomotive, I have often thought that if the front of an engine could be boxed in, and the only outlet to the box be a 2-in. pipe leading into the cab, then we would have tight packings, particularly if this pipe was directly in the front of the cab on the right hand side.

Going back to ancient history, and the days of the old soft packing, usually the engineman did his own work in this respect; he was very careful how he applied the soft hemp rings, and would allow no one but himself to tighten up the gland. He was very careful not to get over-heated rods, and would keep them properly lubricated, as this was the time before oil starvation became a fad. When metallic packings were introduced, for a while the engineman continued to retain interest in the packings, and metallic packings at once showed great saving over hemp, largely because it was looked after the same as before, but since then things have been going from bad to worse between repairs. Finally the "chain gang" came into existence, then the engineman ceased to keep up packings, it being turned over to the shop man, and almost any man was taken for the work. Sometimes this man was a graduate from a wheel barrow, or a bolt cutter. He certainly did not appreciate the work, and as long as he was paid a certain price for renewing babbitt metal rings he considered his duty was done. Sometimes these rings fit, sometimes they do not; new rings are often applied to packing where rings are not the cause of the trouble, then again they are often improperly machined. In addition to this the oil starvation fad struck us. The best lubrication of packing is from the cylinder. When the quantity of cylinder oil was cut down the packings failed to receive their best lubrication, worn rods were quite frequent, burned out and badly cut packing rings were plainly in evidence.

Now contrast the above with the situation on marine engines. All will admit that the marine engineers are skillful and well informed men, probably as good in a mechanical way as anyone connected with any railroad. Yet these men frequently will not make any repairs themselves on metallic packing, but send to the manufacturer of the packing, so that he may send a specialist to overhaul and correct the trouble. He considers the metallic packing business a specialty, and as it is so important to his existence he has a specialist attend to it. Even on the largest ocean liners this course is often pursued. In some cases, however, after the engineer has had years of experience with the packing, he will then attempt to overhaul it, but never until he has had some experience, watching the packing specialist, and learning his lesson thoroughly. Even our largest ship yards desire the packing specialist present when packings are applied and trials run. This is one of the reasons why marine packings are tight, whereas the same packing applied to locomotives fails. Of course, locomotive service is harder than marine service, but not so much so as to cause the packing trouble and the expense of maintaining packing that now exists when everything is considered. It does not require a college professor to take care of packings, but it does and always will require a good mechanic.

The following is about the way the situation is treated: The general manager goes over the road on a cold, clear day, he sees most of his engines with terrific steam leaks around their cylinders, and immediately thinks it all comes from the packings. He sends for the superintendent of motive power and tells him this thing must stop, that the packings are no good, and they had better change to some other make. The S. M. P. sends for the packing manufacturer, and says, "Your goods are of no account, and something must be done. Can you correct the trouble?" Packing man says, "Yes, but not unless you will treat packings properly." S. M. P. says, "Go ahead." Then a certain number of engines are taken on which to conduct this trial. By a little judicious handling of the question by a man who knows his business, it is found that not only can packings be made tight, but thousands of dollars can be saved per year. The S. M. P. is, of course, very much pleased and shows the matter to the general manager, they proceed to pat each other on the back, and say, "Now the good time has arrived, our troubles with packings are over. Our men have been told how to do the thing and they will do it." All mechanical departments become very virtuous, but view this same road six months after. These packings are again blowing. Nobody, however, pays much attention to it as leaky flues have become the great question of the day and the packing business is sidetracked for the time being, and the question is asked, "How are you getting along?" "All right, not much trouble, but, of course, we are not obtaining the results that we obtained at first." Now, why is this? Simply because the men who were instructed at the general overhauling have either been put on other work, discharged or promoted, and new men are endeavoring to do their work without being properly instructed. The new men know nothing of the reformation and things gradually drift back into their old condition.

Tests of metallic packing are about as numerous as they are misleading, and this is the reason why about once in six months an entirely new design of packing is placed upon the market and tried on several roads. It has probably made a good record on an engine on some particular road by the inventor. The inventor has daily kept track of the engine and instructed every one how to take care of it, and is sure that it has been well lubricated, even though he may have had to purchase the oil himself. Every one who handles the engine knows the packing is on trial and proceeds to keep it in shape, unconscious of it probably. The result is that the mileage of this packing is very large, and when compared with the mileage of the standard packing on that road it is so large that everyone wants to rush to the new style, and often they do so. When this packing is put on a large number of engines and in time becomes standard and gets the same treatment the old standard received, it proves to be no better, if as good as the old-timer; then the road often in desperation will go back to their old goods. This farce comedy is worked once in about six months, and on some of our best known systems. One motive power man who had sized up the situation correctly, said he could make a big mileage with old shirts in the stuffing boxes providing they were on test.

We may write it down that we shall never get good satisfaction either in the way of preventing steam leakages or saving expense until metallic packings are treated as a specialty, and a good mechanic on every railroad is held entirely responsible for this work. This man should not be a cheap man by any means; he should be paid equally as well as a general roundhouse foreman, he should visit the packing manufacturers and then see that shop men know how to repair packings and that they do it properly. A man of this kind will save many times his salary.

A short time ago a railroad sent some of their engines to a locomotive builder for repairs. The locomotive builder removed the packings and sent them to the packing manufacturer to be overhauled and put in good condition. It was surprising to examine some of these. One packing in particular was minus a ball joint and apparently had not had a ball joint against the gland for many moons, and must have leaked, judging from the way the interior parts of that packing were hammered up. Why the steam leakage did not completely cover the engine I cannot imagine, for it must have been awful. I suppose the engineman reported these packings as blowing, a roundhouse man with the same regularity applied new metallic packing rings, whereas, if he would have properly sized up the situation and applied a new ball joint, the whole trouble could have been corrected and many dollars saved. Some of these packings were received minus followers, some of them apparently had the followers applied the wrong way about, some of them showed evidence of the vibrating cup being solid up against the side of the stuffing box, either due to excess of lost motion between the piston and cylinder or cross head and guides. In other words, the whole condition was horrible, and neglect in this matter meant a loss of thousands of dollars.

It is certainly unfair to blame metallic packings for faults which may be due entirely to piston rods and valve stems. Sometimes piston rods are not true, cylinders are smaller at one end than at the other, or they may not be round. The same is true of valve stems. Unless they are cylindrical no metallic packing can be expected to be tight. Then again rods are turned up and roughly finished so that they act as a file through the packings, or in truing up rods they may be turned to a size that does not correspond to the diameters of rings kept in storerooms; the roundhouse man in his hurry is compelled to take rings out of stock such as he may find, and very often has to apply the wrong diameter of rings to the rod. Now, under conditions of this kind, it is about as impossible to expect packings to be tight as it would be to expect a tight slide valve, if the valve face was finished in a foundry instead of a machine. In several instances we have known of rings which were originally bored for rods one-half inch less diameter, cut up in small segments and applied to packings. We may readily imagine how this would work out in practice.

CHICAGO MEETING OF THE MECHANICAL ENGINEERS.

The spring meeting of the American Society of Mechanical Engineers will this year be held jointly with the Institution of Mechanical Engineers of Great Britain, and the sessions will be held in Chicago. This location has been selected because it is near enough to St. Louis to permit the members to attend the exposition and yet the discomforts of holding conventions in the exposition city will be avoided. Thus far 200 members of the English society have indicated their intention to attend, and the joint meetings therefore promise to be very successful. In order to provide ample time for discussion the subjects for the English society will be limited to the following: The steam turbine, motor cars, the gas engine, hydraulic and electric cranes, induction fans and garbage destructors. The commitee on meetings of the American Society of Mechanical Engineers has asked for papers on the following subjects: The American steam turbine, the American gas engine, the power plant of the tall office building, the American Locomotive testing plant, the American shop management problem and the modern American machine tool.

JAMES WATT MEMORIAL.

A memorial statue is about to be erected in Greenock, Scotland, on the site of the cottage in which James Watt was born. Subscriptions are solicited in many countries, and an American committee has been organized with Andrew Carnegie as chairman. Subscriptions should be sent to Theodore Dwight, secretary and treasurer of the American committee, 99 John street, New York.

Employment Bureau—Chicago & Alton Railroad.—While nearly all railroads employ somewhat systematic methods of recruiting the several branches of the service, thus far only this road has an employment bureau, established with a view of securing recruits from among the young men living along the line of the road. The object of this is to secure the advantage of the home influence and establish an *esprit de corps* because of employing those who are interested in the country to which the road is tributary. This has been worked up into a systematic policy by an employment bureau which is under the direction of Mr. W. A. Freese, superintendent of telegraph. It is confined to the transportation department and is aimed to elevate the standard of employees in every capacity. In order to reach those who might not otherwise apply for positions circulars are issued and distributed in the towns along the road containing instructions for applying for service. All applications are investigated and records made. Civil service rules govern the bureau and the results for the first year have been very successful, 275 men having been selected by examination from a large number of applicants during that period.

Long Sea Trip With Oil Fuel.—The steamship *Nebraskan* of the American-Hawaiian Line recently arrived in New York after a 12,724-mile (nautical) trip from San Diego, Cal., using oil fuel all the way. The trip was made via the Straits of Magellan in 51 days and 9,300 barrels of oil were consumed. This oil was the crude product of California. By its use, 12 men are saved in the fire room and 3 men only were required for tending the burners.

(Established 1832.)
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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

The locomotive is the only thing on a railroad that actually earns money. If 10 per cent. of the number of locomotives are out of service for any reason, that proportion of the earning power is unavailable. If 20 per cent. are in the shops or waiting to get in, the whole system begins to limp. Many roads are limping because of a lack of shop facilities, and shop improvement is to be one of the biggest business questions of the railroads for some time to come.

By sending an annual pass and a personal letter to every station agent on the line, Mr. J. C. Stuart, general manager of the Erie Railroad, has encouraged these important subordinates and has brought them to understand that they are appreciated as necessary factors in successful management. This recognition is as unusual as it is easy of accomplishment and it constitutes an example which others might profitably follow in all departments. Shop and roundhouse foremen, from whom so much is expected, would give "value received" many times over for an annual pass. Doubtless they would not often use one, but the comfort of having one in the pocket would help the superintendent of motive power to secure better service and better foremen. It costs a road nothing to do this sort of thing and the returns cannot be estimated.

The General Manager fell into the ash pit. He was chagrined and soiled, and his kid gloves were torn. He had cigars for his friends who happened to hear of it, but the story has been a long time leaking out. It occurred last winter on the occasion of an inspection of the roundhouse with the superintendent of motive power and master mechanic, who were trying to find out why locomotive work was delayed at that particular point, the location of which will not be stated now. They had not even entered the roundhouse, but were walking toward it in the fog which hung about the building in the still air. This experience was an effective object lesson to this officer, who up to that time had not appreciated the difficult problem of ventilating roundhouses in cold weather, and he had not dreamed of the conditions which render not only the house itself difficult to navigate, but also the surrounding yard. During the past severe winter, fog in roundhouses has been a serious matter, delaying work and making it impossible to do roundhouse repairs properly. Even with the best ventilating facilities the trouble has not been entirely overcome, and the problem is one to be studied with the greatest care by those who are operating under pressure for power. This general manager will be likely to approve more extensive appropriations for roundhouse improvement, and it would be a great help in progress if other managing officers could get a near view of the difficulties.

WHAT ARE YOUR LOCOMOTIVES DOING?

This is a vital question of railroad operation to-day. Upon the answer depends the standing of the management before the owners of the properties and that management is best which shows the best results in this item of performance.

Managements are increasing the average loading of cars, they are eliminating grades, rectifying alignment, strengthening bridges, improving condition of track, increasing terminal facilities, lengthening sidings, improving water stations; they are closely watching the dispatching of trains and providing in every possible way the facilities which will tend to increase the weight of the average train and shorten its time on the road.

It is perfectly clear also to all who have watched the progress of the past five years that the locomotive is appreciated as the important remaining factor in the problem. A degree of attention is now given to the locomotive department which it never received before the ton mile and the heavy train became watch-words. The attention now given to new shops and the expenditures authorized for their construction and equipment indicate a new and promising interest in the motive power side of operation. All the prominent roads are supplying themselves with the most powerful locomotives which their condition will permit of running and locomotive terminals have exhibited signs of increased interest in the form of improved facilities in connection with locomotive operation. But as yet the surface of the locomotive problem has hardly been scratched. In spite of progress made, nothing is seen in the tendencies of the time which gives promise of placing those to whom the locomotive is entrusted in position to meet the extraordinary demands which are to be made upon them.

Nothing short of a fundamental change of policy will meet the locomotive problem of to-day and of the future. This problem is the administration upon a business basis of the motive power of large aggregations of railroads and it is a problem of men and of methods. The men and methods which sufficed for small roads are inadequate to-day and it becomes a vital necessity that the future be provided for.

Nothing short of a representation of the motive power departments in the management will answer. What is needed is an officer of the grade of vice-president or general manager in charge of motive power and he must be a man who "draws enough water" to build up an organization and formulate a plan which will put the locomotive on a business basis and keep it there for the years which are to come. As a type he must be big enough to secure from the directors that which is needed in protection of their own interests and he must have the authority to inaugurate policies of construction, operation and management which will constitute a permanent plan for putting locomotives in position to do what is expected of them. He must do much besides securing good locomotives. He must be able to institute plans for recruiting the service, for elevating the men in the ranks and giving them cause to look to the company as to one interested in their welfare and he must be able to put motive power work into such a condition as to warrant the best mechanical talent of the country to prepare for high positions of responsibility.

The present large systems require officers for this work, who are equal in ability and authority with the general managers. Is it not sufficient to tax the capabilities of the best railroad man to administer this department, to see that locomotives are such as the conditions require, to see that shops and terminal facilities are right, to know that shops are equipped and operated in accordance with the best commercial business principles, to know that locomotives are operated efficiently and economically and to build up an organization which will carry all these along and provide for its own recruits—is not all this enough, on a large system, to require the exclusive attention of the best business man and executive in the service?

In addition to all this it is to-day necessary, and in the future will be more so, to manage the department so that the grievance committee will lose some of its importance. This will require a most carefully considered and definite policy which will disarm those who make the most of opportunities to widen the gaps between the men and their employers.

Not until the railroads fully appreciate the necessity for establishing large motive power policies and work them out on a long term basis will the question, "What are your locomotives doing?" be satisfactorily answered.

The "lightning changes" or earthquakes of management which seem to be a part of current progress must soon give way to a situation of permanence, and the efforts to make brilliant records must give way to steadiness of operating methods. Nothing can succeed under chaotic methods, such as those which have involved revolutionary changes in the entire organizations of several large systems in the space of two years. When the smoke of these battles clears away the subject of these paragraphs should receive attention, and those who have and those who have not had the battles should calmly enter into a plan for elevating the motive power administration to the high plane on which true business policy places it.

ROUNDHOUSE VENTILATION.

No winter in recent years has brought out the deficiencies of roundhouses as the one from which we have just emerged. The severe weather conditions necessitated an unusual amount of roundhouse work on locomotives and they also made the work unusually difficult. A fortunate result is to attract attention to the importance of the best roundhouse facilities as affecting the movements of trains.

Even in the best equipped and best ventilated houses the fog occasioned by condensation of moisture in the air seriously hampered those who were responsible for running repairs. This was not alone confined to the house itself, but in cold, windless days, the fog over the turntables occasioned more than one "engine in the pit" and was a serious matter.

This points to several things. It is necessary to keep down the moisture by blowing engines down into closed systems of piping and to maintain dry floors by good methods of drainage; to take the smoke out of the house through the jacks and ventilators and to install ventilating machinery, which will clear the unavoidable fog away. An exhauster system of removing the smoke may be necessary, but the best plan seems to be to use the fan system of distributing warmed air all over the house and supply it in quantities sufficient to do the work.

One of the most recently constructed roundhouses which has a thoroughly up-to-date fan heating system which changes the air completely every 15 minutes, was exceedingly foggy last winter. This roundhouse was provided with one square foot of heater piping for every 120 cubic feet of volume of air in the building, but this liberal supply did not prove to be enough. It would be well to try more heating surface and fans of sufficient capacity to change the air every five minutes. Whatever the cost, roundhouses should be made safe and comfortable for the important work which must be done in them.

A return to direct heating by steam coils in the pits has been suggested, but this must always be less efficient than the fan system, which will at the same time heat and ventilate the house. It is a fact that the worst offenders are roundhouses with low roofs, which seems to point to the desirability of supplying more air space vertically. If the writer had the responsibility of a lot of roundhouses he would take some of the best experts in ventilation into his confidence in this problem. It surely is a question the solution of which will tax the best authorities.

NOTES ON A TRIP THROUGH OLD MEXICO.

BY O. R. HENDERSON.

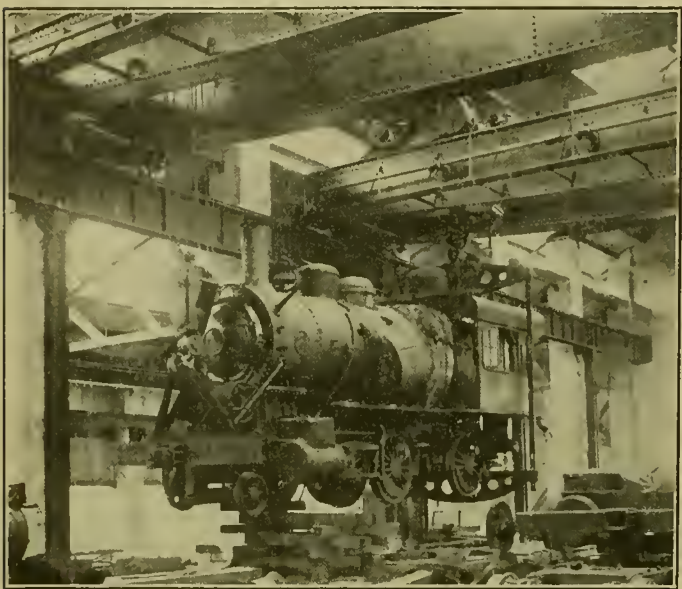
A trip over the Mexican Central Railway in summer time is particularly enjoyable. Popular opinion considers Mexico a hot country and one to be visited in the winter only. While this is true as far as the Gulf cities are concerned, it must be remembered that the Republic is principally a great table land varying from 4,000 to 10,000 feet above sea level. If we consider a transverse section of the country from Tampico to Manzanillo, from the Gulf to the Pacific, we have a stretch of about 500 miles, of which 100 miles on the Gulf Coast and 50 on the West Coast have less than 1,500 feet elevation; the remainder is mostly above 5,000 feet. The Mexican Central operates about 3,000 miles of road, and only about 600 miles have an altitude of less than 1,500 feet.

Starting with Juarez, on the Rio Grande, 3,717 feet above sea level, the first town of any size which we reach is Chihuahau, 225 miles distant (at an elevation of 4,643 feet), after passing through an undulating country. At this point quite large shops are located for locomotive and car repairs. Ortiz, 50 miles further south, is the nearest station to the new Boer colony, which is being founded by General Snyman. Already there are a dozen Boer families on the ground and 50 more are expected shortly. They have had a territory of 83,000 acres set aside for them contiguous to the Rio Conchos and the Boers are very enthusiastic over their new home. The arrangements with the Mexican government have been carried out by General Snyman, through whose efforts the plan has been successfully launched. He states that the Boers will at once accept Mexican citizenship, and we think that both the Boers and Mexico are to be congratulated upon this admirable arrangement.

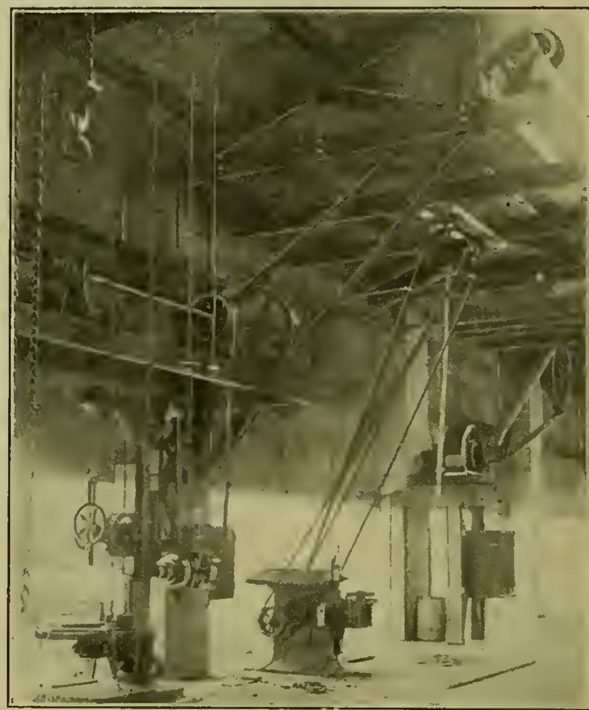
Continuing southward we reach Torreon, 518 miles from Juarez, at which point the Mexican International makes connection. The elevation here is about the same as Juarez, but we now commence to climb to the highest point on the main line, Zacatecas, 8,044 feet above sea level, and 780 miles from Juarez. The grade near the summit is 1½ per cent. and sharp curves continually reversing were needed to keep the grade down to the amount named. As we pass the summit we look down upon the town, which is very picturesque from the railroad. One hundred and twenty miles further south is Aguas Calientes, so named from the thermal springs, around which are clustered several banos, or bath houses. This point is the junction of the Tampico line, although the branch actually leaves the main line at Chicolate, eight miles to the north. At this point the new shops of the Mexican Central are now being completed, to which reference will be made later.

The next important town is Irapuato, 1,005 miles from Juarez, from which point a branch runs to Guadalajara and a short distance beyond. This latter city is 5,054 feet above the sea and is only 125 miles from the Pacific in a direct line, but as yet has no rail communication to the sea. The city is lighted by electricity generated by water power at the falls of Juanacatlan, 20 miles to the east. This installation is quite modern, the alternating current generators having been supplied by the General Electric Company and are driven by rope cables from horizontal turbines.

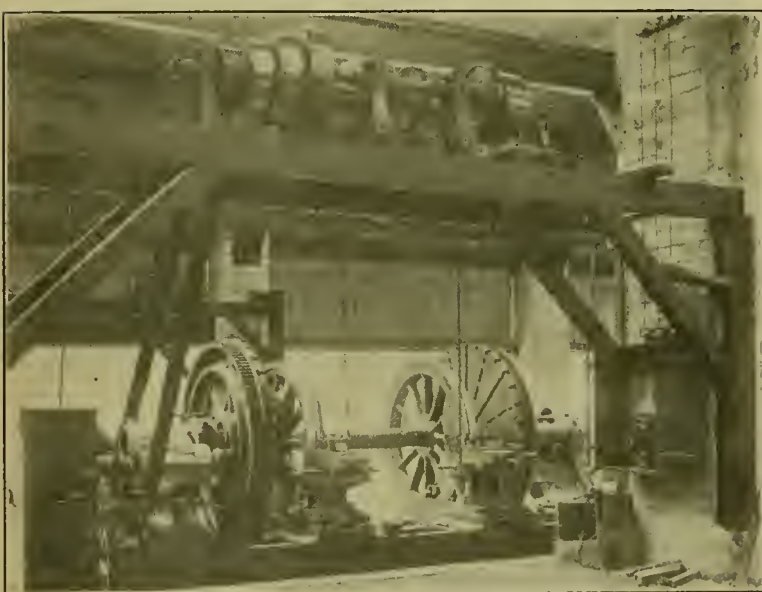
From Irapuato the main line is practically level until we reach San Juan del Rio, and we then pass over two summits before reaching Mexico City, 1,224 miles from Juarez and 7,350 feet in altitude. The country north of Irapuato resembles New Mexico and Arizona, but south of that point is exceedingly fertile and well watered. The Guadalajara branch also runs through a fine agricultural section. Most of the engines on this branch burn wood, as also on the Cuernavaca branch. This wood is mostly the root of the mesquite, which grows abundantly and which, while being very light wood above ground, has roots from 4 to 8 inches in diameter. Coal is quoted as worth $20 a ton Mexican, and wood probably $8 a cord.



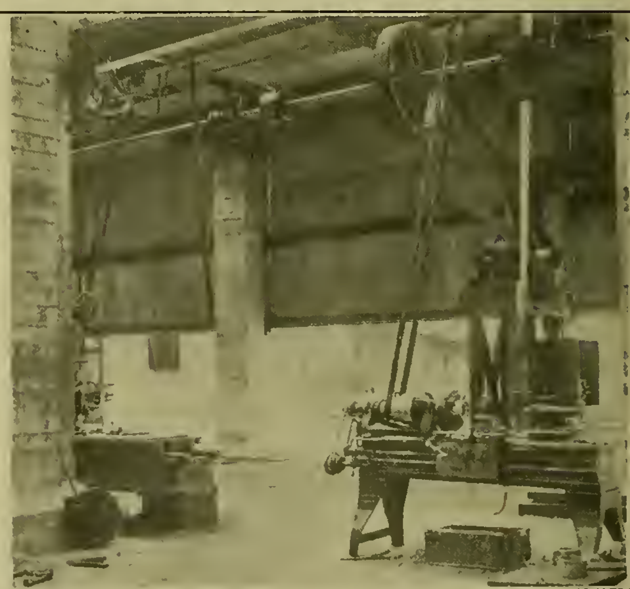
TWO NILES 60-TON CRANES IN THE ERECTING SHOP.



LOCATION OF GROUP MOTORS IN THE MACHINE SHOP.



MOTOR DRIVE FOR A WHEEL LATHE.



GROUP MOTOR IN MACHINE SHOP.

AGUAS CALIENTES SHOPS—MEXICAN CENTRAL RAILROAD.

The company is at present maintaining repair shops at Chihuahua, San Luis Potosi, Guadalajara, Cuernavaca and Mexico City, the latter being the principal shop of the road and where the heaviest work is done. These shops, however, are old and have been added from time to time, until quite a heterogenous collection of buildings and sheds comprise the present outfit. Besides, the motive power has been added to until the shops are inadequate, so that some years ago it was decided to erect new shops at Aguas Calientes, which is a much more central point for the system. The new Aguas Calientes shops are located immediately north of the station, and the first thing that impresses the visitor is the substantial wall surrounding the property. This is composed of adobe with brick pilasters and coping, and is about 12 feet high. It is intended more to prevent articles from being stolen than to guard against strikes.

The first building which you meet is a 12-stall roundhouse about 75 feet length per stall, the walls being formed of concrete and the roof of wood laid flat on joist, supported by two posts between each track. There are fixed wooden smoke jacks over each pit. The floor of the pits is of brick rounded, but a dirt floor is used in the house. There are no doors, and in place of the usual windows in the outside wall there are arched openings about 8 ft. wide and 12ft. high, with iron gratings. Just below the eaves there is a series of openings about 12 ins. wide and high extending along the outside and end walls for ventilation. The roof slopes towards the table and has drain pipes inside the inner circle posts.

The erecting and machine shop is 380 ft. long by 132 ft. wide. The center section is about 68 ft. in the clear and has three longitudinal tracks, 22 ft. centers, with pits 4 ft. deep extending the complete length of the shop. The posts supporting the roof are of concrete 3 ft. square on 20-ft. centers. The roof covering is galvanized corrugated iron with a 3-ft. vertical opening between the center and side roofs. Iron sheathing extends from the side eaves to within 8 ft. of the ground and the gable ends are of concrete throughout. A 12-ft. strip of skylight is placed on each side of the ridge of the roof.

The erecting portion is spanned by two 60-ton Niles electric cranes, and the machine section on one side by a 5-ton, and on the other side by two 5-ton electric cranes. While the large cranes traverse the whole length of the shop the small ones have a traverse of 240 ft. only. The main crane girders are supported by steel posts, anchored to the concrete piers. The side crane girders rest upon cast iron brackets bolted to the piers.

The machinery will be driven by electric motors supported 8 ft. above the floor by wooden frames resting on concrete foundations. The drives will be both group and individual. The cranes and motors are in place, the motors being wound for 500 volts. The machinery has concrete foundations. Most of the machinery has been moved from Mexico City. The shafting timbers are supported by bolts and clamps, applied diagonally so that the lower timbers can be moved in either direction for final adjustment. A tool room about 20 x 60 ft. is provided in one of the side bays. A brick floor is used in the erecting portion. Like the roundhouse, there are no doors or windows in this shop except in the tool room. The smith shop is 63 x 200 ft. and is of same style of construction as the machine shop, but has only one span of roof. The equipment includes several large hammers and heating furnaces.

The power house is perhaps the most interesting of the several buildings. Three 250-horse power Babcock & Wilcox boilers provide steam at 200 pounds pressure. These are to be hand-fired, as labor is cheap, 50 cents Mexican (about 22 cents United States) being the ordinary rates per day for such labor. Draft is induced by the Sturtevant fan system, and it is intended later on to provide an economizer. A Wheeler feed water heater has been set up in the meantime. Electric current for light and power is generated by three DeLaval turbines with Milwaukee electric dynamos. The turbines are of 300 horse-power, each operating two generators of 250 volts potential. The three-wire system is used, thus obtaining 500 volts for power and 250 for lights, all being direct current. The turbines are guaranteed to deliver power at less than 14 pounds of steam per horse-power hour. The turbines run at 9,000 and the armatures at 900 revolutions per minute. It is intended to use a condenser, of the surface type, a cooling tower being used for supplying the necessary cooling water. A Laidlaw-Dunn-Gordon compound, duplex air compressor is in place, having a capacity of 800 cu. ft. free air per minute at sea level. A 10-ton hand crane covers the entire area of the engine room.

The entire installation, both electrical and mechanical, and for the shops as well as for the power plant, was made by the D'Olier Engineering Company, Philadelphia, Pa.

The Mexican Central has made their castings for many years at Mexico City, but this will now be done at "Aguas" (as it is called familiarly), in a building or shed 60 x 216 ft., one 5 and one 8 ton cupola being used for the purpose. This building is now under way and is merely a galvanized roof on concrete piers.

The brass foundry is a brick and adobe building 40 x 80 ft., and is entirely enclosed with walls, differing in this respect from the other structures. The pilasters and trimmings are of brick and the panels of adobe, which makes a very neat structure. There are six furnaces for crucibles in this foundry, with hoists for moving the pots of melted brass.

The planing mill is of the open shed-like construction already described and is 70 x 200 ft. It is also driven electrically. The passenger car paint shop is 130 x 300 ft., and is of brick and abode (like the brass foundry), but it has a saw-tooth roof construction.

The railway company has a mill for rolling scrap iron, etc., at San Luis Potosi, and this is to be moved to Aguas; the piers for this building, which will be 60 x 108 ft., are up, but the roof has not been applied. A pattern shop and house with fireproof adobe walls between each section provides for this work. A fine brick and adobe storehouse and an oil house of same construction completes the buildings, with the exception of an all-brick office, which is in course of erection. It is expected, however, to erect in the near future, a tank shop 48 x 300 ft., a wheel foundry 60 x 144 ft., a wheel and axle shop 40 x 100 ft. and a coach repair shop 130 x 300 ft.

The employes themselves have not been forgotten in the general scheme. A large brick hospital has been constructed as well as a home for the superintendent of machinery and master mechanic. There are also 30 single and 16 double cottages of brick and adobe which will be rented at $10 and $20 per month (Mexican) respectively for the mechanics, and several long rows of adobe huts with a central patio for the laborers.

The whole plant seems to have been admirably planned, and the buildings are well adapted to the climate, which is always moderate, but it seems as if larger structures will soon be needed. There is ample room, however, for extensions. Mr. Ben Johnson, superintendent of machinery, directed the installation.

EDITOR'S NOTE.—Mr. Henderson's notes have been in type for a number of months, awaiting further information concerning the Aguas Calientes shops. Through the D'Olier Engineering Company of Philadelphia this information has been supplied, including the photographs from which these engravings were made.

GOOD TESTIMONY FOR PIECE WORK.

Of all the changes made by the general officers of the company since I have been with the Central Railroad of New Jersey, none has been so mutually satisfactory and financially gratifying to employers and employees in the car-shop department as the introduction of the piece-work system in 1893. Our books and records show as absolutely correct that:

(1) Average time consumed by repairs to our passenger, freight, and coal car equipment is cut down about 35 per cent. This means that the cars instead of being at an average of three days out of service per year for repairs, they are out of service only two days, and the whole equipment earns money one additional day per year.

(2) That total cost of labor repairs to passenger, freight and coal cars has decreased at least 27 per cent. when compared with cost of labor done by day work.

(3) That average rate of pay per man, worked under existing piece-work prices, has increased from 17.5 cents to 22 and 23 cents, or equivalent to a raise of 25 per cent. per hour worked.

(4) All department foremen must be in full charge of their men and be responsible for maintaining good discipline, and keep up the standard of efficiency. They should be made acquainted with and be held accountable for, to a certain degree, the labor and material cost of cars repaired by them or material manufactured. They should be always on the look-out for cheapening cost of labor or articles manufactured by the introduction of new methods or modern tools, but not resort to cutting prices.

(5) That willing co-operation is a great helpmate. That overlooking personal shortcomings, common in one form or another to everybody, makes friends. That the curbing of "I" will be appreciated by all concerned and produce genuine admiration for acts deserving them.

Where these points, mentioned as essential for the economic management of car shops, are applied (enforced firmly but intelligently and humanely), to a shop organization, the fundamental principles of effective organization and economic management for car shops have been put into practice and will reduce on any railroad the total expenditure for maintenance of car equipment from 1½ to 3 per cent.—*Chas. Streicher, before the Pacific Coast Railway Club.*

HEAVY EIGHT COUPLED SWITCHING LOCOMOTIVE.

CHESAPEAKE & OHIO RAILWAY. AMERICAN LOCOMOTIVE COMPANY, *Builders*.

EIGHT COUPLED SWITCHING LOCOMOTIVE.

CHESAPEAKE & OHIO RAILROAD.

Unless built for transfer purposes where heavy trains are to be hauled through comparatively long distances, a switching locomotive weighing 171,175 lbs. is seldom seen in the equipment of a railroad. This engine has eight coupled wheels and gives a tractive effort of 41,200 lbs. It was designed and built by the American Locomotive Company at the Richmond works, and is an example of advance in switching locomotives made necessary by the increasing capacity of road locomotives which renders an ordinary light switch engine incapable of the quick work which has become necessary in the yards. This locomotive has an enormous heating surface for this service and is capable of handling very heavy trains for short distances. It has a 68-in. boiler, piston valves with inside admission, a moderately wide firebox and an extended wagon top boiler. Mr. J. F. Walsh, superintendent of motive power of this road, states that this powerful engine is required for switching service at the yards at Clifton Forge, Va., where there is a heavy grade coming into the yard. The 22 by 28-in. consolidation engines bring trains in from the West which are too heavy for an ordinary switch engine to handle, necessitating cutting trains into three pieces. This engine is intended to handle the heaviest trains that the road engines can pull up to the yard. The following list gives the principal dimensions:

EIGHT-WHEEL SWITCHING LOCOMOTIVE—CHESAPEAKE & OHIO RAILROAD.

GENERAL DIMENSIONS.	
Gauge	4 ft. 9 ins.
Fuel	Bituminous coal
Weight in working order	171,175 lbs.
Weight on drivers	171,175 lbs
Weight engine and tender in working order	292,335 lbs.
Wheel base	13 ft. 7½ ins.
Wheel base, total, engine and tender	45 ft. 7¾ ins.
CYLINDERS.	
Diameter of cylinders	21 ins.
Stroke of piston	28 ins.
Horizontal thickness of piston	6 ins.
Diameter of piston rod	4 ins.
Size of steam ports	1⅝ ins.
Size of exhaust ports	2½ ins.
Size of bridges	1⅞ ins.
VALVES.	
Kind of slide valves	Piston type
Greatest travel of slide valves	5½ ins.
Outside lap of slide valves	1 in.
WHEELS, ETC.	
Number of driving wheels	8
Diameter of driving wheels outside of tire	51 ins.
Thickness of tire	3½ ins.
Diameter and length of driving journals	9 and 9½ ins. diameter x 10 ins. long
Diameter and length of main crankpin journals	7 ins. diameter x 6½ ins. long
Diameter and length of side-rod crankpin journals	7¼ ins. diameter x 5 3-16 ins.
BOILER.	
Style	Extended wagon top, wide firebox
Outside diameter of first ring	67 ins.
Working pressure	200 lbs.
Thickness of plates in barrel and outside of firebox	9-16, 11-16, ⅞ in.
Firebox, length	80 ins.
Firebox, width	70 ins.
Firebox, depth	Front, 70 ins.; back, 67 ins.
Firebox plates, thickness	Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube sheet, ½ in.
Firebox, water space	Front, 4 ins.; sides, 4 ins.; back, 4 ins.
Firebox, crown staying	Radial, 1⅛ ins. diameter
Firebox, staybolts, diameter	1 in.
Tubes, number	351
Tubes, diameter	2 ins.
Tubes, length over tube sheets	14 ft.
Heating surface, tubes	2,572.97 sq. ft.
Heating surface, firebox	132.13 sq. ft.
Heating surface, total	2,705.10 sq. ft.
Grate surface	3,888 sq. ft.
Exhaust nozzles, diameter	5¾ ins.
Smokestack, inside diameter	16 ins.
Smokestack, top above rail	14 ft. 10⅛ ins.
TENDER.	
Weight, empty	52,400 lbs.
Wheels, number	8
Wheels, diameter	33 ins.
Journals, diameter and length	5½ ins. diameter x 10 ins.
Wheel base	18 ft. 1 in.
Water capacity	6,000 U. S. gals
Coal capacity	7 tons

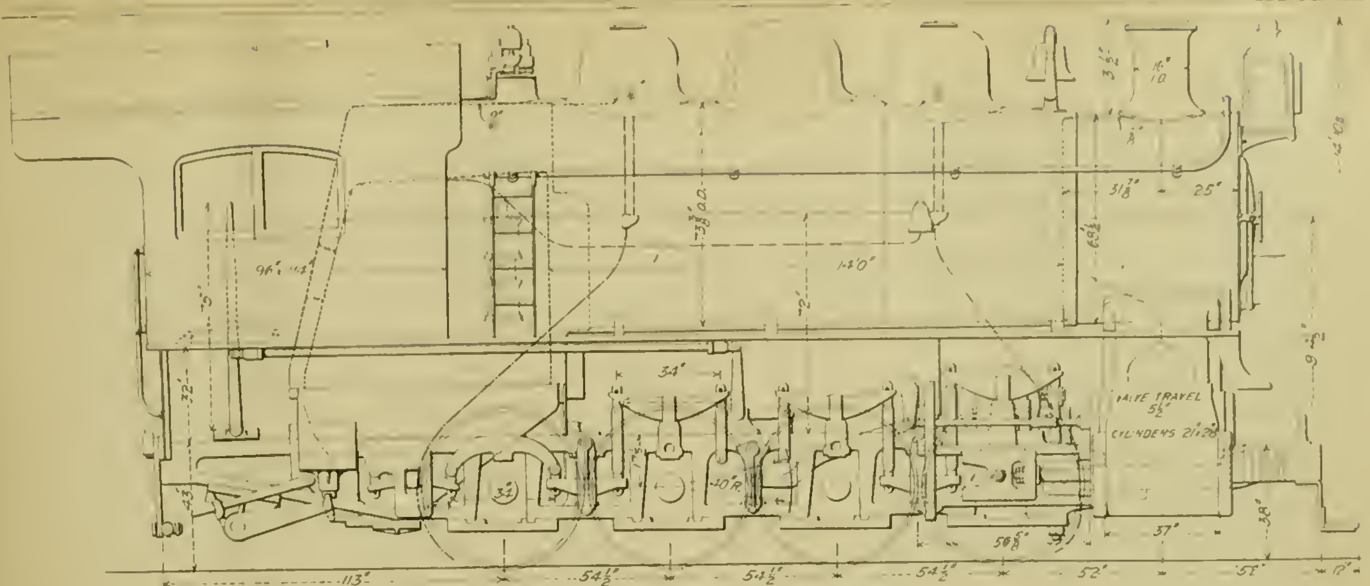
STEAM TURBINE POWER PLANT FOR BOSTON NAVY YARD.

An interesting departure in engineering practice by the authorities of the United States Navy, Department of Yards and Docks, is marked by the introduction of Westinghouse-Parsons steam turbines for furnishing power for lighting the buildings and yards, and power for operating dry dock pumps and miscellaneous machinery.

The initial installation for this character is in process of construction at the Charlestown Navy Yard, Boston, Mass. and for the present one Westinghouse-Parsons turbine generating unit of 750-kw. capacity will be placed in service. This turbine will be of the short-barreled type and is now under construction at Pittsburgh. A Worthington surface condenser will be employed, using salt water for circulation. The condensers will be located between the foundations, which consist of concrete piers. A running vacuum of 28 ins. will be secured through the aid of a dry air pump. Steam will be furnished at 150 lbs. pressure by Babcock & Wilcox boilers in units of 350 h.p., equipped with Roney mechanical stokers. Coil superheaters in the boiler settings will furnish to the turbine a superheat of about 100 deg. F. The boiler house will be equipped with a complete outfit of coal and ash-handling machinery.

The turbine plant will supply 3-phase alternating current at 2,300 volts, this voltage being used for general distribution and for direct use in larger motors, while for lighting lower voltage will be provided by transformation. The turbine generator will be served by a 37½-kw. Westinghouse compound exciter unit.

The engineering work is under joint execution by the Department of Yards and Docks and the constructing engineers, Westinghouse, Church, Kerr & Company, who are installing the plant.

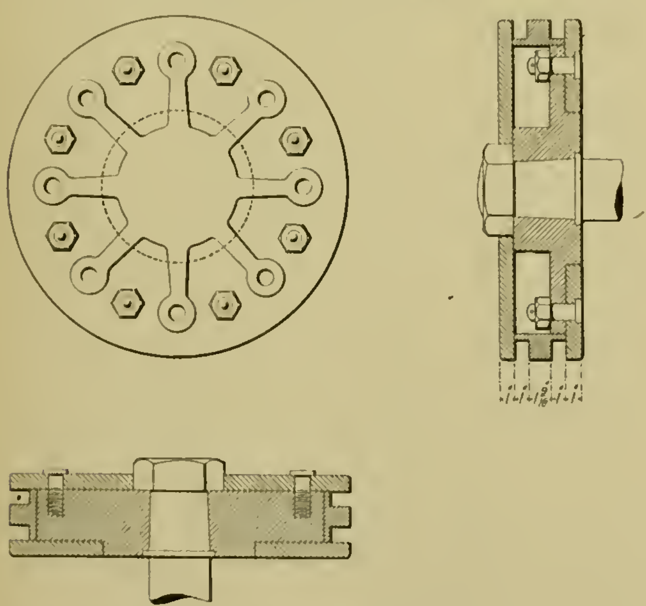


HEAVY 8-COUPLED SWITCHING LOCOMOTIVE.

CHESAPEAKE & OHIO RAILWAY.

THE SEITZ BUILT UP PISTON.

A method of constructing locomotive pistons devised by Mr. Charles Seitz is illustrated by the accompanying engraving made from a drawing received from Mr. J. D. Young, machine shop foreman of the Burlington & Missouri River Railroad at Havelock, Neb. This piston originated with Mr. Seitz, who devised it with a view of increasing the life and reducing the cost of repairs to pistons. He has been employed for 15 years on pistons as a machinist and has given the subject a great deal of study, with a view of constructing a built-up piston which will last the full life of the rod and not require replacement by a new one as the cylinder becomes worn, necessitating reboring. This construction is very simple and the slight cost



THE SEITZ BUILT-UP PISTON.

of renewal to fit a worn cylinder must appeal to everyone connected with locomotive repair work. Should a cylinder require reboring it is not necessary to remove this spider from the rod and replace it with a new one of sufficient diameter to fill the cylinder. By simply removing the follower plates and replacing them with new ones and putting in a new skeleton ring, the piston is ready for replacement and is practically a new head, fitting the new sized bore of the cylinder. This is done at less than one-fourth of the cost of labor and material necessary for repairing an ordinary piston. The AMERICAN ENGINEER believes that there are many earnest, wide-awake machinists and others in railroad shops who are well informed on these subjects and who have good devices of this kind which readers will be glad to know about.

THE POWER REQUIRED IN PLANER DRIVING.

An interesting series of tests were recently made with a motor-driven planer at the works of the Fred M. Prescott Steam Pump Company, the results of which are of importance for their bearing upon the important subject of driving metal planers. The planer used was a 48-in. planer, with 12 ft. bed, built by the Gray Planer Company, which is equipped for individual driving with a type B-10, 220-volt compound-wound direct-current motor, built by the Milwaukee Electric Company. This motor is of 15-h.p. capacity, operating normally at 1,100 rev. per min., and is arranged for variable speeds by field control; a Cutler-Hammer field regulator is used for varying the field's strength with a view to increasing the speed of the machine for various kinds of work.

A number of readings were taken with the planer operating at different cutting speeds, in each of which cases three tools were used, cutting simultaneously; two of the tools were set for a ⅜-in. cut and the other tool for a ⅝-in. cut, and the feed of each was 1-16-in. The following table shows the current required by the motor for the different speeds of the planer from 20 ft. up to 26 ft. per minute:

Cutting Speed (Ft.).	Motor Speed.	Amperes During Cut.	External Resistance; Ohms in Shunt-Field Coil.	Amperes During Reverse.
20	1170	23.5	0	62
21	1210	24	15	60
22	1270	24.5	46	59
23	1330	25.5	65	58
24	1390	26.5	97	57
25	1450	27.5	125	57
26	1510	28.75	148	56.5

The voltage of the circuit upon which the motor was operated remained constant at 230 volts throughout the series of tests.

Particular attention should be given to the variation of current required by the motor. When the planer was operated at a cutting speed of 20 ft. per minute the motor required a rush of current, amounting to 62 amperes for the reversal from cut to return, while when running at the increased speed of 26 ft. per minute the extra current required at reversal had dropped to 56½ amperes. This indicates that it is not only practical but economical to use the field control method of increasing the speed of a motor drive upon a planer. This method of increasing the shunt-field resistance resulted in this case in a material reduction of the current required by the motor at reversals.

We are indebted to Mr. F. W. Cox, superintendent of the Milwaukee Electric Company, for this information.

LETTERS TO THE EDITOR.

COMMERCIAL CONDITIONS IN RAILROAD SHOPS.

To the Editor:

Seventeen years of shop experience have convinced the writer that the success of the modern manufacturing industries depends greatly on their ability to perfect labor-saving devices to cheapen the output of each of their different departments. Up-to-date managers and superintendents of manufacturing concerns are alive to this vital point, and see to it that they have at the heads of their various departments, and particularly in the case of their tool department, the very best man that it is possible for them to secure for the work.

As a general thing, railroad shops do not devote much attention to the tool-making question, as private concerns of similar character do. This is due in a great measure to the fact that, in the words of a well-known superintendent of motive power, the railroads "are in the transportation business and not in the manufacturing business." While this may be to a certain extent true, it does not justify the utter disregard of the tool department that some railroads seem to have. It is not the intention to cast any reflection on any member of the great family of railroad officials, but it is nevertheless a lamentable fact that in the majority of cases the toolroom is given but scant attention. In fact, there are cases, known to the writer, of good-sized railroad shops, employing as high as fifty full-pay machinists, which have absolutely no toolroom whatever; the only approach to a toolroom is possibly a wrench-rack in some out-of-the-way corner, and what few special tools each individual machinist can keep in his own locker—although the more he can steal from another man the more he will have for his own. There can be no denying the fact that work done in shops of this sort must of necessity be done in the crudest manner possible, with accompanying disadvantages to the motive-power equipment and output.

It is not to be insinuated that the machine shops of our railroads of to-day are not in charge of capable men; the fact is, some of as good shop managers as can be found anywhere in the country are in charge of our railroad shops, but a great number of them have been brought up along railroad lines exclusively, and they unconsciously see things from the older railroad point of view only. The effect of this condition of affairs may be seen by considering a few specific cases in the machine shop:

For instance, it would never take a lathe man three hours to bolt a crosshead to a face-plate on a lathe and rebore it for a pin fit if the shop had a full equipment of standard piston fit and crosshead reamers.

It would not take one hour to tap out eccentrics by hand if the shop had an automatic tapping device to tap them in the drill press, by which the work could be done in five minutes.

It would not take four hours to bend the arm of a tumbling shaft and then swing it in the lathe to be able to turn the bearings if they had a tumbling-shaft turning device to do the work.

In place of taking eighteen hours to plane ten eccentric halves by bolting on the planer bed, thirty of them ought to be done in ten hours with a special eccentric-planing jig.

It would not take two hours with a bar and cutters on a drill press to true out knuckle-pin bearings if the shop had reamers with which the same work could be done in fifteen minutes and a standard hole made.

Where it would take one hour to turn a driving brass with an old-style flange and nut mandrel, three of them could be done in the same time by using a mandrel with set-screws to locate them in position, and thus not require truing up, and cupped set-screws to hold them tight.

A special chuck for shoes and wedges, whereby the work could have all the benefit of all the heads on a planer at once, would be the means of reducing the time by at least one-half over the method of using only one head at a time.

It would not take one hour to cut off a set of piston packing rings if the shop had a gang cutter, whereby the same work could be done in ten minutes.

These are but a few examples of the many cases that could be cited from actual experience to show the difference between a shop with an equipment of modern tools and one in which the toolroom end is not given the fullest attention. A closer standardizing of parts, made possible by complete sets of reamers, drilling-jigs, templates, etc., for certain lines of work, such as rod knuckle-joint pins, crosshead pins, etc., would be the means of removing an immense amount of extra labor, time, worry and inconvenience, to say nothing of the great reduction of maintenance.

It is possible to replace a broken part of a bicycle, automobile, typewriter, etc., of any of the standard makes, by simply sending to the factory and specifying only the number and names of the parts required. Why should not this be true, to a great extent, also, of locomotives? Just imagine the great saving it would bring about, and resulting improvement in all departments, if any roundhouse foreman along the line were able to send to headquarters for any broken part and know for a certainty that it could be applied without many hours of fitting?

The question is, however, How can this state of affairs be best brought about? In the first place, a complete set of jigs and templates should be kept on hand by the toolroom foreman for all vital parts of the running gear, rods, etc., that are more liable to become broken or thrown out of place—by this effort, duplicate parts are made possible. Then an accurate record should be kept of all of these; they should be catalogued, indexed, and filed in such a manner as to render it possible for any one, even a stranger, to walk into the toolroom and find easily and quickly anything he might want in this line. When new classes of engines are bought it should be the toolroom foreman's duty to see that the equipment of jigs is brought right up to date for all these new appliances.

With an accurate and complete set of jigs and templates, duplicate parts could always be kept on order. This is the main point—to be able to furnish the parts. The application is of secondary importance. In order to do this with the greatest hope of success, however, the scope of the toolroom should be enlarged. It should not only embrace the making and keeping of labor-saving devices, standard measuring tools, etc., but under its jurisdiction should come the tempering, drawing, hardening, annealing, etc., of all the drills, taps, reamers, etc., that are needed in this department.

This should be so for the reason that it is much easier and far more certain for the man who has watched and worked up a piece of steel, from the rough forging to the finished article, to be able to tell how it will set in the fire than it is for the man at the fire who has had no chance to observe the peculiar properties of this certain piece through its different stages of transformation. This is not idle talk or mere theory, for it is an established fact that even among the same makes of steel there is always a certain amount of variation as to its action and development. Each individual tool has to be handled as a separate and distinct piece to get the very best results, and the only sure way to tell accurately how to handle it is to watch it closely from the start to the finish.

As far as possible, all manufactured parts should be made in one place, presumably at the largest and best equipped plant on the system. This would enable one set of jigs and standards to do all the work, and thereby do away with the greater or less liability of mistakes. It is not possible, however, to do this in all things, and duplicate sets of jigs should thus be kept at the most important points. This would require a man to look after these equipments and see that they were kept exactly the same at all points, something in the same manner that all the manufacturing concerns in the country keep up their gauges. They, as a rule, have a man or a number of men who do nothing else but see that the gauges are kept to an accurate standard; in fact, they have this work systematized to such a point that in many of them the temperature of the gauge-room is never allowed to vary from one year's end to another.

There is no necessity of this, however, on a railway system, in general repair work, as this work does not require anything like this degree of accuracy. This work can be done by some one in connection with other work. A good, all-round practical man would fill the bill, whose duty it would be to see that these templates, jigs, etc., not only are kept up to an absolute standard, but that they were used in shop practice to the best advantage. He should, in fact, be a man who could not only maintain and apply these ideas, but could also create and develop new ones as the occasion required.

In connection with this work, he could see that the tool steels are handled to the best advantage, not only in the actual use on the machine, but in the storing, keeping, checking, tempering, grinding, etc. The writer has been in shops where a special high-speed steel was being used that cost 70 cents a pound, and the shop was not getting any better results than they were when using the old carbon steels. This was due simply to the fact that there was no one there whose particular duty it was to look after this; some of the men in charge did not know and some did not care, and so the thing went on, with no good results for any one, and only added expense to the company.

In this connection, the question can be asked, and very properly, too: Of what use is an up-to-date tool system if it is not kept up? I can answer emphatically—None! But another question can also be asked, and that is: What reason is there that it *cannot* be kept up? And the answer is, also—None! The only thing that needs a remedy, and, in fact, the only weak spot possible in a modern and up-to-date tool system, is lack of interest or lack of knowledge among those directly connected with it.

The writer is inclined to the belief that lack of knowledge is more nearly correct, and for this reason: It is admitted by all interested that in the last decade no such remarkable change of shop methods and appliances has been brought about by any one movement as by the introduction of the new high-speed steels. The changes are so great and so many that it is impossible for the best of foremen, let alone the average of the rank and file, to keep pace with the movement and see that everything is keyed up to the point where it is possible to always obtain the best results. In the present every-day run of railroad life, a master mechanic, a general foreman, or even a machine shop foreman, has entirely too much to look after to allow him to devote sufficient time to the tool or steel end of his department.

What is needed to overcome this difficulty is a demonstrator or teacher, a man who not only possesses the necessary knowledge, but also the ability to impart it. This man should work hand-in-hand with the tool man, and it should be his duty to see that all new tools are thoroughly understood by everybody who will be called upon to use them. He should go from shop to shop as any new tools were introduced and see that they were worked at all times to the best advantage. He should see that the best methods are adopted for tempering, handling and applying all steels, and that all tools are kept up to the proper capacity.

Without going into more elaborate detail, and without touching on one of the greatest of all the problems, *labor*, I can say without fear of contradiction that the above fairly well covers the ground of the many improvements that could be inaugurated by advancing the tool end of a railroad shop in comparison to that of a manufacturing concern.

Widen the scope of each toolroom locally till it embraces everything that properly belongs to its department; then see that the tools along the line are kept checked up together: and the results will be beyond the most sanguine expectations. The motive power will be brought nearer a universal standard; the working method of the entire system, as far as the shops are concerned, will be placed on a sure and accurate basis, and the saving thereby brought about will, I feel certain, be far greater than can be possible in any particular line of shop practice.

H. W. Jacobs,

Union Pacific Railroad, Omaha Shops. Omaha, Neb.

THE OLD MACHINE TOOLS—MOTOR-DRIVING.

To the Editor:

I note with interest your remarks in the March issue of this journal regarding the work that is being done by some old tools. So much has been said about the demand for new and stronger machines that will be able to stand the strains put upon them by using improved steel and under improved management that in some shops the problem of how to get the most out of the old tools seems to be a greater one than it really is. The best way to solve the problem is to study each machine as to its capacity and give to it such work as it will readily take care of. Much of the work done does not need a more powerful machine, but a faster one. It will be found in many cases that a machine needs only to be speeded faster, which can, in the case of a lathe, be readily done by increasing the speed of the countershaft.

Contrary to the opinion of some, most lathes have not speeds enough to suit the work done upon them. Where this is the case the reversing belt to the countershaft can be changed to give a forward motion, and in that way the available number of speeds will be increased. A case in point: A 24-in. lathe in a certain shop was so speeded that a 3-in. shaft could be turned at a cutting speed of only 30 ft. per minute. Mr. Push came in one morning with a pocketful of "purple-cut" tool steel, and in order to get the benefit of this it was necessary to double the speed of the lathe. The old machine now does the work at a cutting speed of 60 ft. per minute, and the chips come off so hot that visitors light cigarettes from them. Of course, the machine springs considerably under the heavy first cut, but it carries a second and lighter cut all right, and leaves a good surface for the grinder to finish.

In some places the old tools can be used for rough machining only, leaving the finishing to be done in a more substantial machine; and there are cases, of course, where, in order to remove a large amount of metal left by forging, a heavy and powerful tool is needed. One shop had a strong, heavy lathe for doing certain machining work, but could not turn out all that was needed. An old discarded lathe was put back in service and used for roughing the work handled upon the heavier lathe. The writer saw the machine at work upon a forging 9 ins. in diameter, taking a cut ½ in. deep, with a feed of 1-16 in., at the high cutting rate of 62 ft. per minute. In this case only the roughing was done on the old machine, as it was too badly worn to do accurate finishing.

Some old lathes are doing better work than formerly by being motor-driven. With some methods of motor connection, however, the range of speeds is no better than with the old belt and cone pulleys, but by properly adapting the motor speed-regulating apparatus to a more or less limited variation of diameters, and by giving the lathe such work as will come within the proper range, it is surprising *how much more work* can be turned out than with the old arrangement.

It is surprising to see, as we look around, how little consideration is given to the proper arrangement of some motor-driven machines. Looking over a large shop recently, the writer saw drives of nearly all descriptions. In some cases the motors were connected directly to the machines by gears, some by silent chains, and others were connected by placing the motor upon the floor and retaining the old countershaft with the necessary belts. Some of the machines were group-driven, and in many cases the controllers were conveniently located. Altogether, the general scheme seems to have partaken of the hit-or-miss style.

Another shop visited presented quite a contrast; here the idea seems to prevail that leather should be used for shoe-soles or hydraulic cylinder packing, but not for driving machinery. In one corner of the shop the machines are at present driven as a group, but the large majority of machines are driven by individual motors. Each application was considered by itself, and only what seemed best was adopted. The controllers are conveniently located, so that the operator can easily adjust the machine's speed while it is in motion. Gears and chains are covered, not only to keep out the dust, but to prevent interference with a misplaced finger. In the main, the scheme in the latter shop seems to be very convenient.

As these two shops are close enough together to be neighborly, each might have derived considerable benefit from a mutual interchange of ideas and opinions. But the business of motor application is so new that the best cannot as yet be consistently expected.

M. E.

HEAVY DRIVING-WHEEL LOADS.

To the Editor:

On page 153 of the current number of the American Engineer there appears an illustrated description of the 4—4—2 type express locomotives recently built for the Vandalia Line by the American Locomotive Company at their Schenectady Works.

In the course of this article the following statements occur: "These are heavy engines, weighing 179,444 lbs., with 109,500 lbs. on driving wheels. This is the most remarkable feature of the design, as a weight of 27,375 lbs. per wheel is the greatest driving-wheel load in our record of locomotives. This even exceeds the practice of the Pennsylvania Railroad in the Class E2 and E2a engines, which have 109,033 and 109,000 lbs. on drivers, respectively."

In regard to the latter statement, I beg to direct attention to the fact that, according to the official classification book issued by the motive-power department of the Pennsylvania Railroad, May 1, 1902, the adhesive weight, in working order, of the Class E3, 4—4—2 type locomotives, is as follows:

Weight on first pair of drivers..........	55,000 lbs.
Weight on second pair of drivers........	56,600 lbs.
Total	111,600 lbs.

This represents an average load of 27,900 lbs. per wheel, and testifies eloquently to the solidity of the magnificent permanent way and bridges of the Pennsylvania Railroad. In these locomotives, 55.5 sq. ft. of grate area and 2,640 sq. ft. of total heating surface are apparently found quite sufficient to utilize 111,600 lbs. of adhesive weight, through the medium of 22 x 26-in. cylinders, 80-in. driving wheels, and 205 lbs. steam pressure. This indicates what can be accomplished by a properly designed boiler, in which good circulation and a moderate amount of heating surface are substituted for the far too common practice of providing an enormous heating area, which is frequently rendered of relatively low efficiency by poor circulation, induced by contracted firebox water spaces and overcrowding of the flues.

Edward L. Coster,
Assoc. Am. Soc. M. E.

25 Broad St., New York, April 11, 1904.

EXTENDED SMOKE BOXES FOR LOCOMOTIVES.

To the Editor:

After reading your very interesting letter in the April number of the AMERICAN ENGINEER it occurred to me more forcibly than ever, *Why are the American railways using the extension front end?* When it first came into use it was intended for a spark-arrester, and was so constructed that it did hold sparks to a certain extent; but after a while, when the novelty had worn off, the engineers would not blow them out except when actually obliged to in order to get steam. Since that time a great many master mechanics have succeeded in putting up front ends which will clear themselves. Now, if that is what we have come to, what is the need of all this extra expense in maintaining so much paraphernalia in a front end, if the people on the other side can get a better steaming locomotive with a smokebox like the one shown on the Caledonian locomotive? I do not see why we should use such a cumbersome thing on the fronts of our boilers. I know from experience that our locomotives steamed better with the diamond stack than they ever have after fitting them with the extension front end. The inside arrangement was the same as the New York Central is using today. Of course, we cannot say at this time how the present large boilers would work with a short smokebox, but I do not see how it could be any different with them than with the smaller ones. After noting what you say about the performance of the Caledonian's locomotive to the ton of coal, it looks to me as if we were a long way in the rear of our cousins on firebox and front-end arrangements. Instead of going ahead for the past fifteen years, it seems to me we have gone back in the matter.

GEORGE A. FERGUSON.

N. Y. C. & H. R. R. R., Depew, N. Y.

AN IMPORTANT NEW TERMINAL-YARD, LIGHTING AND POWER PLANT.

WEEHAWKEN, N. J.

WEST SHORE RAILROAD.

IV.

(*Continued from page* 128.)

THE GENERATORS.

As indicated in the plan drawing of the engine room in the inset supplement accompanying the second article of this series (March, 1904), the generator equipment of the Weehawken power plant consists of four slow-speed alternating-current generators, each direct connected to a Westinghouse horizontal Corliss engine. All four machines are of the engine type with revolving fields and are wound to deliver three-phase alternating current, but the two smaller machines are intended for a different class of service than the larger ones and thus differ somewhat in service details.

The two alternators driven by the 1,200-h.p. engines are each of 750-kw. capacity and deliver the 3-phase current at a frequency of 25 cycles and at a voltage of 600 volts with the normal engine speed of 94 rev. per min. Those direct-connected to the 650-h.p. engines are each 400-kw. capacity machines, and are designed to deliver 3-phase alternating current at a frequency of 60 cycles and at a voltage of 2,300 volts with the normal engine speed of 120 rev. per min.

Both sets of machines have revolving field coils and stationary armature windings, with all high-voltage connections carefully covered. The construction is of the latest and most modern type, and is planned to prevent disagreeable humming from structural defects. The insulation of each machine is carefully looked to, it being specified that the insulation resistance between windings and that between windings and core shall be a megohm; the windings are also subjected to the usual high-voltage tests of more than double the normal running voltage. The machines are all wound for close regulation and are designed to operate conveniently in parallel. The regulation is such that no machine will rise in voltage more than 50 to 60 volts when full load is thrown entirely off. The field magnets are all wound for an excitation voltage of 250 volts.

The two 750-kw. generators were furnished, together with one 50-kw. 250-volt direct-current exciter dynamo, by the Bullock Electric Manufacturing Company, Cincinnati, Ohio. The rating of the two 750-kw. machines is that they shall deliver the normal full load output continuously for twelve hours without rise of temperature of any part more than 40 degrees, C., above that of the surrounding air; they will carry a 25 per cent. overload for two hours with not more than a 55-degree, C., increase of temperature, and a 50 per cent. overload continuously for five minutes without injury to the insulation. The efficiency of these machines is guaranteed to be 95 per cent. at full load.

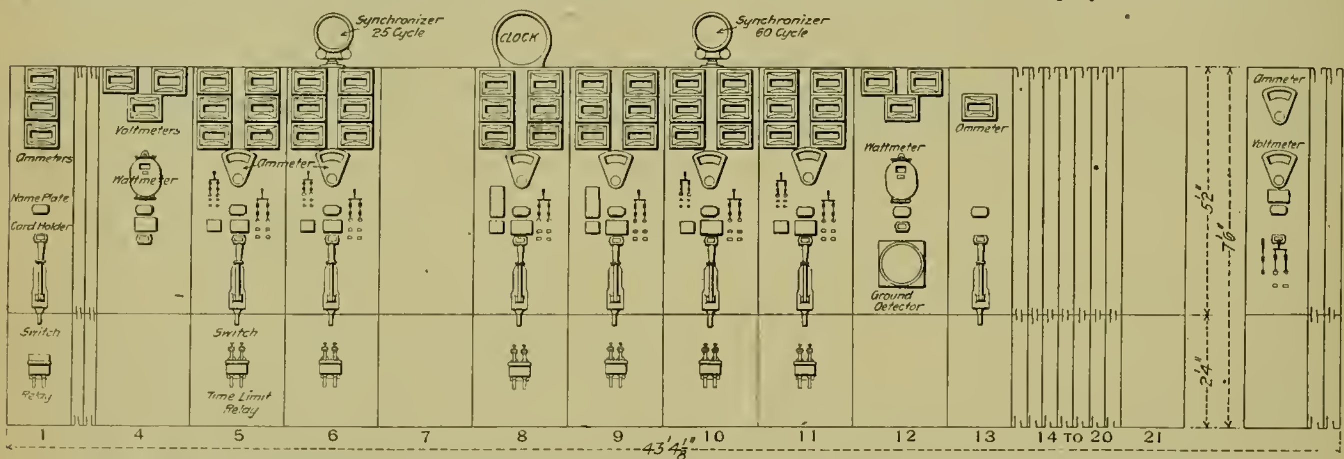


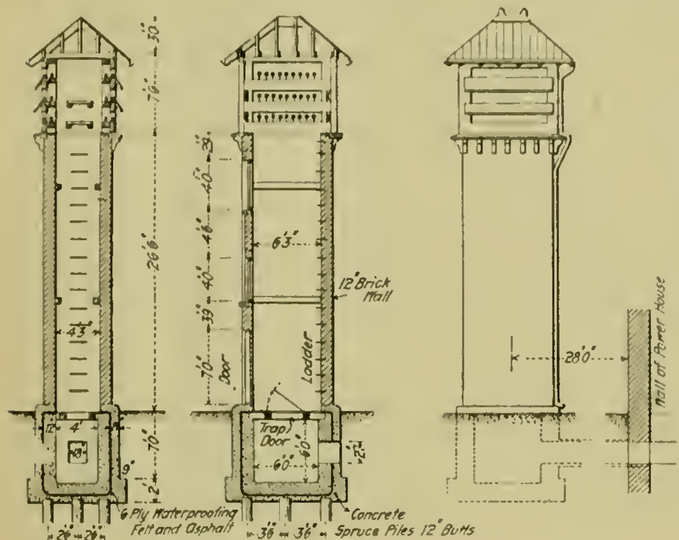
DIAGRAM OF THE SWITCHBOARD, SHOWING ARRANGEMENT OF GENERATOR AND FEEDER PANELS, WITH INSTRUMENTS.

TERMINAL-YARD LIGHTING AND POWER PLANT.—WEST SHORE RAILROAD.

The two 400-kw. generators were supplied, also with a 50-kw. 250-volt, direct-current exciter, by the General Electric Company, Schenectady, N. Y. The rating of these alternators is that they shall deliver their normal full load for twelve hours continuously without an increase of temperature of any part more than 40 degrees, C., above that of the surrounding air; they will also carry a 25 per cent. overload for two hours without temperature rise of more than 55 degrees, C., and a 50 per cent. overload continuously for five minutes without injury to the insulation. The efficiency guaranteed for these machines is 93 per cent. at full load.

Both exciter generators are multipolar direct-current machines and are direct-connected to 90-h.p. Westinghouse vertical cross-compound engines. They are each of 50-kw. capacity and have ratings similar to that of the alternators. They are wound for close regulation, with means for easily adjusting the percentage of compounding either 5 per cent. above or below normal, and have guaranteed efficiencies at full load of 90 per cent. The exciter units are located beneath the switchboard gallery, as indicated in drawings in the preceding articles.

It may be a matter of surprise to many that alternating current is to be generated in two different frequencies, namely in 25 and 60 cycles. But this is to be done on account of the peculiar operating conditions, which are to be met in this plant. The two larger machines are intended to carry the motor load of the distribution system and the two smaller machines will take care of the lighting load. It was found that by using 25 cycles (instead of 60 cycles) a large amount of money could be saved by the elimination of reduction gearing



DETAILS OF THE SPECIAL CABLE TOWER, OUTSIDE THE ENGINE ROOM, FOR LEADING OUT THE OVERHEAD AND UNDERGROUND DISTRIBUTION CIRCUITS.

at the motors, inasmuch as with 25 cycles the motor-speeds are correspondingly lower; the saving in gearing for the grain-elevator motors alone is estimated to amount to nearly $10,000. The higher frequency (60 cycles) was used for the lighting circuits inasmuch as arc lights operate much more satisfactorily at this frequency.

The question of voltage was also an important consideration. The voltage of the power circuits was made relatively high (600 volts) in order to save transmission losses; yet this voltage is not too high for interior use with safety. The economy of this voltage, over 110 or 220 volts, is considerable in the operation of the large motors used in the grain elevators as the transmission distance is fully 1,000 ft. The distribution circuits for the lighting system are operated at 2,300 volts, because of the extended area of the lighting circuits.

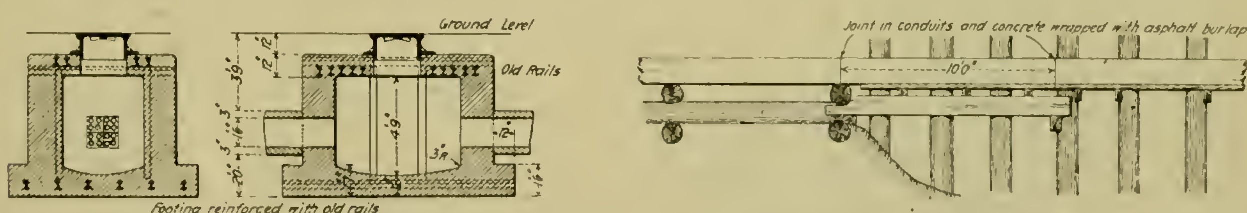
In addition to the above-mentioned equipment of the engine room there is also a motor-generator set installed for an interesting class of work. This motor-generator consists of two revolving-field engine-type machines, mounted on one shaft and bedplate. This machine is designed to deliver from one side a 3-phase alternating current at a frequency of 60-cycles and potential of 2,300 volts, when supplied on the other side with a 25-cycle 3-phase alternating current of 600 volts; it will also similarly deliver a 25-cycle, 3-phase alternating current at 600 volts when supplied with a 60-cycle 3-phase alternating current of 2,300 volts in the opposite order. This outfit has a capacity of 100 kw. at a speed of 300 rev. per min. Both machines have stationary armature windings and are carefully constructed and insulated. The rating of these machines is that they shall deliver a 25- per cent. overload continuously for one hour without temperature rise of any part more than 55 degrees above that of the surrounding air, and to carry a 50-per cent. overload for five minutes continuously without injury to the insulation. The efficiency of the set is 85 per cent. at full load. The fields of both machines are wound for the standard exciting current of 250 volts. This machine was also furnished by the General Electric Company.

The usefulness of this motor-generator set will be readily apparent. In the day-time, when the lighting load is very low and the power circuits are in operation, what small amount of lighting current will be required can be thus transformed from the 25-cycle power circuits by its use, and thus the 400-kw. generators may be allowed to stand idle. Conversely in the night, when the lighting circuits are in use, any small amount of current that may be required on the power circuits for night work in the repair shops, or otherwise, may be transformed from the 60-cycle lighting current, which will relieve the 750-kw. generators from operation at very light loads at night time. In this way the motor-generator set serves as a combined voltage and frequency transformer and is used as an interconnecting link between the two electrical distribution systems. Its use may be readily seen to be very important in thus saving either set of generators from being compelled to be operated at extremely light loads, at any time. Another important advantage of the use of the motor-generator set, is that during light loads upon one system, the power factor on the other system can be greatly increased by overexciting the motor field.

SWITCHBOARD.

The switchboard is located at the southeast corner of the engine-room upon a gallery of structural steel construction with a concrete floor, 11 ft. 4 ins. above the main floor. It is a large board, consisting of 24 panels and is constructed of 2-in. blue Vermont marble of the best quality. Each panel is of the uniform height of 7½ ft., including a sub base; panels numbered 4 to 12 inclusive, are 24 ins. wide and the remainder are 16 ins. wide. The board is mounted upon a strong framework of angle iron construction with a polished oak base.

The front elevation drawing of the switchboard indicates the arrangement of the panels. The first three panels are feeder panels, each of 500-kw. capacity, for the 25-cycle, 600-volt 3-phase current. The fourth panel is a 1,500-kw. total output panel for these feeder panels, containing voltmeters, a Lincoln synchronizer and a total recording wattmeter. Panels Nos. 5 and 6 are the generator panels for the 750-kw. 25-cycle 3-phase generators, and panel No. 7 is a blank panel to be held in reserve for a future 750-kw. generator.



DETAILS OF TYPICAL MANHOLE CONSTRUCTION OF THE UNDERGROUND CONDUIT SYSTEM, AND OF FLEXIBLE CONSTRUCTION AT DOCK BULKHEADS TO PERMIT UNEQUAL SETTLING OF GROUND LEVEL.

Panel No. 8 controls the 600-volt 25-cycle side of the motor-generator, and panel No. 9, the 2,300-volt, 60-cycle side of the same, the capacity of either panel being 100 kw. Panels No. 10 and 11 are the generator panels for the 60-cycle, 2,300-volt, 3-phase generators, and Panel No. 12 is a 800-kw. total output panel for the 60-cycle, 2,300 volt current, containing voltmeters, a Lincoln synchronizer and a total recording wattmeter, like the other total output panel. Panels Nos. 13, 14, 15 and 16 are 200-kw. feeder panels controlling the 60-cycle, 2,300-volt 3-phase power feeders and panels Nos. 17, 18, 19 and 20 are 100-kw. feeder panels controlling the 60-cycle, 2,300-volt single-phase lighting circuits. Panel No. 21 is blank, being held in reserve for a future feeder circuit.

Between panel 21 and the three panels shown at the extreme right is a space of 5½ ft., which is left vacant for the arc light circuit controlling apparatus, the type of which will be determined later. The remaining three panels shown at the right hand end of the board are 50-kw., 250-volt, direct-current panels, each controlling one of the exciter generators for the field excitation circuits of the various generators and motor-generators; panel No. 24 is held in reserve for a future exciter.

The equipment of the switchboard embodies the latest improvements in alternating current work. The alternating current generators, as well as all power feeders, are connected by oil switches at the controlling panels, and their field circuits are controlled by field discharge switches, which will automatically short-circuit the field coils so as to discharge the heavy and dangerous momentary rise of potential that results when the field excitation circuit is opened. The generator circuit breakers are of the time delay type, having overload time interval devices to prevent them from opening on the momentary "cross-currents" due to "hunting" of the generators. All the rheostats are located just beneath the switchboard gallery floor and are operated by hand wheels, conveniently located upon floor stands in front of the switchboard as shown; this location makes an important provision against fire at the rear of the switchboard—the usual location. The wiring is fireproof throughout by the use of fireproof-braid covered wire.

DISTRIBUTION SYSTEM.

All the distribution circuits leave the switchboard by way of the fireproof transformer vault underneath in the basement, to which they are carried through tile conduits. These lead vertically downward from behind the switchboard, so that they are not exposed to injury on the engine floor, behind the exciter units. This transformer vault is located directly under the switchboard gallery, as shown in the basement plan, presented in the preceding issue; it is a room of fireproof construction and contains all the station transformers, tub transformers and other similar electrical apparatus; in case of fire the same will thus be localized at this point. It is important to note here that the lightning arresters are all located outside the power house.

From this vault the feeder circuits leave the building through an underground connection to a separate cable tower, which has been erected just outside the engine-room wall. The general system of lighting and power feeders are carried away from here by overhead lines, although the feeders to the elevators, across the yard, are carried in underground conduits, owing to the congestion of tracks in that direction. The overhead lines lead to the points of distribution at both ends of the yard, the usual step-down transformers being located at centers of consumption. In all cases the power feeders and lighting feeders are kept entirely separate, as the power circuits are operated with all three phases and the lighting circuits single phase. All the power and lighting circuits carried on the pole lines use the 60-cycle, 2,300 volt current, the 25-cycle, 600-volt current being used exclusively for the operation of motors at the grain elevators.

The power feeders for the grain elevator, which also supply the lighting circuits there, are carried in a 16-duct underground conduit, leading from the transformer vault, directly across the yard to the elevators. These conduits are constructed of four 4-duct tiles, laid in concrete, as shown in the accompanying engraving. An important feature of this conduit construction is that it is arranged, where necessary, for flexure and variation of level. Near the dock bulkheads an interesting form of construction is made use of, as shown in the engraving; in this case the joints are loosely wrapped and rest upon logs to freely permit change of level without injury—this is particularly necessary at this point, owing to probable change of the ground level. The other interesting details of this construction are made clear in the engravings.

The entire Weehawken improvement is being developed under the general directions of Mr. W. J. Wilgus, Fifth Vice-President, and Mr. H. Fernstrom, Chief Engineer of the New York Central & Hudson River Railroad Company. The architectual features of the Power Station building were designed by Mr. C. W. Smith, and the steel structure by Mr. G. A. Berry, both reporting to Mr. Olaf Hoff, Engineer of Structures. Mr. C. J. Parker was in charge of the construction of the building and foundations. The electrical and mechanical portions of the equipment were designed and erected by Mr. Edwin B. Katte, Electrical Engineer of the railroad company.

MOTOR-DRIVEN MACHINE TOOLS.

Applications to Special Machinery.

The importance of the electrical method of driving machine tools by individual motors has often been discussed in these columns, in the various phases of its applications to different branches of shop work, but the magnitude of the subject and the very extensive scope of operations in testing its usefulness prohibit a comprehensive treatment of the question in any single article. In this article it is desired to call attention to the scope of the work that has been accomplished, as in no other way can it be shown how general the use of the electric motor is becoming in our machine shops.

While it is admitted that the introduction of motor-driving has not come unattended by a large number of troubles and that many difficulties have had to be overcome, still a glance at the various illustrations of motor-driving applications presented herewith is sufficient to indicate what a multitude of difficulties met in belt driving from line shafting have been avoided by the use of these motor drives. It is true that the difficulties met in the driving of special machinery have been instrumental, to a large extent, in bringing about the introduction of individual motor driving, as a result of which the many advantages were revealed and became understood. The various illustrations in this article give an idea of some of the possibilities.

Fig. 1 presents a view of a large machine shop, in which individual motor-driving is used exclusively for the machine tools; this is a remarkable example of the results that are obtained by the exclusive use of this system. Not a single line shaft or countershaft is to be seen in this shop, the only belts used being those upon individual machines. The light and airy effect of the absence of overhead shafting and belts, as well as also the cleanliness possible, is well shown by this view, which is of one section of the machine shop of the Bullock Electric Manufacturing Company, Cincinnati, Ohio.

This is a condition, however, that may be found at a large number of different shops in this country at the present time. It is interesting to note that not only the electrical manufacturing shops, but also some of the largest industrial shops have adopted this system to the exclusion of belt driving, for reason of the many advantages. Among the latter may be mentioned, as one of the most important, the works of the Wellman-Seaver-Morgan Company, Cleveland, Ohio. In this shop also not a belt is to be seen, even the smallest tools, such as power hack saws and the like, being individually driven by motors. Many other shops using this system exclusively have been mentioned in these columns.

The effect of this rapidly increasing use of the motor-drive has been to make severe demands upon the machine tool builders to adapt their tools to the requirements of the new drive. In this interesting work the Betts Machine Company, Wilmington, Del., have been pioneers. They have anticipated the trend of progress in this direction and have done very important work in the development of practical motor-drive applications. Fig. 2 illustrates a neat and serviceable drive which they have applied to one of their large crank-driven slotters. The motor has been conveniently mounted upon the side of the frame at the rear and drives direct through gearing, there

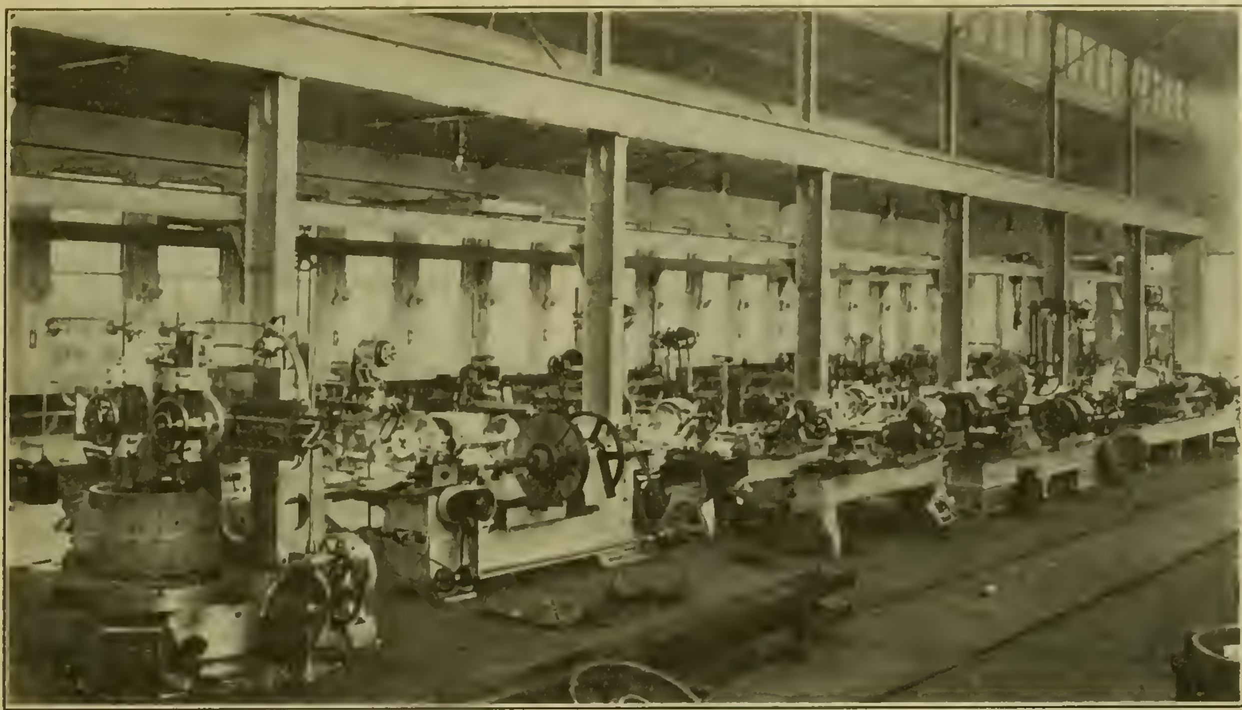


FIG. 1.—A MODEL MOTOR-DRIVEN MACHINE SHOP.—WORKS OF THE BULLOCK ELECTRIC MANUFACTURING COMPANY.

being three runs of gearing for changes of speed. In this way the motor requires practically no additional room and is out of the way of the operator. The motor used is a General Electric Company direct-current motor, operating at variable speeds by field control.

In Fig. 5 is illustrated another Betts tool arranged for motor-driving. This is the Betts standard horizontal boring machine, and in arranging for the motor-drive the cone pulleys were retained. An interesting method of overcoming the difficulty of tightening the belt of such short length is to be seen on this tool; the motor is mounted upon a rocking bracket over the headstock, so that the motor and all may be tipped back to tighten the belt. This motor is also a General Electric direct-current motor, similarly arranged for variable speeds, and drives the upper cone pulley direct through a gearing reduction.

Fig. 3 is an illustration of an application of motor-driving to a large horizontal boring, drilling and milling machine, built by Beaman & Smith, Providence, R. I. On account of the size of this tool the problem of applying the drive was much simpler, but the neatness and compactness resulting from this arrangement of the drive are worthy of particular notice. There is here no possible interference with crane service in handling heavy pieces of work into the tool, and thus the tool may be operated in any part of a shop regardless of surroundings. The motor used here is a Bullock direct-current motor, operating at variable speeds by the multiple-voltage system.

Figs. 4 and 6 illustrate two interesting Crocker-Wheeler drives applied to operate machines at variable speeds by the multiple-voltage system. The former is a large Bement, Miles & Company horizontal planer-type milling machine, with special gear mechanism for adjusting the feeds. The motor is mounted upon the side of the frame at the rear, in place of the usual belt-drive pulleys, and drives direct from there through gearing. This motor is a 15-h.p. direct-current motor, and the controller for operating it in connection with the multiple-voltage system is shown at the front, convenient to the operator.

The Reliance Machine & Tool Company of Cleveland, Ohio, is another of the progressive tool builders that have shown appreciation of the increasing popularity of the motor drive. In Fig. 6 is shown their new 3-inch bolt cutter arranged for driving by a Crocker-Wheeler motor, mounted on a bracket at the back of the machine, replacing the usual four-step cone pulley. This view is taken from the motor side of the machine to show the five trains of reducing gears through which the power is delivered to the spindle at a point midway between its bearings; this is an important advantage in effecting a smooth and even drive. Besides saving in floor length this also places the gears out of the way of injury even when not enclosed. The motor-controller is mounted horizontally on the end of the frame under the head, with the handle extending towards the operator, conveniently within his reach, while standing in a position to operate all other movements of the machine.

Additional examples of motor driving will be presented in a subsequent article.

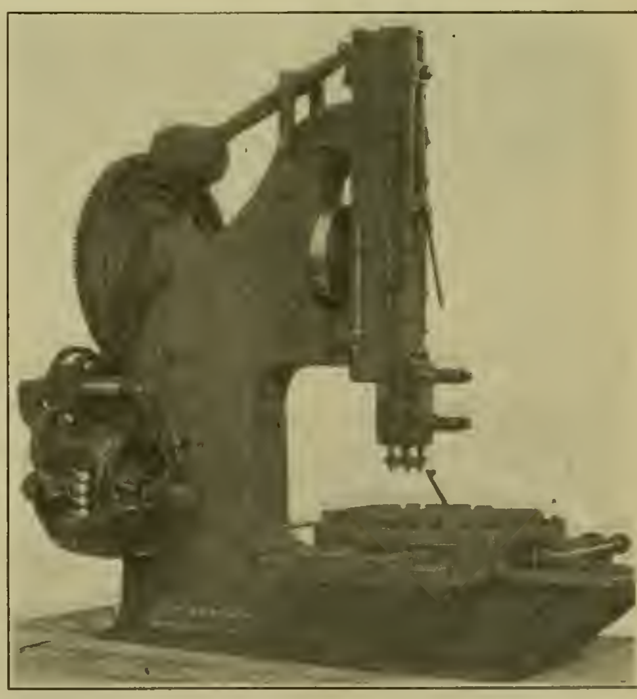


FIG. 2.—GEARED VARIABLE-SPEED MOTOR-DRIVE UPON A LARGE SLOTTER.—BETTS MACHINE COMPANY.

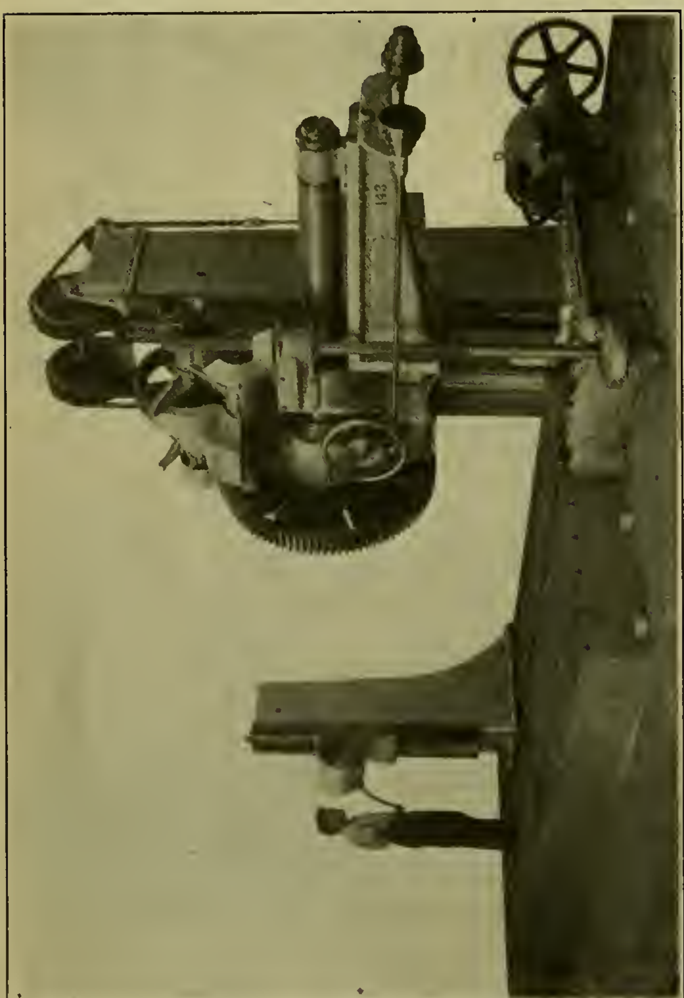


FIG. 3.—DIRECT DRIVE FOR A LARGE HORIZONTAL BORING, MILLING AND DRILLING MACHINE.—BEAMAN & SMITH.

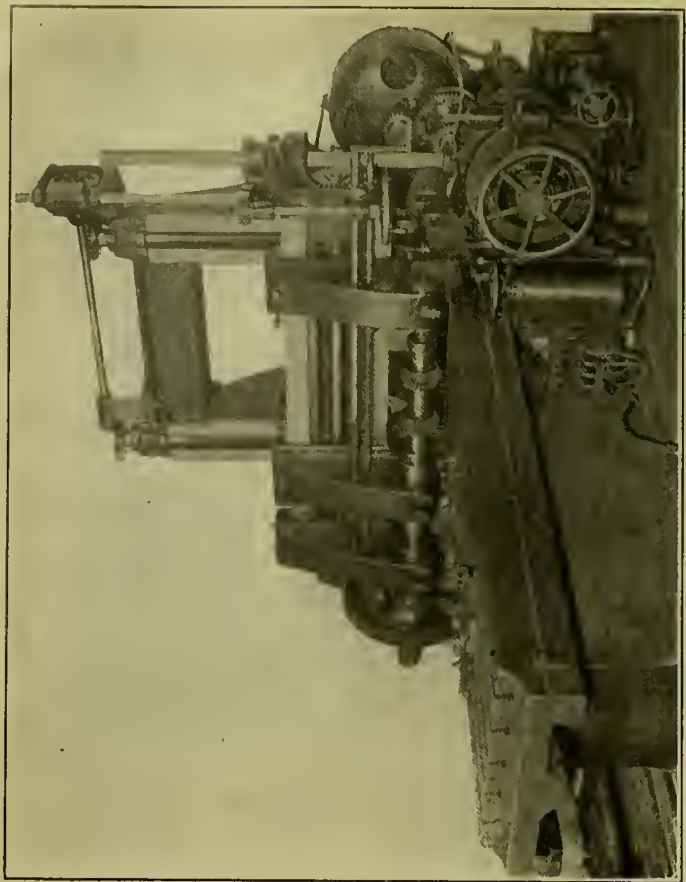


FIG. 4.—CROCKER-WHEELER MULTIPLE-VOLTAGE MOTOR DRIVE UPON A LARGE HORIZONTAL MILLING MACHINE.—BEMENT, MILES & CO.

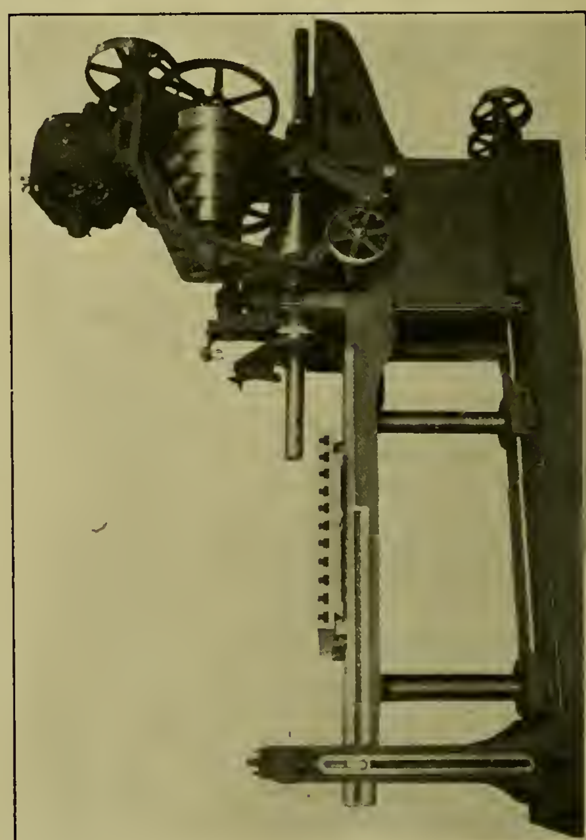


FIG. 5.—BELTED VARIABLE-SPEED MOTOR DRIVE UPON A HORIZONTAL BORING MACHINE.—BETTS MACHINE COMPANY.

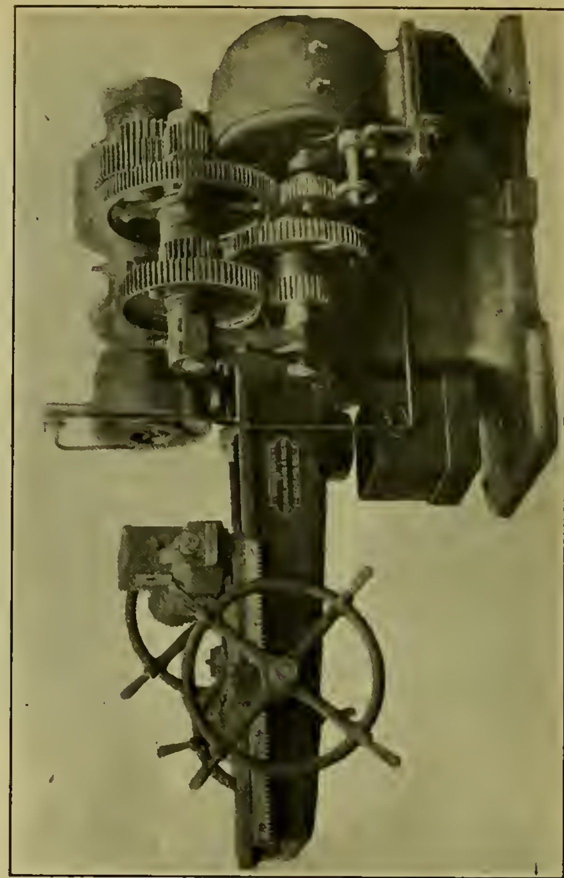


FIG. 6.—CROCKER-WHEELER MULTIPLE-VOLTAGE DRIVE UPON A 3-INCH BOLT CUTTER.—RELIANCE MACHINE AND TOOL COMPANY.

THE APPLICATION OF INDIVIDUAL MOTOR-DRIVES TO OLD MACHINE TOOLS.

McKees Rocks Shops.—Pittsburgh & Lake Erie Railroad.

BY R. V. WRIGHT, MECHANICAL ENGINEER.

X.

THE BORING MILLS.

Some interesting changes were necessary in adapting the individual motor driving to the old boring mills which it had been decided to thus equip for the new McKees Rocks shops. The more important work in this line was in connection with the 48-in. Pond car-wheel borer and the 72-in. Pond boring mill, which had been used at the old shops, and this article will describe the work necessary in changing them for electrical driving.

THE CAR WHEEL BORER.

Fig. 48 illustrates the old 48-in. Pond car wheel borer, as equipped with an individual motor for variable speed driving. As this tool is used exclusively for the facing of hubs of and the boring of car wheels, the range of table speeds required is not very great, and it was seen that the motor could easily take care of it without any additional runs of gearing. Accordingly the speed cone which was used with the belt drive was simply replaced by the large Morse silent-chain sprocket, B, which receives the drive direct from the motor, as shown. The motor was arranged to be supported by a substantial cast iron bracket which is bolted to the frame of the tool in a convenient position for the drive. On account of the projecting location of the rear end of the hub facing spindle and of the feed belt, it was necessary to make the motor bracket of a rather irregular design, as shown in the drawing, although a very solid and substantial design was effected

The motor is a Crocker-Wheeler type 10 1-L.S.-C.M. multiple-voltage motor, and is operated at variable speeds by a type

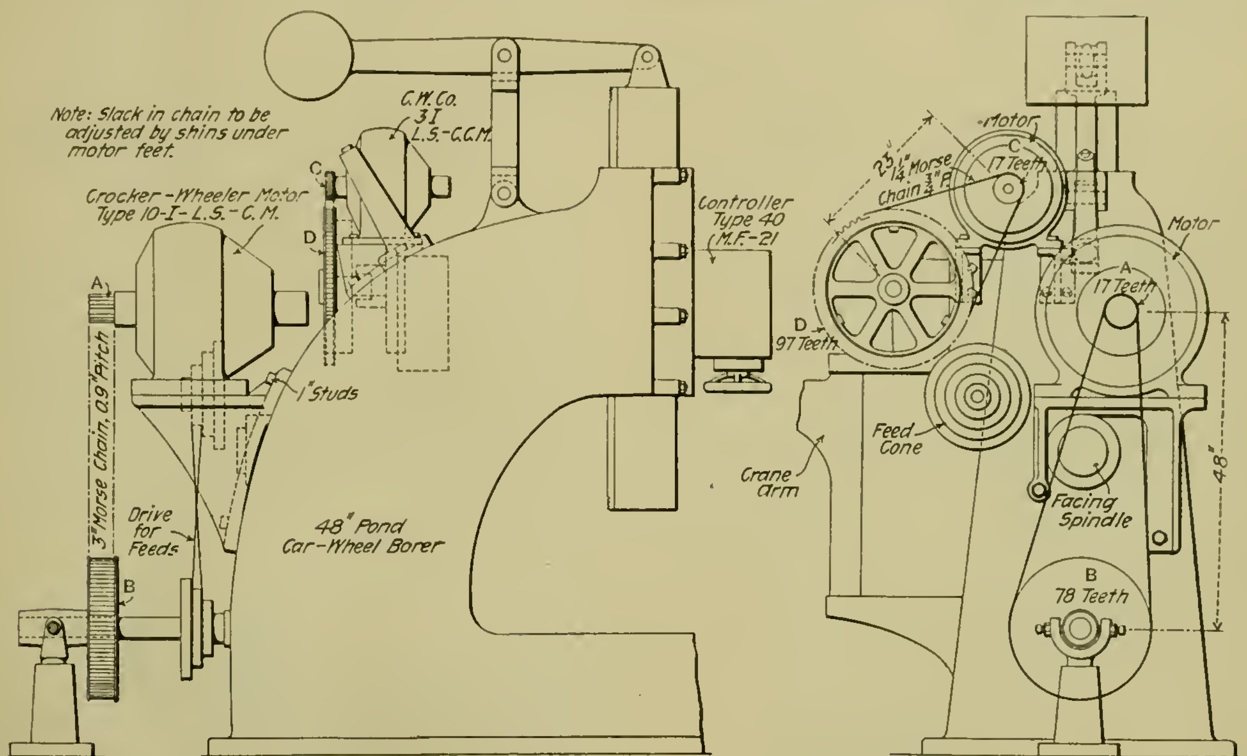


FIG. 48.—DETAILS OF THE APPLICATION OF INDIVIDUAL DRIVING TO THE 48-INCH POND CAR-WHEEL BORING MACHINE, SHOWING ALSO ARRANGEMENT OF SEPARATE MOTOR FOR OPERATING THE WHEEL HOISTING CRANE.

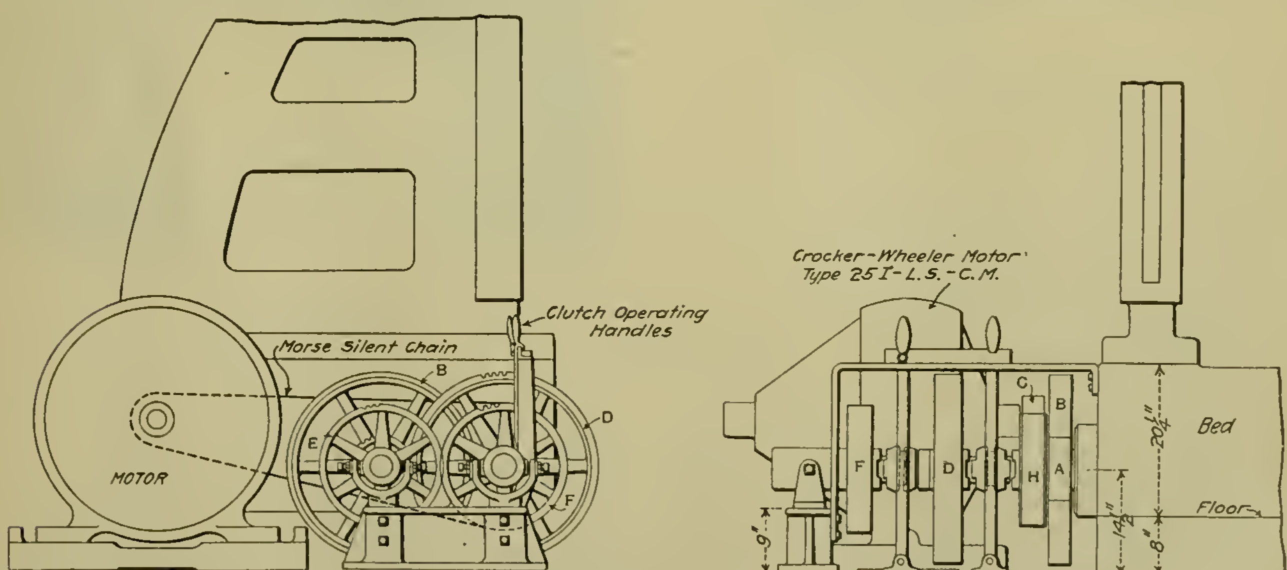


FIG. 49.—THE MOTOR DRIVING ARRANGEMENT FOR THE 72-INCH POND BORING MILL, SHOWING USE OF THREE GEAR RUNS AND INTERLOCKING LEVERS FOR OPERATING THEM.

40-M.F.-21 controller. This gives the tables a range of speeds of from 2.8 to 35 rev. per min. The controller is mounted on the front side of the boring-spindle frame, as shown, which makes it very convenient for the operator.

The small crane for placing wheels and work upon the table, which forms a part of this tool, was formerly operated by a pulley which was driven from the countershaft; this pulley ran continuously and the crane was operated by the throwing in or out of a clutch. Part of this clutch was cast in as a part of the pulley, so that in order to preserve this combination

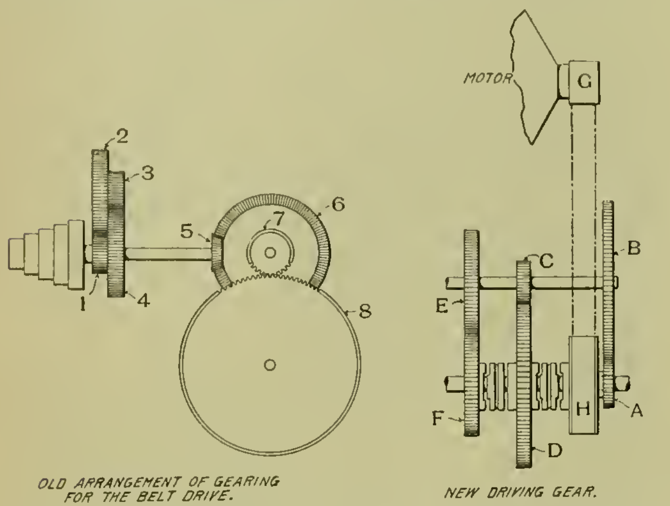


FIG. 50.—DIAGRAMS OF THE OLD AND NEW ARRANGEMENTS OF GEARING FOR THE DRIVE OF THE 72-INCH MILL, INDICATING THE CHANGES NECESSARY TO BE MADE.

and avoid making a new clutch mechanism, the large Morse chain sprocket, D, was made so that it could be slipped on to the pulley and bolted to it, as shown. The motor which is used to operate this crane mechanism is a Crocker-Wheeler type 3 I-L.S.-C.C.M. motor, and is supported by two cast-iron brackets.

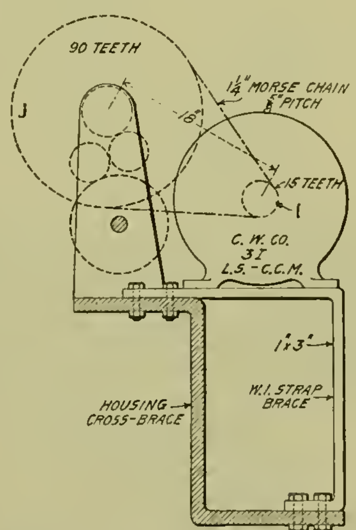


FIG. 51.—ARRANGEMENT OF THE INDIVIDUAL MOTOR DRIVE FOR OPERATING THE CROSS RAIL, RAISING AND LOWERING MECHANISM.

THE BORING MILL.

Figs. 49 and 50 illustrate the application of the individual variable-speed motor drive to the old 72-in. Pond boring mill. This application involved an interesting change in the gearing runs.

Fig. 50 shows the arrangement of the belt cone and back gearing which were formerly used with the belt drive. Gears 2 and 3, which were cast in one piece, ran loose on a short stud shaft and, as back gears, were thrown in and out in practically the same manner used on the ordinary back-geared engine lathe.

In applying the motor the entire arrangement of belt cone and gears 1, 2, 3, and 4, were removed and the stud shaft was replaced by a longer shaft having an outboard bearing. A complete new set of gearing and clutches for changing runs were added, as shown in the other half of the same diagram, Fig. 50, and these are arranged to be driven from the motor by means of a Morse silent chain, as shown. The arrangement of the runs of gearing, clutches and clutch interlocking device are practically the same as used upon the lathe described in the second article of this series—pages 166 and 167, May, 1903.

The motor used for this drive is a Crocker-Wheeler, type 25 I-L.S.-C.M. motor and is operated through a type 80-M.F.-21 controller. The controller is mounted upon a floor stand close to the frame of the tool, at the right side of the table, so as to be in a convenient position for the operator. The table has a total range of speeds of from 0.24 to 23.5 rev. per min., and the motor has a nominal capacity in horse-power of 15 from .86 to 23.5 rev. per min. of the table.

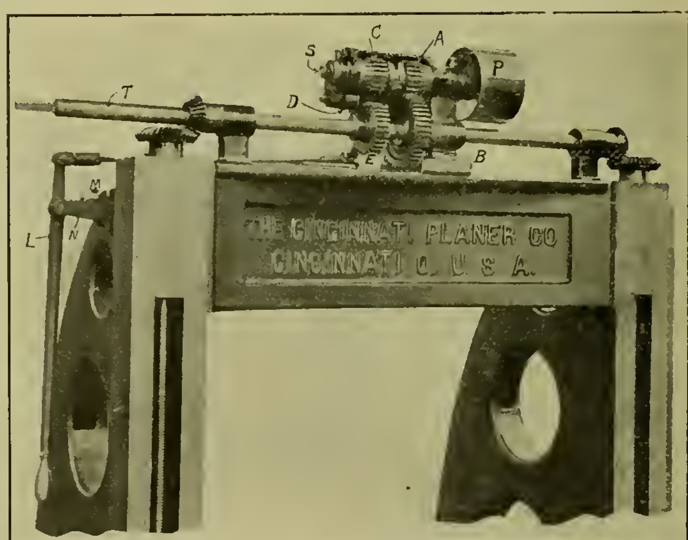
The crossrail is raised and lowered by means of a separate motor (Crocker-Wheeler type 3 I-L.S.-C.C.M.), which is mounted on top of the cross brace of the housing. This arrangement is shown in a separate drawing, Fig. 51. The motor rests upon a bracket of wrought iron straps and drives, by means of a Morse silent chain, the cross-rail gearing which was formerly operated by belt from the countershaft.

THE LANGEN POWER CROSS-RAIL ELEVATING MECHANISM FOR PLANERS.

DESIGNED BY GEORGE LANGEN.

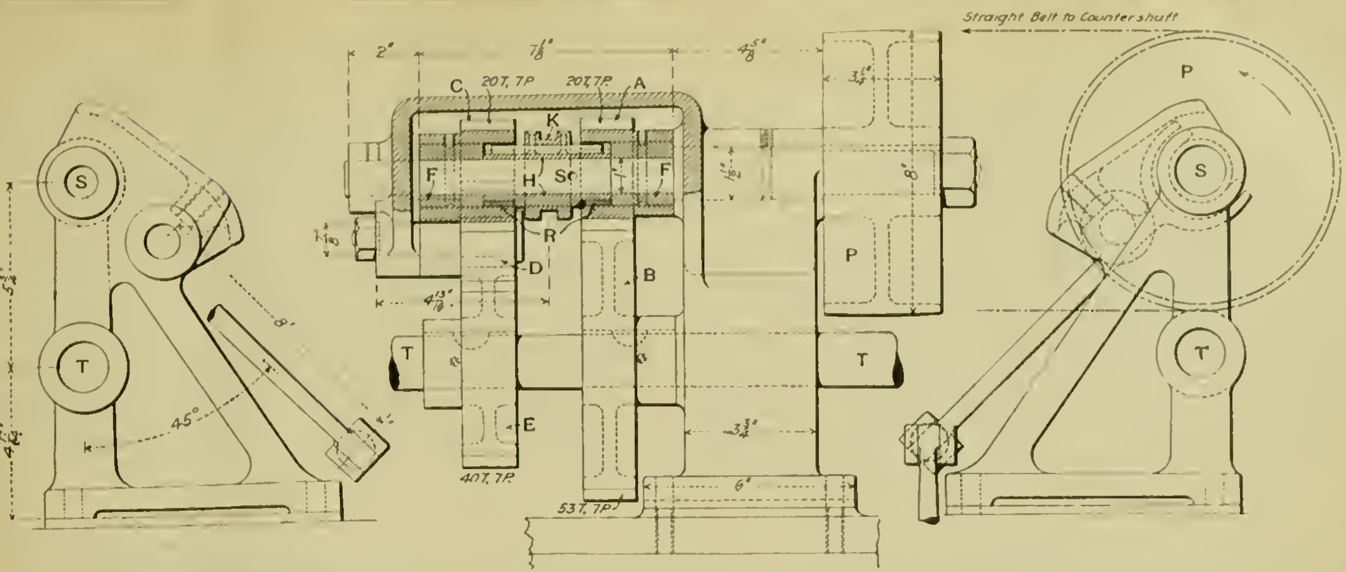
Provision for elevating or lowering a planer cross-rail by power is one of the most important features of the equipment of a planer, and is one the importance of which as a time saver has not been appreciated. The accompanying engraving illustrates a new power elevating mechanism of striking originality for this work, which will replace the usual method of operating the elevating screws by throwing tumbler gears in mesh with a jerk. The advantage of the scheme of this device is that it can be thrown in gear while the tool is running, absolutely without shock.

The half-tone engraving shows the location and appearance



THE LANGEN IMPROVED ELEVATING DEVICE FOR THE CROSS RAILS OF METAL PLANERS.

of the mechanism, with cover removed, upon the arch of a planer housing; the details are shown in the accompanying drawing of the device. The mechanism receives its power from the countershaft upon pulley, P, which is keyed on and drives shaft, S. From the mechanism, power is delivered through gears, B or E, to the shaft, T, which operates the elevating screws. The interesting feature is the friction cone connection by which either the raising or lowering train of gearing is set into operation. The mode of operation may be understood from the detail drawing.



DETAILS OF THE LANGEN POWER ELEVATING MECHANISM FOR PLANER CROSS RAILS. CINCINNATI PLANER COMPANY.

Each of the driving gears, A and C, has a perforated bush, F, driven into its center, which eliminates the counterbore necessary for the spit-clutch ring, R, and their perforations also carry the oil for the bearing. R is the split clutch ring in either gear and H is a steel sleeve secured to the pulley shaft. This sleeve presents a new method of holding friction rings in place endwise, without putting in additional washers or collars; it will be noticed that the ends are turned down, so that each end fits loosely into the split ring, the center being left larger in diameter, so that the wedge rings cannot pull out of the gear. This steel sleeve is splined its entire length and the collar, K, has a key secured to it, which slides in this spline, and is tapered on each end to fit the taper opening in the split wedge rings, and consequently does the expanding on whichever side it is forced over by the levers.

A and B are the raising gears; C, D and E are the lowering gears. It can readily be seen that the raising gear B is much larger in diameter than the gear used for lowering the rail. This gives a slow speed and plenty of power for raising the weight of the rail. D is an idler gear used to revolve gear E in opposite direction of gear B. The lowering gear, being smaller in diameter, gives one-third higher speed while letting down the rail, when there is practically no power required.

The half-tone shows this device as applied to a Cincinnati planer. It is so situated on the arch as to bring the large driving gear that raises the rail exactly in the center of the machine, so that if there should be any torsion to the elevating shaft, it will be distributed equally on each side. The bracket also provides for an additional bearing for the elevating shaft to take care of any spring or side thrust that may be caused by the gears.

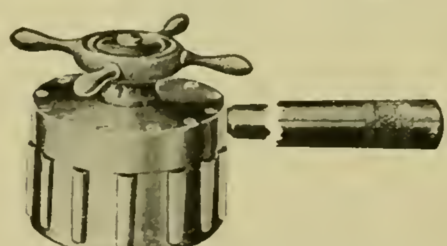
L is a long handle pivoted on bracket M, and reaches down on tne side of the housing to within convenient reach for the operator. This long handle gives a long leverage for operating the taper counter-wedges, and so gives the operator full control of the movement of the rail, making it possible to raise or lower the rail to within a scratch line on the housing. N shows the handle ends of the locking screw, which is used to hold this handle in a fixed position while not in use. On the larger machines this locking device is brought down near the handle, so that it can be reached from the floor.

This new power elevating device is the invention of Mr. George Langen, superintendent of the Cincinnati Planer Company, Cincinnati, Ohio, which company will hereafter place the same on their entire line of planers.

Mr. G. R. Joughins has resigned as mechanical superintendent of the west lines of the Santa Fe to accept the position of superintendent of motive power of the Intercolonial Railway of Canada, with headquarters at Moncton, N. B.

TRIPLE VALVE BUSHING ROLLER.

The device illustrated by the accompanying engraving is designed to render the repairs of triple valve bushings easy and rapid, and to make it possible to do this work with relatively unskilled labor. It was developed at the San Bernardino shops of the Atchison, Topeka & Santa Fe Railawy. The device rolls the bushings by means of a series of small conical rollers, which are held in a cylindrical casing. This casing provides a housing for the rollers, the exterior surfaces of which project through slots in the casing. The rollers are urged in an outward direction by the pressure of a cone, which is adjusted by a screw and thereby adjusts the position of the small rollers by being moved in and out by means of the hand wheel upon the top of the device. The taper of the cone and the rollers is such as to give a perfectly cylindrical surface to the bushing when the device is turned by means of the handle shown in the engraving. A triple valve with a worn bushing is secured in a socket vise. The roller device is inserted in the bushing. The rolls are pressed outward by means of the hand



TRIPLE VALVE BUSHING ROLLER.

wheel, and the irregularities due to wear are rolled out, leaving the bushing smooth and symmetrical. When the operation is completed the rollers are withdrawn into the casing and the device is removed from the bushing.

It is stated by those who have used this tool that its work is excellent and that the surface of the bushing is left in excellent condition, the metal being hardened and left smooth. This process is similar to the action of rollers in burnishing a journal of an axle in the lathe. The surface is said to be superior to that obtained by grinding because it is left hardened and smooth. The necessity for accurate work requires most exact and careful construction of the tool, and the workmanship is all that can be desired. All of the wearing parts are of hardened and ground steel. Those who are using this instrument make a special point of the fact that the machine leaves the surface of the bushing denser than before the operation of truing and that this affects further surface of the bushing favorably as to wear. Further information may be obtained from Mr. H. G. Hammett, Troy, N. Y., the manufacturer.

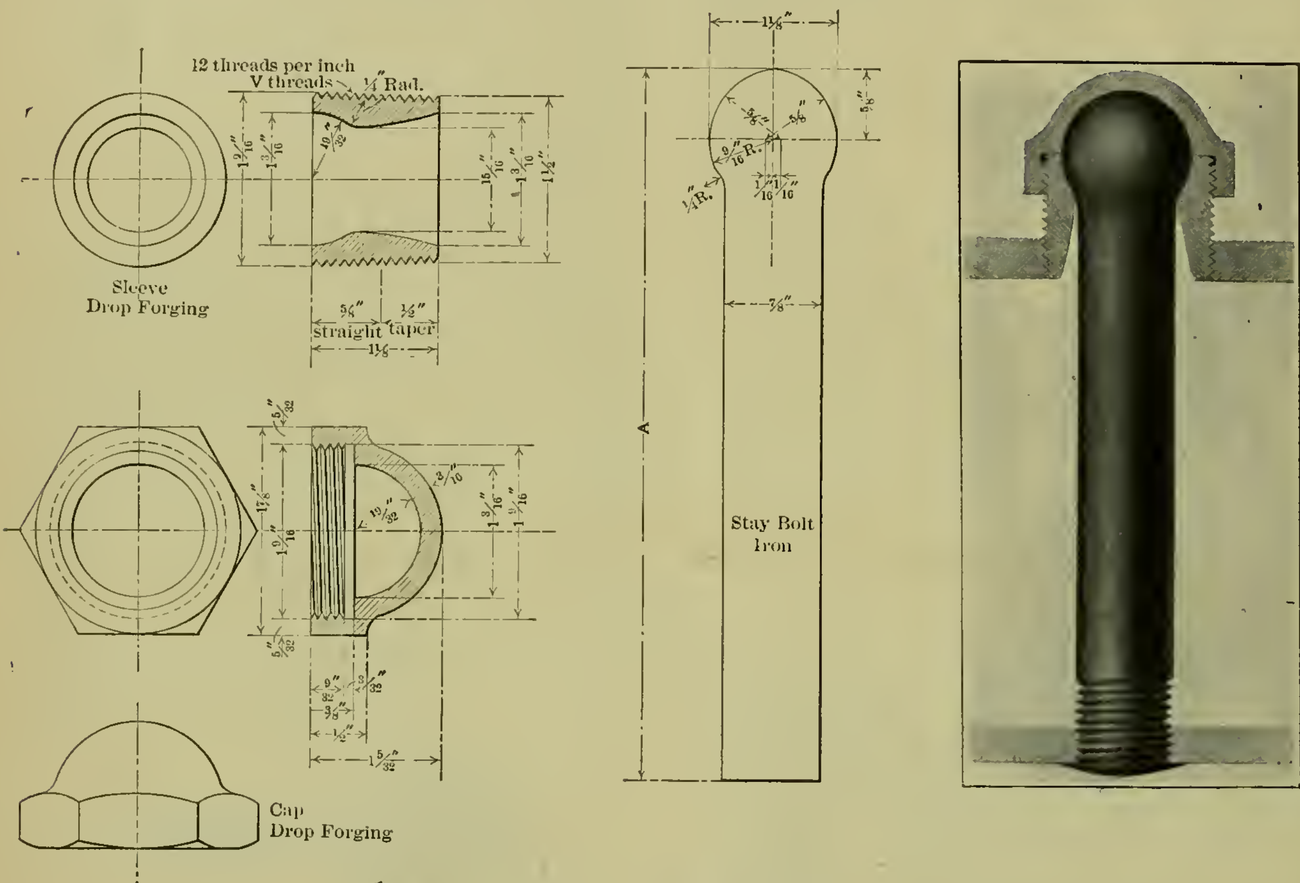
THE TATE FLEXIBLE STAYBOLT.

No problem in locomotive boiler practice has ever caused as much anxiety as that connected with staybolts. The difficulty has increased with increasing boiler pressures and with advancing demands made upon locomotives in service, both of these conditions being aggravated by bad water. While the introduction of wider fireboxes and wider water spaces has constituted an improvement, the motive power officials who adhere exclusively to the plain staybolt are as anxious about their boilers as they ever were. Many efforts have been made to render ordinary staybolts threaded into boiler sheets flexible enough to prevent fracture induced by the expansion and contraction of the sheets, but those most advanced in the improvement have applied bolts threaded into the inner sheet and connected to the outer sheet by flexible heads. Conversation with a number of motive power officers, who are using these bolts, indicates a universally favorable experience, the only thing to guard against being the construction of the head in such a way as to permit scale to form on the flexible joint and make it rigid. The construction illustrated in the accompanying engravings is presented with the belief that it will not become clogged with scale. Several years' service on one of the largest railroad systems and one on which the staybolt problem has been most systematically studied, forms the basis of this assertion.

The files of this journal for the last ten years contain what was intended to be a complete record of progress in improvement in staybolt practice. Because of its importance in connection with flexible bolts the following paragraph by Mr. T. A. Lawes, superintendent of motive power of the Chicago & Eastern Illinois Railroad, are reproduced from page 238 of our August number, 1902:

"The cost of renewing 105 staybolts, in lots of six at a time, in one year on a certain engine carrying 200 lbs. of steam was $113.40. This includes taking down and putting up the parts of the engine which were in the way of the boilermakers; it also includes the cost of blowing off the engine, letting water out of the boiler and filling same, and cost of the water. The cost of the same number of flexible staybolts, put in all at one time, when the engine was in the shop for repairs, was $94.50, no charge being made for stripping, as flexible staybolts were applied when new sheets were put in. From this it appears that the cóst of flexible staybolts for the first year's service is $18.90 less than the same number of common staybolts. Now, if the same number of common staybolts were to break the second year, we would save $113.40. However, since the side sheets of our engines carrying 200 lbs. of steam last but two years, flexible staybolts are renewed with the side sheets, except that the sleeves and caps are used again with the new staybolts. So far as first cost is concerned, flexible staybolts are cheaper than common staybolts when common staybolts are renewed in the roundhouse in lots of six at a time.

"The great advantage in the use of flexible staybolts is that the service of the engine is increased, since they do not break and engines are not held for renewals of bolts. It is our rule to take out staybolts where six adjacent staybolts are broken. The loss of service of our engines in one year under this rule, taking out 105 staybolts and renewing them, amounts to twelve days. In addition to labor and material, this period also includes the time it takes to blow off steam, letting out water and cooling off boiler, so that men can work in it; also filling up the boiler, but not getting up steam. It may be of interest to state that the greatest number of flexible staybolts we have used in one engine is 430; the least is 140. We have 27 engines equipped with these bolts—in all 5,280 flexible staybolts in use."



THE TATE FLEXIBLE STAYBOLT.

It will be noted that Mr. Lawes did not include in the cost the value of the time of 12 days per year, lost on account of the staybolt renewals. Assuming the value to be $35.00 per day, this additional item clinches his argument. Another gentleman, who has investigated the cost, places it at $1.04 per bolt replaced, including the items mentioned by Mr. Lawes. The investigation referred to also places the life of an ordinary staybolt in the danger zone at from 10 to 12 months.

From experience up to date, it is claimed that the Tate staybolt will last the life of the firebox, and when the sheets must be renewed the cap and sleeve will be as good as new, for the application of another bolt which will be supplied at less cost than that of an ordinary staybolt. The manufacturers of the Tate staybolt state that they have never yet had one break, and that they have been applied on the Pennsylvania Railroad. They also state that after an experience in the worst districts and on engines which are exceptionally hard on staybolts, they expect the bolts to last at least seven years under such conditions.

Returning again to the comparison of cost of the ordinary rigid and the flexible staybolt, let us assume that in 10 locomotives averaging 1,000 bolts each, a road has 10,000 bolts in service. Assuming that 10 per cent. of these, or 1,000 bolts, must be renewed every year at a cost of $1.00 per bolt, this will cost $1,000 per year for renewals. In seven years the cost would be $7,000. If flexible staybolts were applied, which (supposing the sheets to be good for seven years) would cost $600 for the service of seven years, the saving would be $400 in the staybolts alone without including the time lost by the engines.

These engravings show that the length of the staybolt is increased by this construction. The threaded portion is only long enough to enter and be properly riveted to the inside firebox sheet. There is no edge for the lodgement of sediment. A complete spherical socket is formed by the sleeve and cap and the sleeve is formed to give a curved flare in which the manufacturers state from actual experience that sediment does not lodge permanently. In the construction of the bolt there is no place where the material is ruptured so that corrosion is invited. A taper on the water side of the sleeve produces a steam tight joint and assists in throwing the load off of the threads onto the sleeve itself. In other words, instead of weakening the sheet by the number of 1½-in. holes for the sleeves, the space is filled with solid material. For inspection of the heads of the bolts the caps are easily removed. To install these bolts the threaded end has 1¼ ins. of additional material in order to screw the bolt into place. The sleeve is screwed in by means of a wrench on the cap, and when the bolt is sufficiently tight, a sudden reverse movement of the wrench releases the cap from the sleeve.

Further information concerning the Tate flexible staybolt may be obtained from the Flannery Bolt Company, 339 Fifth avenue, Pittsburgh, Pa. It was developed and patented by Mr. J. B. Tate, foreman boilermaker of the Pennsylvania Railroad at Altoona, Pa., and will be manufactured at the new plant of the Flannery Bolt Company, at Bridgeville, Pa. The company proposes to follow up the service of these bolts very closely through competent inspectors.

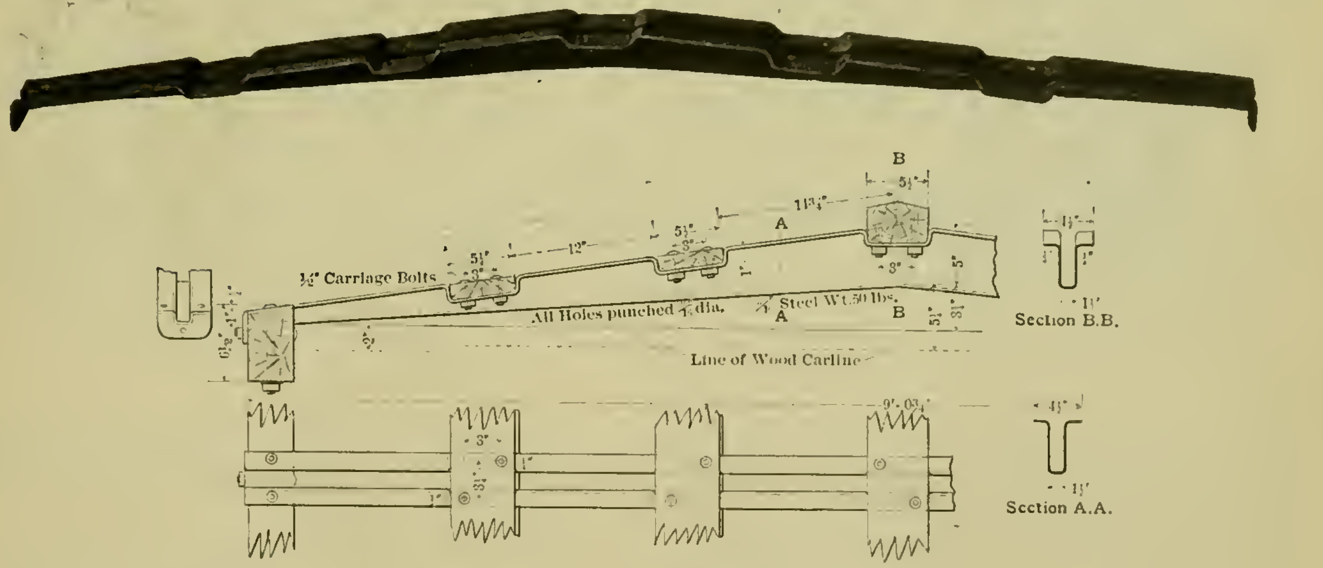
THE CLEVELAND PRESSED STEEL CARLINE.

The Cleveland City Forge & Iron Company has just installed a complete plant of the latest types of heavy hydraulic and pneumatic machinery for the work of the Cleveland Car Specialty Company, recently organized to place on the market some pressed steel car specialties, and the first article ready for the market is the pressed steel carline. This carline is manufactured under the Haskell and Maltby patents now owned by the Specialty Company. There are now over 75,000 of them in service and they are constantly growing in favor.

The pressed steel carline is light in weight, pleasing in appearance, and very strong, being about 2½ times the strength of the same weight of rolled commercial shapes. The securely fastened by half-in. bolts which bind the side plates together, making spreading of the sides impossible. The steel carlines do not stretch, cannot shrink and are always the same distance apart. This in connection with the purlines and ridge pole being securely bolted to the carlines, results in a rigid and substantial construction that proves a sure cure for leaky roofs.

The steel carlines are indestructible, and in cases of total destruction of a car by fire or other causes, they will have a scrap value of $2.50 to $3 per car, and are guaranteed to last for the life of the car.

This carline is designed to be used with any style of roof, whether outside or inside metal, plastic or double board, and will increase the life of any car roof with which it may be



THE CLEVELAND PRESSED STEEL CARLINE.

use of seven carlines per car (a reduction of practically 50 per cent. over wooden carlines) at the same time gives greater strength and rigidity to the roof, and permits a saving in weight of from 250 to 300 pounds per car. The height at the eaves with the pressed steel carline is from 2 to 4 in. less, with the same inside dimension, or the cubic capacity may be increased. The cubic capacity of the American Railway Association standard car is 2,448 cubic feet, while the same car with Cleveland Pressed Steel Carline has 2,537 cubic feet.

A 38-ft. car recently built, equipped with seven steel carlines, was tested with a load of 15,000 pounds on the running board. This only caused a deflection of ⅜ in. in the carline, without any permanent set when the load was removed.

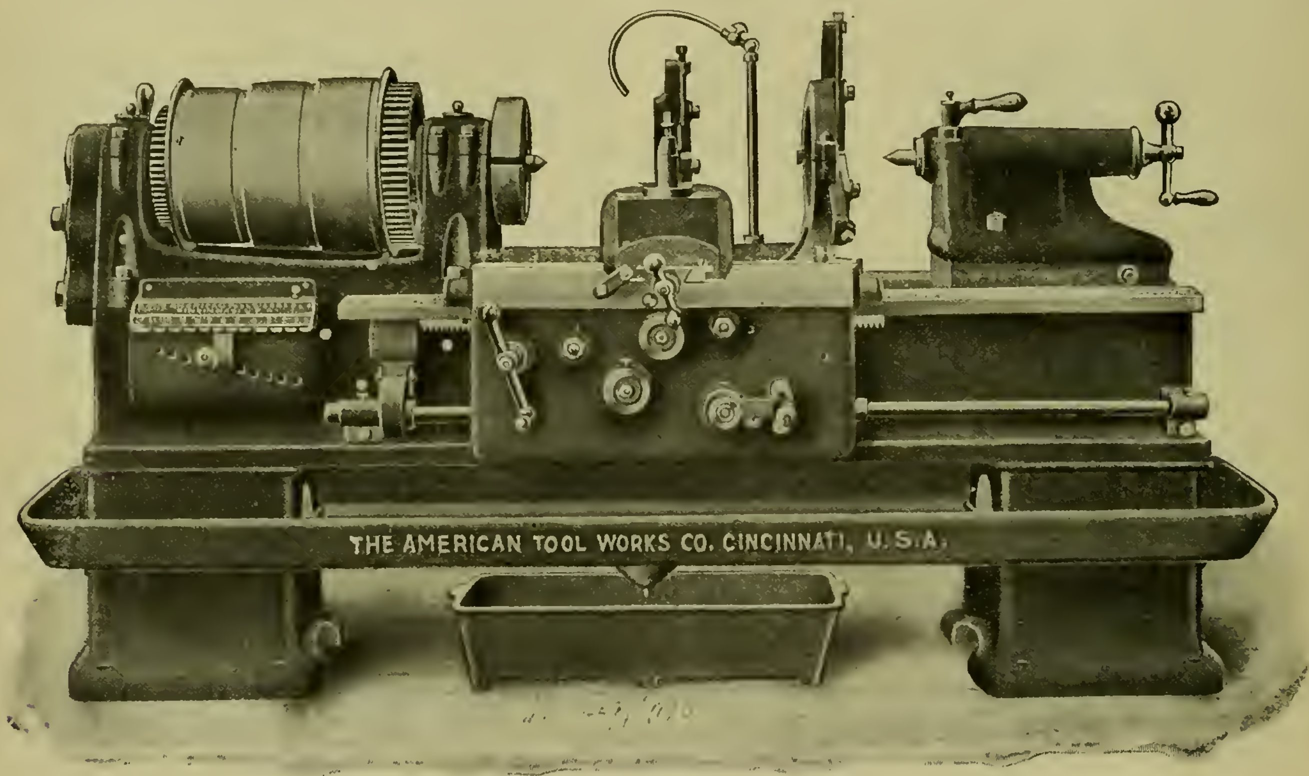
The pressed steel carline passes over the side plates, having lips turned down outside of the plates, to which the carlines are used. In cars where the under course of boards are laid lengthwise of the car, a special nailing strip is inserted in the carline.

There are two designs of pressed steel carlines, the standard U shape section, and a composite carline, being the wooden nailing strip combined with a one-half or Z section of the standard carline. The combined carline is designed particularly for use in connection with longitudinal roofing board construction. With the use of these carlines, railroads will be enabled to obtain in freight cars and stock cars the very desirable points of increased capacity, greater durability, and lighter and stronger construction without material increase in cost.

In addition to the carlines, there will soon be ready for the market a new pressed steel spring plank and other pressed steel specialties. The offices of the company are at Case avenue and Lake street, Cleveland, Ohio.

A NEW MANUFACTURING LATHE.

The accompanying engraving illustrates the very latest production of the American Tool Works Company, of Cincinnati, Ohio. This machine is their new "American" high-speed manufacturing lathe, which will be found of particular efficiency in turning up shafts of small diameters. It is given an unusual amount of strength in all its parts, in order to adapt it to the very heavy requirements which progressive manufacturers demand from a tool of this character. The bed is made extra deep and wide, and is supported by substantial cabinet legs. The apron and carriage are provided with extra strength, the apron being powerfully geared, with longitudinal and cross-feed friction. The patent drop V pattern of the bed makes it possible to place a great deal of extra metal in the bridge of the carriage, this being usually a point of weakness in a lathe. The headstock is made extremely rigid, and is equipped with a cone of three steps, all of large diameter, for a 4-in. double belt. This endows the lathe with a very great amount of belt power; so much so that the contact of the belt when on the smallest step of the cone is greater than on the ordinary 36-in. lathe. As the lathe is intended primarily for working at very high spindle speeds, the bearings are of unusual size, made of phosphor bronze, and scraped to a perfect fit.



A NEW MANUFACTURING LATHE—AMERICAN TOOL WORKS COMPANY.

In the lathe illustrated by the accompanying illustration the entire screw-cutting mechanism is omitted because of the character of the customer's work. This mechanism, of course, can be included when desired, and is similar to that incorporated on the regular "American" lathe, with a range of forty-four changes immediately available while the machine is in full operation without removal of a single gear. The lead-screw is located on the inside of the bed, directly under the cutting tool, which thus centralizes the strain and obviates all twisting tendency, common in lathes where the screw is on the outside and pulls through the apron.

This high-speed lathe is at present built in this one size (actual swing 20 ins.); it can also be supplied, as shown, with a means of constant and effectual oil supply to the cutting tool, together with a large pan of symmetrical appearance for catching oil and chips. Further details regarding this machine, and describing recent remarkable tests performed with it, will be cheerfully furnished by the builders to those interested.

PERSONALS.

Mr. T. F. Barton, master mechanic of the Illinois Central at Paducah, Ky., has been transferred to succeed Mr. George W. Smith as master mechanic at Chicago. Mr. Barton is succeeded at Paducah by Mr. R. J. Trumbull, general foreman at the Burnside shops, Chicago.

Mr. G. W. Bynow has been appointed general foreman of the shops of the Delaware, Lackawanna & Western Railroad at Scranton, Pa., to succeed Mr. H. Shoemaker, promoted.

Mr. M. R. Coutant has resigned as master mechanic of the Erie Railroad at Susquehanna, Pa., to become master mechanic of the Ulster & Delaware Railroad, with headquarters at Rondout, N. Y.

Mr. W. E. Scott has been appointed trainmaster of the Chicago, Cincinnati & Louisville, with headquarters at Peru, Ind.

Mr. W. C. Ennis, master mechanic of the Pennsylvania division of the Delaware & Hudson, has had his jurisdiction extended over the Susquehanna division, with headquarters at Oneonta, N. Y.

Mr. Eugene M. Kann has been appointed acting general foreman of the Wabash Railroad at Delray, Mich., succeeding Mr. J. M. Barnes.

Mr. A. Stewart has been appointed mechanical superintendent of the Southern Railway to succeed Mr. S. Higgins. His headquarters will be in Washington, D. C. Mr. Stewart has heretofore held the position of general master mechanic.

Mr. F. A. Symonds has been promoted from the position of foreman of the Louisiana & Arkansas to that of master mechanic of that road, with headquarters at Stamps, Ark.

Mr. J. R. Skinner has resigned as assistant superintendent of motive power of the Delaware & Hudson at Oneonta, N. Y.

Mr. Charles Wincheck has been appointed general foreman of the shops of the Santa Fe Railway at Needles, Cal. He recently resigned as master mechanic of the Mexican Central.

Mr. W. S. Morris has resigned as mechanical superintendent of the Erie Railroad and is succeeded by Mr. George W. Wildin, recently appointed assistant mechanical superintendent.

Mr. W. Miller has been appointed master mechanic of the Terminal Railroad Association of St. Louis, with headquarters in St. Louis, Mo.

Mr. W. N. Dietrich has been appointed electrical engineer of the Canadian Pacific Railway, with headquarters at Montreal, Que.

Mr. G. A. Schmoll, superintendent of motive power of the Baltimore & Ohio at Newark, Ohio, has transferred his headquarters to Wheeling, West Virginia.

Mr. E. B. Gilbert has had his title changed from master mechanic to superintendent of motive power of the Bessemer & Lake Erie Railroad.

Mr. Alfred Lovell, assistant superintendent of motive power of the Atchison, Topeka & Santa Fe Railway, has transferred his headquarters from Topeka to Chicago.

Mr. H. L. McLow, master mechanic of the El Paso & Northeastern at Santa Rosa, Tex., has been appointed assistant superintendent of motive power of that road with headquarters at Alamogordo, N. M.

Mr. W. H. Hudson has been appointed general master mechanic of the Southern Railway, having been promoted from the position of master mechanic. His headquarters will be at Birmingham, Ala.

Mr. J. B. Kilpatrick has been appointed superintendent of motive power of the Eastern lines of the Chicago, Rock Island & Pacific, with headquarters in Chicago. He has been assistant superintendent of motive power at Chicago.

Mr. B. A. Worthington has been appointed assistant director of maintenance and operation of the "Harriman Lines," consisting of the Union Pacific, the Oregon Short Line, the Oregon Railroad & Navigation and the Southern Pacific companies. Mr. J. Kruttschnitt was recently placed in charge of operation and maintenance of these lines and will be assisted by Mr. Worthington, who has had a remarkable career, beginning as a telegraph messenger boy.

Mr. Arthur Warren has accepted the management of the publicity department of the Allis-Chalmers Company. His admirable success in developing the publicity department of the Westinghouse interests is well known and is sufficient promise for his present work. He has had a long and wonderfully successful career as a journalist and as London correspondent of the Boston *Herald*. The Allis-Chalmers Company has done wisely and well to secure his services.

Mr. R. B. Kendig has been appointed mechanical engineer of the Lake Shore & Michigan Southern Railway with headquarters in Cleveland, Ohio. The position of assistant superintendent of motive power of this road was abolished upon the resignation of Mr. H. H. Vaughan. Mr. Kendig entered railroad service at the age of 16 years, as a messenger boy in the office of the superintendent of the Pennsylvania Railroad at Renovo, Pa. One year later he became a machinist apprentice at that point and served five years. He then entered the drafting room and was soon transferred to the drafting room at Williamsport, Pa. From that position he entered the service of the Lake Shore as chief draftsman at Cleveland, four years ago.

EXHIBIT OF PRESSED STEEL CARS.

The four cars, each of 50 tons capacity, shown in this illustration form a part of the exhibit of the Pressed Steel Car Co. at the World's Fair at St. Louis. They embody many of the best car appliances and constitute an instructive exhibit.

One of them is a Pennsylvania standard, Class G. S A, gondola of pressed steel, 40 ft. long, and with wooden drop ends and drop doors. Its weight is 39,400 lbs. The third is a pressed steel side dump gondola, built on an entirely new design. It is 41 ft. 6 in. long and the whole bottom of the car consists of drop doors, through which the whole load can be dumped at either side of the track and the doors, when closed, give the car an entirely flat bottom. This car is specially intended for ballast, gravel and sand or other material which is dumped. It has two kinds of doors for demonstration purposes. The doors of one side are controlled by a sliding shaft and on the other side by a fixed rod, the operating gear being worked by a worm and wheel. The fourth is a box car, with structural steel underframing and steel superstructure. A portion of the siding is omitted in order to show the framing. This car weighs 40,000 lbs. and is built to the American Railway Association standard interior dimensions. In this construction the side framing assists in carrying the load. The first is an improved steel flat car with wooden floor. It weighs 33,100 lbs. and is much lighter than cars of similar capacity of ordinary construction.

INSTRUCTIVE EXHIBIT OF PRESSED STEEL CAR CONSTRUCTION.

In addition to this equipment the Pressed Steel Car Co. are exhibiting their pressed steel mine dump car, which is a new departure in steel construction; also their pressed steel Fox tender truck frame, pressed steel body and truck bolsters, brake beams, pressed steel side stakes and center plates, together with a number of their model appliances for use in freight car construction.

ROUNDHOUSE CRANES, JACKS AND VENTILATION.

To the Editor:

My attention has been called to the article in your April issue on roundhouses, written by Mr. Soule. On page 122, in speaking of the use of cranes in roundhouses, the article reads as follows: "In this case smoke jacks cannot be used, and some form of roof ventilation must be depended on to carry off the smoke."

I wish to correct the statement by calling the attention of your readers to the fact that the Dickinson multi-telescoping smoke jack and the Dickinson interlocked overhead traveling crane fulfill these conditions exactly and are designed for this purpose.

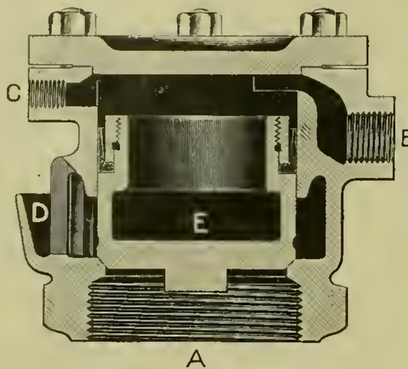
You will soon be placed in position to describe this system fully for the benefit of your readers. PAUL DICKINSON.

Security Building, Chicago, April 22, 1904.

BRODERICK & BASCOM RUPE COMPANY.—A new price list of power, steel and crucible steel switch ropes has been received from this company. It is being distributed among railroad officials, and copies will be sent upon application to the offices of the company, 805 North Main street, St. Louis, Mo.

CYLINDER RELIEF AND VACUUM VALVE.

This valve is made by the Star Brass Manufacturing Company, Boston, Mass. It is designed to relieve excess pressure due to water in a locomotive cylinder and also to relieve the vacuum in drifting. No springs are used, the valve being held to its seat by the steam pressure. It is held away from its seat by the vacuum created in the steam passages in drifting. The inlet A is connected to the steam port leading to the cylinder and gives a 3-in. opening. To the inlet B a ¾-in.



CYLINDER RELIEF AND VACUUM VALVE.

pipe is connected, leading to the live steam chamber in the steam chest. The vacuum forming in the passage when the throttle is closed causes the atmospheric pressure to raise the valve and when the throttle is open the piston holds the valve E closed, unless forced open by water from the cylinder. D is a large orifice for communication with the atmosphere. The connection C is for a drain plug or cock. It should be noted that the area of the piston portion of the valve E is greater than that of the valve below it. This valve is designed specially for locomotives which are fitted with piston valves and also for compounds.

THE ALLFREE HUBBELL VALVE GEAR.

This valve gear, which is being applied to a number of locomotives, is advocated with a view of reducing cylinder condensation by reducing the radiating surfaces of steam ports, and by a special construction of the valves, cylinders and saddle which is designed to protect the steam from loss of heat in its passage to the cylinder and to maintain the cylinder continuously hotter than is possible under the usual construction. This is done to contribute toward a higher pressure of steam for the cylinders.

The valve movement itself is modified by a simple addition to the existing link motion without replacing that motion, which delays the opening of the exhaust port at all points of the cut-off. This holds the steam in the cylinders for a greater portion of each stroke and thereby increases the ratio of expansion, decreases the compression and secures more work out of a given quantity of steam than is obtained in the case of ordinary link motion. This addition to the link motion also delays the closing of the exhaust port at all points of the cut-off, thereby decreasing the compression and decreasing the negative work in the same proportion.

The cylinder clearance is reduced to about 2½ per cent., as against about 8 per cent. in the case of ordinary 20 by 26-in. cylinders. The locomotives which are now in service having this valve motion are reported to be doing very satisfactory work. A copy of a valve motion report from a locomotive built on this principle at the Cooke works of the American Locomotive Company shows very unusual delay of the exhaust opening and exhaust closure of the valve. The engine referred to has 20 by 26-in. cylinders, and the report indicates that at full gear, ½ stroke and ¼ stroke, the exhaust opening occurs at 25⅜ in., 22⅞ in., and 22¼ in. respectively. The corresponding exhaust closure occurs when the piston is ½ in., 2 3-16 in. and 2 13-16 in. from the end of the stroke for these respective cut-offs. These figures are remarkable and entitle the valve gear to special consideration on the part of those who are interested in the locomotive.

BOOKS AND PAMPHLETS.

Niles-Bement-Pond Company. A new catalogue of machine tools has been received from this company. It is a large book of 750 pages, and is really a compendium on the practice of this concern.

This is the most complete catalogue of machine tools ever published. It opens with six full-page illustrations of the various works of the Niles-Bement-Pond Company, and following these are thirteen pages of medals and diplomas awarded the various constituent companies of this concern. These medals date as far back as 1871. The medals of the more recent expositions, however, are much in the majority. The reproductions of the medals are particularly excellent. The main part of the catalogue follows. First are the machines for railroad shop use. These include a most complete line of driving-wheel lathes. Fourteen different full-page illustrations are given of these machines, showing all sizes from 51-in. to 100-in. swing, and one or two special machines adapted particularly to the use of modern high power tool steels. The other railroad tools include three different styles of car-wheel lathes, a large variety of axle lathes, cutting-off and centering machines, quartering machines, car-wheel borers and hydrostatic wheel presses. The next division of the catalogue is devoted to lathes, including all sizes from the Pratt & Whitney bench lathe to the massive Bement 125-in. crank shaft lathe. The variety of heavy lathes shown is especially complete. Besides the standard lathes, a number of special lathes, including pulley lathes, turret lathes and automatic screw machines are shown. Fifty pages are devoted to planing machines, and a specially large variety of heavy planers are shown. Various methods of driving by magnetic clutches and motors mounted on the top of housings are illustrated. The large portable rotary planers are among the most interesting machines described in this section of the catalogue. These machines are self-contained, the motor being mounted on the saddles. The largest has a swing of 120 ins. and is arranged so that it can be lifted by a crane and placed in any position on a floor plate. Slotting machines and milling machines take a large number of pages; several very handsome full page illustrations being devoted to work done on the Pratt & Whitney thread milling machines. A large number of heavy drills are shown, including vertical drills, radial drills and multiple drills. Among the most interesting pages in the catalogue are those devoted to boring machines. First are the horizontal boring machines which include all varieties of boring machines in which the work remains stationary the cutting being done by revolving cutters. A particularly complete line of floor boring machines or horizontal boring, drilling and milling machines are shown, including every conceivable variety of these machines. Fifty pages are devoted to boring and turning mills. Here again, the large mills are most interesting, but more space has been devoted to describing the smaller machines. The 16-ft. and 20-ft. mills are particularly massive. Following the section on boring and turning mills are a few pages devoted to miscellaneous machine tools, and then comes a very complete line of boiler shop machinery, including plate planers, bending rolls, punching and shearing machines, hydraulic presses, steam and hydraulic riveters. In the latter part of the catalogue the full line of Bement steam hammers is illustrated, together with a number of installations of Niles electric traveling cranes. The last pages are devoted to the small tools made by Pratt & Whitney Company. In the arrangement of the catalogue, particular care has been taken to put the various machines in their logical order, so that any machine can be found without reference either to the table of contents in the front of the book or the complete index at the back. Metric as well as English dimensions are given throughout and code-words are placed under each machine. The whole catalogue is a particularly good piece of press work, the cuts coming out with great sharpness and clearness. Some idea of the size of the book can be obtained from the fact that it weighs about 10 pounds, the entire edition amounting to 75 tons of catalogues. While the catalogue is not intended for general distribution it will be gladly sent to users of heavy machine tools.

Manual of American Street Railways. Reprinted from Poor's Manual of Railroads for 1903. Published by Poor's Railroad Manual Company, 68 William street, New York, January, 1904.

This is a reprint in pamphlet form of the statistics of city and suburban electric and other surface and elevated railways which have appeared in the thirty-sixth annual volume of Poor's Manual. It also contains a summary of street-railway mileage, equipment and capitalization.

ST. LOUIS EXPOSITION. A very accurate idea of the great exposition soon to be opened at St. Louis is given in an attractive booklet of 40 pages, with fine engravings and an excellent map of the grounds, which has been prepared for distribution by the Boston & Maine Railroad. It will be mailed free on application to Mr. D. J. Flanders, general passenger and ticket agent of this road, Boston, Mass.

JEFFREY MACHINERY.—In a little pamphlet of 28 pages designated as "Circular No. 73," the Jeffrey Manufacturing Company of Columbus, Ohio, furnishes a summary of its specialties in conveying machinery for every kind of service on railroads, in mines, manufacturing establishments and in engineering construction work. Each special application is illustrated from photographs of actual construction and the catalogues in which detailed information is given are referred to by numbers.

PNEUMATIC HOISTS.—A catalogue of pneumatic hoists has been received from the Chicago Pneumatic Tool Company. In 32 pages it illustrates and describes pneumatic hoist motors, general hoists, data for hoists, general hoists and trolleys combined, stationary winding drums, cylinder air hoists, telescopic air hoists, air cranes and elevators. The pamphlet is designated as their special hoist catalogue. It is printed on fine white coated enamel paper and it presents all the information, including consumption of air, which a purchaser needs for ordering these labor-saving devices.

ELECTRIC COAL MINING PLANT.—In their Bulletin No. 4, the Jeffrey Manufacturing Company, Columbus, Ohio, present a well-written paper, by Mr. Sanford B. Belden, showing the enormous returns which are obtained upon investments in electric coal mining equipment. This pamphlet gives what people want to know, the facts upon which to base the appropriation of money for the introduction of improved machinery and methods. It also presents approximate costs. This is the highest type of literature of this character.

RAILWAY MOTIVE-POWER EXPENSES.—Under this title the Falls Hollow Staybolt Company have issued a pamphlet containing quotations from prominent motive-power officials and observations on the staybolt problem from the pen of Mr. John Livingstone, of Montreal. This little pamphlet presents in convenient form a lot of information concerning staybolts which should be brought to the attention of every motive-power official in the country. Copies will be furnished on application to the Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio.

"THREE SCORE YEARS AND TEN. A RECORD OF STEADY GROWTH."—This is the title of a beautifully arranged pamphlet that has recently been issued by the Fairbanks Company, commemorating the seventieth birthday of the company and also presenting an interesting general survey of the magnitude of its business. Ten branch houses in the United States are illustrated and five in Canada and England. No better idea can be gained of the extent of the business of the Fairbanks Company than by glancing through this pamphlet.

WESTINGHOUSE-PARSONS STEAM TURBINE.—A new, comprehensive and exceedingly interesting catalogue of these steam turbines has been distributed by the Westinghouse Company's Publishing Department. It illustrates the construction and installation of these turbines, and in well-written chapters presents the history, development, commercial features, records of tests, and statements of advantages of these remarkable power producers. Among the engravings is a striking comparison of the size of 5,000-kw. direct-connected generating units of the reciprocating and turbine types.

SOMETHING PNEUMATIC.—Is the title of a monthly magazine, published by the Chicago Pneumatic Tool Company. It is devoted to the interests of pneumatic appliances and their motive power. The April number contains descriptive articles on the Redfield pneumatic saw, a new design of single stage air compressor, the use of penumatic hammers in boiler work, in stone working establishments, the long-stroke hammer in gold mining, and several convenient foundry tools. This magazine will be forwarded gratuitously to anyone interested in the field which it covers. Address, Chicago Pneumatic Tool Company, Fisher building, Chicago, Ill.

DRIVING CHAINS. The Joseph Dixon Crucible Company, Jersey City, N. J., have issued a leaflet on the subject of the proper care of driving chains. This concerns the lubrication of chains with a special compound manufactured by them, which experience has proven to be more satisfactory for this purpose than any other they have used. The leaflet also states the importance of keeping driving chains clean. In view of the fact that chain driving is now becoming quite general in connection with motor-driven machine tools, this subject wll interest many of our readers.

STORAGE BATTERY INDUSTRIAL LOCOMOTIVES.—In their new Bulletin No. 5, the Jeffrey Manufacturing Company present the advantages of storage battery locomotives for working about the yards and buildings of industrial establishments. It illustrates some of the different types of equipment for this purpose which has become a necessity in large plants. The flexibility of this form of locomotive renders it specially adapted to this purpose and there is no fire risk in using these locomotives in and around buildings. The pamphlet includes extracts from a paper read by Mr. F. L. Sessions, before the American Institute of Electrical Engineers. It is the best presentation of the subject available anywhere.

AMERICAN SHEET & TIN PLATE COMPANY.—Two artistic booklets have been issued by the American Sheet Steel and the American Tin Plate companies. These contain a brief history of iron and its application to roofing; instructions, "How to Construct a Tin Roof," and a large amount of tabulated technical information concerning black and galvanized iron and steel sheets, roofing tin and similar products for use of builders. These will be sent upon application to Mr. W. C. Cronemeyer, advertising agent of the American Sheet & Tin Plate Company, Pittsburgh, Pa.

THE ICE IS OUT.—Fishing in the streams of Maine has begun, and sportsmen are beginning to plan their trips to the beautiful regions of Maine, which offer so much for them. In New Hampshire, Lakes Winnipesaukee and Sunapee and Newfound Lake take the lead; but there are hundreds of smaller ponds and lakes, and numerous trout brooks besides. Vermont has Chaplain, Memphremagog and Willoughby, all prolific haunts; while away over the border line in Quebec, New Brunswick and Nova Scotia are many famous resorts. For 2 cents in stamps the Boston & Maine Passenger Department, Boston, will send their illustrated booklet, "Fishing and Hunting," which describes the fishing and gaming section of northern New England and Canada; also another booklet, invaluable to the sportsman, with the fish and game laws for 1904 of Maine, New Hampshire, Vermont, Massachusetts, Quebec, Nova Scotia, New Brunswick and Newfoundland.

CRANDALL PACKINGS—Is the title of a 54-page pamphlet describing and illustrating the various kinds of packings manufactured for steam, ammonia and hydraulic machinery by the Crandall Packing Company, Palmyra, New York. This company has, in its experience of 20 years, developed a large line of packings using rubber and its various compositions. The descriptions include expansion, sectional ring, spiral, high pressure ring, high pressure coil, marine, valve rod and hydraulic packing for a variety of services. They also include special steam hammer ring packing for all forms of rods and many other special kinds. Our readers will be particularly interested in the air pump and throttle stem packing, which is manufactured especially for packing locomotive air pumps and throttles. It is furnished in sets for the steam and air ends of pumps and is made to perfectly fit the rods and boxes, the number of rings being just sufficient to fit the pumps without cutting. This packing has been adopted by many of the leading railroads. The pamphlet describes sheet and other packing, the line being complete for the purposes mentioned. The company has offices at 123 Liberty street, New York, and 30 La Salle street, Chicago.

THE SAFETY CAR HEATING AND LIGHTING COMPANY.—This company has recently issued a new edition of its map of the United States, showing the locations of Pintsch gas plants and the railroads using the gas in the various States. The centers for gas supply are practically all the large railroad centers of the country. Accompanying this is a small pamphlet containing a directory of Pintsch plants, giving the name and address of the one in charge of the plant. In case a car leaves any point with an insufficient supply of gas or with equipment which requires attention, the next works on the route may be notified by wire and proper attention may be given. This indicates the systematic methods of this company.

A list showing the progress of the Pintsch equipment up to the end of last year indicates that there are now 80 gas plants in the United States, 75 in Germany, 87 in England and a total of 372 plants all over the world. The list also shows that Germany has 45,200 cars lighted with this gas; England, 21,100; the United States, 22,243 and that the total number all over the world is 128,881 cars. In Germany 5,583 locomotives are so lighted. The number of Pintsch gas buouys and beacons is 1,426. This form of help to harbor and river navigation is recognized as indispensable. Another recent publication of this company, "Directions for Management and Catechism of Steam Heating Apparatus on Trains" is also worthy of note. It is a little book of pocket size containing in concise form directions for the management of steam heating apparatus of trains, making up trains, regulation of temperature and changing of engines. In the catechism proper are questions and answers relative to the description of the apparatus, operation and care of it and responsibility of employes. The catechism constitutes a much-needed innovation for the proper education of employes, the use of which will contribute greatly to the proper use of the apparatus and therefore to the comfort of travelers. The equipment statement already referred to includes 2,209 cars equipped with Pintsch light and 2,964 cars equipped by this company with steam heat last year. In connection with the introduction of 2-in. train pipes in place of 1½-in. these people have developed their coupler No. 920-A, which is furnished with 1½ or 1¼-in. gaskets, as desired. This coupler has straight ports and a substantial and simple locking device.

NOTES.

Mr. John L. Weeks, treasurer and general manager of the American Steam Gauge and Valve Manufacturing Company, died April 2. He had been connected with this company for over thirteen years, and he will be greatly missed in the company and by a large circle of friends.

The Walter A. Zelnicker Supply Company, of St. Louis, have just received a large order for their double-clutch car movers from a large export company of New York for shipment to foreign countries.

Baldwin Locomotive Works.—The Chicago offices of the Baldwin Locomotive Works and the Standard Steel Works have been moved to rooms 623 and 625 Railway Exchange Building, Chicago.

Corrington Air Brake.—The new Cole four-cylinder balanced compound locomotive built by the American Locomotive Company for the New York Central Railroad, and illustrated in this issue, is equipped with the Corrington consolidated engineer's valve.

The Derry-Collard Book Club.—A new plan for selling books on the installment basis has been arranged by the Derry-Collard Company, 256 Broadway, New York. Those who are interested in a convenient method of securing technical books with easy payments should send for a copy of the circular describing the plan.

The Canadian Westinghouse Company, Limited, of Hamilton, Canada, have recently engaged Mr. C. C. Starr, who was formerly connected with the firm of John Starr, Son & Company, to act as their representative in the Maritime Provinces, with headquarters at 134 Granville street, Halifax, N. S.

The T. H. Symington Company.—April 1 this company made a change in its sales department in the Chicago territory, which has been handled by their agents, the Railway Appliances Company. The T. H. Symington Company now has its own office in room 315, Railway Exchange, Chicago, which is under the charge of Mr. E. H. Symington, general Western sales agent.

Crocker-Wheeler Co.—These manufacturers of electric generators and motors will on May 10 open a branch office in the Hibernia Bank building, New Orleans. Mr. W. P. Field, of the St. Louis office of the company, will be the representative in charge. Although there are fifteen Crocker-Wheeler branches, from Boston to San Francisco, including St. Louis and Atlanta, this new office has been made necessary, to accommodate the steadily increasing market for electric machinery in the South and Southwest.

Kennicott Water Softener Company.—This company has moved into its new quarters in room 525, 527 and 529, in the new Railway Exchange building, corner Jackson and Michigan Boulevard, Chicago. This magnificent new office building brings together a large number of railroad offices and headquarters of concerns closely associated with railroad business in Chicago.

The Mamolith Carbon Paint Company.—This company has increased its capital stock to $200,000 for the purchase of the plant of the Iridian Paint Company and has moved its offices in Cincinnati from the Johnston building to the building formerly occupied by the Iridian Paint Company. Mr. A. B. Burtis, manager of the Mamolith Carbon Paint Company, states that extensive improvements are to be made.

Auburn Ball-Bearing Company.—This company has removed its main office and works from Auburn to 18 Commercial street, Rochester, N. Y., where greatly improved and extended facilities are available to take care of their increasing business. They manufacture ball bearings of all kinds, ball thrust washers, propeller bearings, aligning, step and pedestal bearings, and a large number of transmission specialties. Mr. Mark D. Knowlton is president, Mr. Henry La Casse vice-president, and Mr. Frederick Kirk Knowlton secretary.

Crocker-Wheeler Co.—This company has doubled its capital stock, which is now $2,000,000. The company has had a remarkable career, and those who are acquainted with its history will not be surprised to learn that its growth has required this increase of capital. It was organized in 1882 by Dr. Schuyler S. Wheeler and Prof. Francis B. Crocker, with a comparatively modest beginning. After vigorous and rapid growth it now has fifteen branch offices from Boston to San Francisco, and does a very large business in electrical power apparatus. The capitalization was several times increased until in 1899 it had become $1,000,000. Its rapidly extended business has made it necessary to double this amount.

The Allis-Chalmers Co., Milwaukee, Wis.—This company has recently greatly extended its business by taking up the building of gas engines, steam turbines, hydraulic and electrical machinery, in addition to the class of output for which its several works have for many years been well known, viz.: the construction of reciprocating engines; pumping, rolling-mill and blowing engines; flour-mill, saw-mill, rock-crushing and cement machinery; also machinery for manufacturing perforated metals. An additional department of publicity has just been organized, with Mr. Arthur Warren as manager. This department has its headquarters at the offices of the company in Milwaukee, Wis.

B. F. Sturtevant Co.'s New Plant.—Since the removal of the foundry and pattern departments from the old plant at Jamaica Plain to the extensive new quarters at Hyde Park the moving of the other departments has progressed satisfactorily. The fan, heater and electrical departments have already been installed, and the machine-shop equipment is well advanced. All the machinery in the plant will be of the most modern and approved types, and complete systems of cranes and industrial railways will contribute to accurate, rapid work at a minimum cost. In the handsome office building the publication department is generously provided for, and its equipment includes a pressroom and storage space for paper stock and printed matter. This company has for several years maintained a printing plant of its own, and is now handling all of this work itself excepting engraving.

Allis-Chalmers Co.—Mr. Ervin Dryer has resigned his position with the Westinghouse Electric and Manufacturing Company and has accepted an appointment with the Allis-Chalmers Company. Mr. Dryer's connection with the Westinghouse Company extended over a period of sixteen years. He is one of the most competent salesmen in the electrical and mechanical field, and his wide acquaintance throughout the Western part of the United States will be of great service to the Allis-Chalmers Co. in the extensive new developments which they have undertaken. Mr. Dryer has already entered upon his new duties with the Allis-Chalmers Co., and his headquarters will be at their offices in the New York Life building, Chicago. He will give his attention to their engine work, as well as to the sale of Bullock electrical apparatus, which the Allis-Chalmers Co. now control through their acquisition of the Bullock Electrical Manufacturing Company, of Cincinnati.

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CONTENTS.

FOUR-CYLINDER DE GLEHN COMPOUND LOCOMOTIVE

4-4-2-TYPE.

PARIS-ORLEANS RAILWAY OF FRANCE.

WITH AN INSET.

There is now running on the Pennsylvania Railroad a 4-4-2-type, De Glehn compound locomotive, built especially for that road at the Belfort works of the Société Alsacienne de Construction Mechaniques. This locomotive was ordered by the Pennsylvania in order to make an experimental study of the type which has made such remarkable records abroad and has been adopted as standard construction by all the leading railways of France. As large a locomotive of this type as could be obtained was desired and as there was insufficient time before the opening of the St. Louis World's Fair for a special design to be prepared, the locomotive was built from the drawings of the heaviest De Glehn passenger engines, those running on the Paris-Orleans railway.

Through the courtesy of M. Solacroup of the Paris-Orleans railway and M. A. G. De Glehn, of the Société Alsacienne de Construction Mechaniques, general drawings of this engine are presented in this journal. While the illustrations show the Paris-Orleans locomotive, they also indicate the construction, with the exception of a few relatively unimportant details, of the Pennslyvania locomotive. A somewhat smaller design, that of the heaviest passenger locomotive on the Northern Railway of France, is now in service on the Great Western Railway, in England.

This locomotive is unique in representing a continuous and systematic development of the four-cylinder compound on the divided and balanced principle, which Mr. De Glehn began in 1885. It has steadily increased in favor, and is unquestionably the most advanced type of locomotive in use in Europe, yet there is not a single patent on any part of its construction.

Very little that is new can be said about the De Glehn compound at the present time. Articles by Messrs. De Glehn and Herdner, in this journal, in September and December, 1902, and January and December, 1903, clearly state the principles involved. This design was not developed with special reference to fuel economy alone, but this was an incidental advantage sought. The object was to obtain the utmost possible capacity within a limited weight.

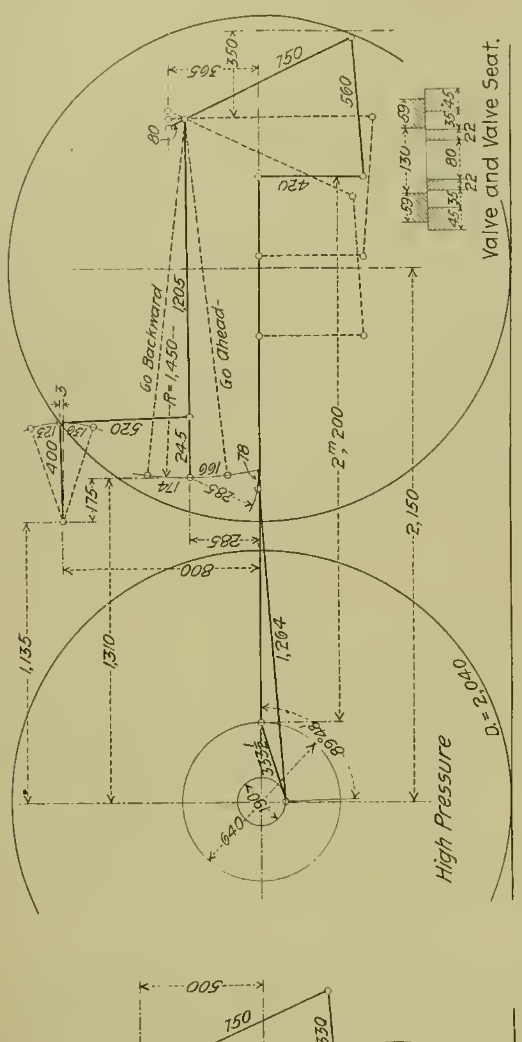
For a locomotive weighing 65 tons, to haul in regular, everyday work, 370 tons behind the tender, a distance of 184 miles, from Paris to Calais, in three hours and ten minutes, with one intermediate stop, and do this on a coal consumption of 38½ pounds per mile, is one result obtained by this system. In this run there is a fifteen-mile hill of one-half of one per cent., and 23 miles of one-third of one per cent. There are four other hills of nearly one per cent., one of which is seven miles long. Under these conditions on the Northern Railway of France, with a locomotive lighter than the one herewith illustrated, a steady speed of fifty-six miles an hour is maintained, on the one-half per cent. grades and 1,500 horse-power sustained. The maximum speed in this run is never allowed to exceed seventy-five miles per hour. It would be difficult for American railroads to match this work with a locomotive of this weight.

Word has just been received that one of the Paris-Orleans engines, which is exactly like the one illustrated, has just indicated 1,900 horse-power, at 70 miles per hour, with 350 tons behind the tender, the drawbar pull at that speed being 7,350 pounds. It must be remembered that this engine weighs only 80 tons. Mr. Sauvage in his recent paper before the Institution of Mechanical Engineers of England stated that one of the Paris-Orleans engines hauled 350 tons (behind the tender) for 200 miles at an average speed of 55 miles per hour, and for 73 miles the average speed was 63 miles per hour. From indicator diagrams the effective power was from 1,200 to 1,800 horse-power, the water consumption being not more than 24 pounds per indicated horse power per hour, as an average from a number of experiments. The boiler evaporated 7.7 pounds of water per pound of coal.

The essential principles of this type are: 1. Four cylinders, the low pressure between the frames and underneath the smoke box, being coupled to the leading crank axle; the high pressure being outside the frames and further back, coupled to the rear driving wheels, thus dividing the stresses of the cylinders upon the axles and the cylinders upon the frames and balancing the reciprocating parts. 2. Each cylinder has its own valve and valve gear, the high and low pressure valves being connected to separate reversing screws, which, however, may be coupled together in their operation from the cab. This renders it possible to change the ratio of expansion between the cylinders and it also divides the work which each valve gear has to perform. 3. A starting valve admits boiler steam to the low pressure cylinders and opens the high pressure exhaust to the atmosphere. This is controlled from the cab and makes it possible to use either high or low pressure cylinders alone in case of a break-down, in addition to the function of increasing the starting power of the engine.

The remarkably fine set of drawings reproduced in the inset accompanying this issue must be allowed to speak for themselves, and they are well worthy of careful study. In reproducing the drawings the metric system units are retained as it is undesirable to attempt to translate them. Attention is called to the Walshaert valve gear, with two eccentrics on the crank axle for the inside cylinders and return cranks for the outside cylinders. The plate frame construction is exceedingly interesting in the depth of the plate at the driving boxes and its reinforcement at this point. The depth here is nearly 35 in.

The bracing of this frame is remarkable. The bracing occurs at the bumper, at the low pressure cylinders, a box casting at the high pressure cylinders, between the driving wheels, in front of the fire box and at the draw casting. Most of these braces are very deep and they will permit no weaving or twisting of the frames. This frame construction is flexible



HIGH-PRESSURE MOTION.

LOW-PRESSURE MOTION.

DIAGRAMS OF VALVE MOTIONS, DE GLEHN 4-CYLINDER COMPOUND LOCOMOTIVE.—PARIS-ORLEANS RAILWAY.

horizontally, very stiff vertically, and frames seem to be very free from breakage in France.

The boiler is long and is not packed full of tubes; the tubes, 139 in number, are 14 ft. 5 in. long and of the Serve ribbed type of 2 9-16 in. inside diameter. The tube spacing provides plenty of room around the group for circulation of water between the tubes and the shell. This is shown in one of the sectional drawings. The grate has a sharp slope and is narrow. It is designed for coal which is rather better than ours, and for American conditions a wide fire box would be exceedingly desirable.

The smoke box is perfectly clear of obstructions. It has no steam pipes or diaphragm, the stack, which is 20⅛ in. at the top and 17¾ in. at the bottom and 2 ft. 8⅞ in. high, is extended downward into the smoke zox, with a flaring base. The exhaust nozzle is high and fitted with a variable exhaust attachment; as used in France this device is invaluable. The stack has a plate cover, which is a great protection to the fire box and tubes when closed.

In this particular locomotive the low pressure cylinders develop somewhat less than half the total amount of work and the crank axle is therefore relieved of that proportion of the work which it would have to do if all four cylinders were coupled to the same axle.

The reciprocating parts are very light. The crossheads weigh 238 pounds each; the high pressure piston, 100 pounds; the low pressure piston, 242 pounds; the high pressure main rod, 278 pounds; low pressure main rod, 425 pounds.

An examination of this locomotive is convincing of two things: First, that the design, as a whole and in every specific detail, has been carefully and systematically studied and, second, that the operation of such an engine must be carefully looked after. The fact is that American roads are not up to the handling of locomotives like this. Instead of condemning the design this is one of its strongest recommendations, indicating, as it does, how far foreigners are in advance of us in the handling of locomotives on the road. The work which the French engineman gets out of light locomotives is also an important study for our roads.

American railroad men, on examining these drawings, are sure to express their impressions in the word "complicated." There is no question of the fact that in order to get more work out of the weight allowed for locomotives more complication than that of current American practice is absolutely necessary. In order to secure the necessary results, under present conditions of train operation, it is necessary that methods of treating locomotive running repairs should be radically improved, even for present simple methods of construction. If our ordinary locomotives are to give satisfactory service, they must be properly maintained and methods which are really adequate for the proper maintenance of ordinary two cylinder, single expansion locomotive will be sufficient for taking care of more complicated machines. The trouble is that maintenance methods now are known to be grievously at fault, and must be improved irrespective of improvements in the locomotive itself.

There is nothing about a railroad train as complicated as the air brake. We must have the air brake and must maintain it for what it will do. If by complicating the locomotive, more work can be had per ton of weight, the complication is justified exactly as it has been in marine and stationary practice. The value of the complication in this particular locomotive will soon be ascertained on the testing plant at St. Louis.

GENERAL DIMENSIONS, DE GLEHN COMPOUND.

PARIS-ORLEANS AND PENNSYLVANIA RAILROADS.

Weight—On driving wheels	79,500 lbs.
On truck	46,500 lbs.
On trailers	34,000 lbs.
Total, in working order	160,000 lbs.
Tender, loaded	132,500 lbs.
Wheel Base—Driving	7 ft. ½ in.
Truck	7 ft. 6½ ins.
Total, engine	28 ft. 6½ ins.
Tender	20 ft. 6 ins.
Total, engine and tender	59 ft. 5 ins.
Driving wheels, diameter	6 ft. 8 3-16 ins.
Truck wheels, diameter	3 ft. 1 13-16 ins.
Trailing wheels, diameter	5 ft. 11-16 in.
Cylinders—Diameter..High-pressure, 14 3-16 ins.; low-pressure, 23⅝ ins.	
Stroke	25 3-16 ins.
Boiler, straight top—Diameter	4 ft. 11½ ins.
Pressure	227 lbs.
Tubes, Serve, ribbed—Inside diameter	2 9-16 ins.
Length	14 ft. 5¼ ins.
Heating Surface—Tubes	2,435.7 sq. ft.
Firebox	181.1 sq. ft.
Total	2,616.8 sq. ft.
Grate area	33.9 sq. ft.
Capacity of tender	Water, 5,500 gals.; coal, 22,000 lbs.

Length of engine	12 ft. 8⅝ ins.
Length of tender	28 ft. 3¼ ins.
Length from pilot to tender coupler	70 ft. 11⅞ ins.
Width of engine	9 ft. 9½ ins.
Height to center of boiler	8 ft. 10 5-16 ins.
Firebox—Length inside	10 ft.
Width inside	4 ft. ½ in.
Thickness of plates (sides, crown and back)	⅜ in.
Tube sheets, thickness of	1 5-16 ins.
Valve gear	Walschaert's
Steam ports:	High-pressure, 14⅛ x 1¾ ins.; low-pressure, 20½ x 2 1-16 ins.
Exhaust ports:	High-pressure, 14⅛ x 3¼ ins.; low-pressure, 20½ x 3¼ ins.
Bridges	High-pressure, ⅞ in.; low-pressure, 1 1-32 in.
Eccentric throw	High-pressure, 7 15-32 ins.; low-pressure, 9 1-16 in.
Valve travel, maximum:	High-pressure, 5½ ins.; low-pressure, 5 9-16 ins.
Outside lap	High and low, 1 1-16 ins.
Lead, full forward gear:	High-pressure, 5-16 in.; low-pressure, 9-32 in.

RATIOS, DE GLEHN FOUR-CYLINDER BALANCED COMPOUND.

Maximum tractive force, operating simple (lbs.)	18,270
Maximum tractive force, operating compound (lbs.)	19,527
Volume of two high-pressure cylinders (cu. ft.)	4.61
Ratio total heating surface to volume high-pressure cylinders	559.24
Ratio low-pressure to high-pressure cylinder volumes	2 77
Tractive weight to total heating surface	39.85
Tractive weight to tractive effort, compound	4.07
Tractive weight to tractive effort, simple	4.35
Tractive effort to heating surface, compound	7.58
Heating surface to grate area	77.16
Heating surface to tractive effort, compound	13.19%
Total weight to total heating surface	62.09
Tractive effort × driving-wheel diameter to heating surface	609.95

BIG LOCOMOTIVES OVERLOADING AND LOCOMOTIVE FAILURES.

In order to ascertain the attitude toward and the appreciation of the position of the big locomotive, five questions were addressed to a number of leading railroad officials as follows:

1. Are big locomotives satisfactory?

2. Are locomotive failures increasing as the size of locomotives increases?

3. If so, is it due to the fact that the locomotives are big, or to overloading?

4. Stated generally, is it not good policy to load engines lightly enough to get an average speed of, say, about 15 miles an hour when business is heavy and to load them heavily when business is light?

5. Given a distance of, say, 6 miles between side tracks, is not the capacity of the road limited by the time required for the slowest train to make this distance?

The replies constitute a remarkable reflection of opinions from some of the best operating men in the country. What these men say on any subject will be eagerly read, but their comments on the increasing size of locomotives and its effect on questions of operation and maintenance must be considered as specially significant of the necessity for proper design, operation and adequate facilities for maintenance of big locomotives.

Delaware, Lackawanna & Western Railroad.

1. Our experience with such locomotives, being the standard consolidation freight engines we are using and which we have been buying for several years, is, I think I may say, entirely satisfactory. We are so well satisfied with these that we are buying more each year to take the place of the lighter engines we are retiring from service.

2. Our experience does not show that locomotive failures are increasing as result of the larger power we are using. I think probably during the last three years locomotive failures have increased in number, as compared with the similar period immediately preceding, but my view of this is that the abnormally large tonnage handled, with the general shortage of power, has required the railroads to run their locomotives harder and with less attention in shops and round-houses than previously, and as a result of trying to get increased mileage out of them in this way failures on the road have appreciably increased.

3. It is quite possible, too, that the desire of the transportation department to get as much service out of the locomotives when on the road as possible has led to their being overloaded at times, and this, of course, is bound to result in more failures.

4. Generally speaking, I should say that it is not good policy to load engines to an extent that results in their dragging along over the road, making a low rate of speed and getting in the way of other trains. As a result of our practice in this regard we feel that it is better to give a fair load and one that will enable slow freight trains to make 15 to 18 miles an hour running between stations and thus get them over the road in good time. More service can be gotten out of engines and crews both in this way than by loading the engines to the very last limit. Especially is this true on lines having as heavy traffic as ours.

5. I think, without question, the capacity of the railroad is limited to a great extent by the time required by the slowest trains to make distances between the passing points along the line.

W. H. Truesdale, President.

Seaboard Air Line Railway.

1. I believe there is great economy in the use of heavy engines. The maximum economic weight of the engine used must, however, be adjusted to the conditions under which traffic is moved. I do not believe it would be economy to use in road service as big an engine as could be economically used on mountain grades.

2. Engine failures have increased with increase in size of engines. I do not know whether the ratio of increase in engine failures agrees with the ratio of increase in weight.

3. I believe the increase in failures with big engines is due to overloading and increased steam pressure carried, in comparison with pressure formerly carried by engines of less capacity.

4. It is economic, and therefore good policy, not to load heavy engines in excess of their efficient rating. This must be determined by traffic conditions. When the movement of business is heavy a larger tonnage can be successfully moved by reducing the engine rating measurably. When traffic is light engines can be loaded economically up to the limit of their efficient rating.

5. The capacity of a railroad is limited by the time consumed by the slowest train moving between stations.

J. M. Barr, President.

Norfolk & Western Railway Company.

1. The larger engines now in use are not only satisfactory but, in my opinion, have proven to be an absolute necessity, because the vastly increased traffic would have been congested to a greater extent but for the increased train load and relatively decreased train mileage effected by increased capacity of engines.

2. The increased size of locomotives has increased the number of engine failures, but I do not think that the increase has been out of proportion to what should have been anticipated under the new conditions brought about thereby, and that when railways have adjusted their methods and facilities to the new conditions requiring time and the expenditure of money the failures will not show a relative increase. The increased failures are also due to the improved method of loading engines up to their capacity from the beginning to the end of runs, over the minimum as well as the maximum grades, which has been effected by a more perfect system of helper and pusher service, and practiced to a greater extent since the introduction of the big engines, whereas engines formerly were fully loaded only on mountain grades, and hence were very lightly loaded over the greater distance run.

3. The increased failures are due to new conditions referred to in answer to question 2.

4. In my opinion, engines should be loaded up to their effective rating, which is a load with which they can make maximum speed with class of freight hauled, while under way.

5. In my opinion, the necessity for passing sidings is determined by the time between terminals, hence on a train basis the capacity of a road is limited by the time consumed, and not by the distance, between side tracks.

L. E. Johnson, President.

Buffalo, Rochester & Pittsburgh Railway Company.

1. As big locomotives are termed to-day weighing anywhere from 230,000 to 300,000 lbs., we have none of these which could be considered as our engines weigh only about 180,000 lbs. in working order. If you assume to call these big engines, our records show them to be very economical. They not only make their mileage, but the cost to operate them per mile is low. Comparing these engines with the lighter or smaller type of engines, we find the cost for repairs, coal and water consumed, are approximately proportional to

their hauling power. The oil, wages, and various supplies cost per mile is slightly greater for the larger engines than for the smaller ones.

2. Our experience and records show that we have no more failures with these engines than with the smaller ones.

3. In our opinion it is a good policy to load engines light enough to make an average speed of fifteen miles per hour when business is heavy.

4. Given a distance of, say, six miles between side tracks, we have but one or two places of this kind, and do not think it a good policy to run trains so slow as to delay other traffic on the line. In our opinion, it is very bad policy to load engines down to such an extent as will cause them to stall or make very slow speed. It deprives the railroad company of their use and keeps the men on duty too long a time so that at the latter end of their trips they are tired, naturally indifferent to all surroundings as well as to their own lives.

A. G. Yates, President.

The Wabash Railroad Company.

I am sorry I have not the time to go into the several questions you ask thoroughly and answer them at length and in detail. As I have not the time to do this I am practically confined to a categorical reply:

1. This question is rather indefinite and a good deal like the question, "What is the size of a lump of chalk?" I presume, however, you refer to the very large locomotives of from 180,000 to 200,000 lbs. on drivers. I have not been an advocate of the very large engine, the reasons for which are numerous, among the most important being:

First: The large increase in the cost of car repairs due to handling very large trains. There is such a large percentage of old and light cars still in service that it is difficult to make up a train of general traffic without having several such cars in it, and with large engines these cars are apt to cause trouble. Even with trains of modern cars the damage to the draft timbers and rigging in the starting and stopping of these trains is considerable.

Second: The track and maintenance repairs are very largely increased by the running of unusually heavy engines. The saving of a few cents per ton mile in wages of trainmen can very easily be offset by increased cost of track maintenance and car repairs.

2. Are locomotive failures increasing as the size of locomotives increases? I will not say that locomotive failures increase as the size of the locomotives increases, but the expense of maintaining and repairing locomotives is, of course, much greater for large than for small engines.

3. If so, is it due to the fact that locomotives are big or to overloading? Repairs of locomotives ordinarily are due to the use made of them. If they were not used at all it would cost no more to keep up a big engine than a small one, and therefore the trains they haul and the speed at which they are run and the shocks received due to heavy trains are the principal elements of repairs and, of course, the effect of these elements is practically proportionate to the size of the locomotives. The element of loading is, of course, a great factor in repairs, as an overloaded engine, like an overloaded man, is bound to break down in some part much sooner than it would if the work done was well within the limits of the power of the locomotive or of the man.

4. The policy of the Wabash is to so load and rate an engine that it can make its schedule time without difficulty—in fact, so as to have a little reserve power left in order to make up some time when the train is laid out at a meeting point. Under the present strict rules of overtime in force on almost all roads, it is not economical to load an engine down to the last notch. It is better to get the engine and the traffic over the road on time and have the engine get out promptly on its next run than to put on the last car possible for it to haul and then have the train delayed, thus adding to the expense of operation and bring forth complaints from shippers, etc. Of course, such a policy does not induce the highest tonnage possible per train mile, but in my opinion, the loading per train mile, while it is a desirable thing up to a point where other factors should be considered, can easily become a fad which may be detrimental to the interests of the company and really increase, instead of decrease, the expenses of operation.

5. This is rather a theoretical proposition and it may be that I do not fully grasp the meaning of the question. The capacity of a road is limited or affected by a great many factors, the principal factor governing the capacity of a road being that of grades. I assume, however, that the intent of your question is more as to the capacity as to the number of trains than the capacity for tonnage. Of course, on a single-track railroad the frequency and length of sidetracks is a most important element in the number of trains which can be handled and the delays which would ensue while one train was waiting for another to pass. The slowest train run on a road is generally the train of the least importance and the one which is sidetracked and has to keep out of the way of the higher grade and faster trains, and therefore the slowest train, in my opinion, would not be the limiting factor in regard to all the traffic of a road. I should say it would be very apt to be the average speed of trains, say trains running at an average speed of 15 miles an hour.

J. Ramsey, Jr., President.

Chicago, Burlington & Quincy Railroad.

1. Are big locomotives satisfactory? Yes, in a general way, although this does not mean that all big locomotives are satisfactory. It is not strange that when the capacity of locomotives was increased so enormously that the executed designs prove faulty in a good many details. When we have had as much experience with locomotives of modern capacities as we had with locomotives built and "tried-out" 15 years ago, we shall have evolved a satisfactory machine.

2. Locomotive failures are certainly increasing, but on the best railroads I doubt if they are increasing anything like as rapidly as the capacity of the locomotives have increased; that is to say, on a well-regulated railway I believe that locomotive failures are much less in proportion to any unit of work done than formerly. It is not quite fair to measure locomotive failures in proportion to the miles run for freight service; the tons hauled one mile, and in the passenger service, the speed and weight of train must be taken into consideration.

3. I should say that a good many failures have been due to overloading, or to want of intelligent loading. The most frequent cause of failure with engines of large tractive power on low grade lines is entire deficiency in boiler capacity. The demands on a locomotive boiler to furnish steam to an engine of large tractive power loaded to full rating on a low grade line are far in excess of what is considered good practice with stationary boilers and probably cannot be met unless the boiler is considerably enlarged or its efficiency increased by use of automatic stokers; even automatic stokers, however, will not dispose of the ashes and clinkers, and keep the fire in the condition in which it must be maintained to develop the required horse-power for a good many hours at a stretch.

4. Stated generally, is it not good policy to load engines lightly enough to get an average speed of, say, about 15 miles an hour when business is heavy and to load them heavily when business is light? I should say that the question of speed would depend largely on the character of the railroad. On single track lines and on many double track lines, it is necessary to keep trains moving at 15 miles per hour in order to make an average speed of 10 miles per hour, or better, over the divisions. It is also a fact that in busy times trains cannot be loaded quite as heavily, and keep the road open, as they can when business is dull and there is less traffic congestion.

5. The capacity of the road is not only limited by the time it takes for trains to run from one passing track to another, but also the time it takes for trains to get into clear at those passing tracks. For that reason the capacity of a road is very much increased by having heading-in passing tracks operated with interlocking, so that trains can head in and get out of the way as quickly as possible. By the same token a good deal is saved if trains can move through the passing track and pass out at the other end without any back-up movement. The ideal train movement is obtained when trains may be passed by each other at passing tracks without stopping either train. A very near approach to this can be obtained with good lap sidings, and in winter weather the avoidance of delays on passing tracks has a very important effect in reducing not only engine failures, but train failures, hot boxes, etc.

F. A. Delano, General Manager.

Illinois Central Railroad Company.

1. Are big locomotives satisfactory? Yes.

2. Are locomotive failures increasing as the size of locomotives increases? Yes.

3. The difficulty experienced with the larger locomotives is principally caused by flues or staybolts and packing. This is on account of greater amount of work performed by the larger engines due to increased size, and more particularly due to the increased pressure which these engines carry. On this system engines of all classes are required to haul a tonnage in accordance with their size and capacity, and the failures of the larger engines under these circumstances are increased by reason of the additional number of parts, as the latter are principally of the consolidation type.

4. This would be largely due to the nature or character of the principal traffic on any district in question. On this road our dead freight trains are scheduled to make about an average of ten miles per hour, while the higher class trains run an average of from 15 to 20 miles an hour.

5. There is no question but that the distance between side tracks, particularly on single-track road, governs the road capacity for moving the freight business, and where the traffic is heavy I regard an average of six miles distance between side tracks too great. Four miles would, in my opinion, be the proper distance.

J. T. Harahan, Second Vice-President.

Grand Trunk Railway System.

1. Big locomotives are not entirely satisfactory.

2. Locomotive failures are increasing as the size of locomotives increases.

3. These failures are due both to increase in size and to overloading.

4. It is good policy to load engines lightly enough to get an average speed of, say, about 15 miles an hour when business is heavy and to load them heavily when business is light.

5. On a given distance of six miles between side tracks the capacity of the road is limited by the time required for the slowest train to make this distance.

Notwithstanding the fact that increased tonnage is handled by the more modern locomotives (which are merely the style of locomotives formerly used but of increased dimensions) as is shown in the foregoing answers to questions, the gains made by their use are by no means net, for the reason that they cause much more wear to the track and rack the equipment, making the cost of maintenance excessive, and this condition will continue until the lighter constructed cars are superseded by the cars of modern construction. The heavy locomotive, however, is a necessity in passenger service as well as freight. The travelling public demand modern equipment and high speed in order to give the comforts that are necessary and the increased protection to the passengers, and on account of the high speed extra heavy equipment is required. Ten years ago passenger coaches of 60,000 lbs. weight were common. To-day a modern coach weighs over 100,000 lbs., sleeping cars, parlor and dining cars weighing as much as 135,000 lbs. It can readily be seen, therefore, that this extra tonnage, together with the increased speed, requires enormous power, which can only be secured by the use of the exceedingly heavy locomotives.

Charles M. Hays,
Second Vice-President and General Manager.

The Atchison, Topeka & Santa Fe Railway System.

1. "Are big locomotives satisfactory?"—Very decidedly.

2. "Are locomotive failures increasing as the size of locomotives increases?"—I do not think so. The number of miles run per engine failure on the Santa Fe System is much greater this year than last, and we have been receiving new and large locomotives constantly during the last twelve months.

3. The size of the locomotives, in itself, has nothing to do with the matter. Some large locomotives are not properly designed, because of the fact that it is, and always has been, customary with railroads to find out how large the various parts of a locomotive should be, in order to avoid breakage, and then to make them stronger. This necessarily involves more or less breakages until the facts are determined. One of the principal causes of engine failures is the choking of the boiler with an unnecessary number of flues, in order to secure greater heating surface. Much of this trouble has been attributed to the wide firebox. While this feature of modern engines has been carried to extremes in some cases, it is a fact that fuel is much more economically and effectively burned in wide fireboxes than was formerly the case in narrow ones. The evaporation of largely increased volume of water, in modern boilers, must result in a corresponding increase of solid precipitates, or scale. It is more than ever necessary to purify feed water, but this important matter has received relatively little attention. Imperfect circulation, due to narrow water legs and excessive number of flues, has resulted in many burned side sheets, and this disaster has been attributed by various people to various causes—among others, to the quality of coal used. When from three waterleg gauges dry steam may be taken, while the engine is in service, further conjecture as to the cause of burned side sheets seems to be unnecessary.

4. In the opinion of the writer, an average speed of 12 or 13 miles an hour is more desirable than 15 miles per hour. Either term is indefinite, in a measure, because much depends upon detention enroute, the term "average" applying to the distance between terminals, divided by the time, from hour and minute of departure to hour and minute of arrival. Engines should be loaded only to such an extent that it will be practicable for them to make the desired schedule time, be it 12, 15 or 20 miles per hour; and all engines should be so proportioned as to regularly perform this service without machinery failures, it being understood that no machinery can be indestructible, and that breakages must occasionally occur. When business is heavy, engines should be given uniform loads, in accordance with the above statement. When it is light they will, in most cases, have to take what offers, and at such times, if the business is balanced, a lighter engine will prove preferable. With inferior business it will usually be practicable to delay forwarding until there is an accumulation sufficient to afford full load for the engine to be employed. While it may seem that this practice, if followed, will result in delays which will seriously affect the volume of business, especially where competition is sharp, a matter of a few hours at originating terminals is not of vital importance, if the train is kept moving afterward.

5. The slowest train—assuming that only one coming under this category is on the district at a time—can only affect the opposite movement of trains over successive blocks of six miles. The slower the trains, the smaller the tonnage capacity of a single-track road, but the delays incident to meeting or passing by freight trains is much less in the aggregate than is the delay of freight trains incident to the movement of passenger trains. In any case, much depends upon the distance between telegraph offices.

I wish to voice a protest against the conclusions which are in some instances preceding known facts, concerning the operation of so-called heavy engines. Many companies have purchased large engines, but have not made adequate provision for their maintenance. Naturally, it is not to be supposed that a plant which would satisfactorily take care of engines twenty years ago can perform the same function with respect to modern locomotives. The care of the modern engine requires a modern shop, and so does the proper and economical care of an antiquated locomotive. One can hardly expect to employ an engine of double the weight of those formerly used and to maintain these engines at the same cost per mile run. In fact, this unit of cost is obsolete and should be discarded in favor of one which will establish the cost per gross ton mile transported, meaning, of course, the weight of the cars and contents, but omitting the weight of the engine, which from necessity must propel itself.

J. W. Kendrick, Third Vice-President.

Nashville, Chattanooga & St. Louis Railway.

1. Big locomotives are satisfactory provided they are not too big. Am quite sure the limit has been exceeded in some instances. Local conditions should govern to a very great extent. Our latest engines:

Weigh	165,000 lbs.
Cylinders	21 x 28 ins.
Diameter of driving wheels	55⅝ ins.
Steam pressure	195 lbs.

These engines are as large as can be used economically at the present time by this company from the fact that we find it necessary to limit the number of cars in the trains, this being brought about by the inability of the draft rigging to withstand the strain of starting longer trains on heavy grades. This 50-car limit applies to the Chattanooga division, where there are any number of grades 50 to 80 ft. per mile. On the Atlanta division, where the grades are 35 ft. per mile, these same engines are limited to 60 cars.

2. Am afraid they are. This should not be the case were the engines well designed. Our principal trouble is from flue failures. Longer flues, larger flue sheets, higher steam pressure, shallow fireboxes of the wide fire-box type, all tend to make life a burden so far as leaky flues are concerned.

3. In a great many instances, failures of large engines are caused from faulty design or poor workmanship. The tendency is to overload, the inevitable result of which is engine failures. Our rule is to rate the engines so they can get over the road nicely, and conductors have instructions to set off cars rather than take possession of the road.

4. Engines should be rated so as to make 12 or 15 miles per hour over the heaviest grades, and to do so without running fuel consumption up.

5. Yes and no. Yes, if there are practically the same number of trains each hour. No, if the trains are bunched, which is usually the case. There are hours when there are but few trains between certain stations, and at such times it makes but little difference

whether trains are 30 or 40 minutes covering the 6 miles. During the busy hours, the time of the slowest train does limit the capacity of that part of the road crowded with trains.

J. W. THOMAS, JR., General Manager.

——— & ——— RAILWAY.

1. Big locomotives are not entirely satisfactory.

2. Locomotive failures increase as the size of the locomotives increase.

3. I do not think locomotive failures are due to the fact that the locomotives are too big or to overloading. I think they are due largely to bad workmanship and lack of knowledge of the machine. A high pressure locomotive must be very well put together and carefully designed to do its work with satisfaction.

4. I believe it is good policy to load engines so they may make a reasonable speed, but this depends entirely on the facilities. A four-track road can load engines heavily for a low speed and a double-track road with ample sidings and a comparatively light passenger traffic can do the same. On a single-track road with heavy passenger service and fast freight business low-speed trains will be seriously in the way.

5. The capacity of the road is, of course, limited by the time required when slow trains are occupying the track, but this would not necessarily be all the time.

— — ———, President.

the answers to be determined upon each railroad, after study and full knowledge of the conditions as they are or as they may be made. Somebody asked somebody else, so I've read, what he thought the best way to "bring up" a boy. "Show me the boy," the somebody else replied.

I claim to know little about large railroads and large engines on them. I express myself according to my light and in response to your courteous request. Very truly yours,

F. W. CRAM, President.

THE NEW YORK, CHICAGO & ST. LOUIS RAILROAD COMPANY.

1. I think, as a whole, big locomotives are satisfactory.

2. While I have no data from which to make accurate statement, I think it quite probable there are increased failures of big locomotives in comparison with the smaller ones.

3. If so, a portion of the trouble may be ascribed to the larger locomotive, and also, in many instances, to overloading. Another factor during the past winter has been the very unusual weather conditions.

4. I think where conditions will permit, it is good policy to load engines so that an average speed of about 15 miles per hour can be maintained, the same to apply when business is heavy or light.

In answer to your fifth inquiry: I am not prepared to give an opinion on this subject, although I am inclined to think the inference to be derived from your question is correct.

W. H. CANNIFF, President.

CHICAGO & NORTH WESTERN RAILWAY COMPANY.

1. Are big locomotives satisfactory? We have found ours entirely so. They are not, however, of the largest existing type, our maximum weight on drivers being 126,000 pounds. We have no compound engines.

2. Are locomotive failures increasing as the size of locomotives increases? Our experience is not in the affirmative. Our company has increased its shop facilities and the efficiency of its tools to the extent that we have been able to give prompt attention to running repairs, and where running repairs are kept up it oftentimes eliminates the necessity for any great enlargement of the so-called "back-shop." This also disposes of your third inquiry.

4. This inquiry has a pleasant sound and in the abstract our reply is in the affirmative. It is an accepted fact that one of the principal yard sticks of railway operation is freight train tonnage. That is what we all strive for, but there is a great difference in various roads on account of their localities and the business which they handle, also with different parts of the same road for the same causes; therefore, in actual practice one must be governed by the conditions which confront him at the minute. In other words, train service in our territory at least must accommodate the traffic and we cannot always make the traffic subordinate to service that we would like to maintain.

5. Given a distance of, say, 6 miles between side tracks, is not the capacity of the road limited by the time required for the slowest train to make this distance? I assume this is from the standpoint of a single-track line without any intermediate blocks between sidings. We have been able to very much increase the capacity of various parts of our line by the introduction of intermediate manually controlled telegraph blocks, dividing it up into sections of 2½ to 4 miles each.

W. A. GARDNER, General Manager.

BANGOR & AROOSTOOK RAILWAY COMPANY.

1. I don't know what you would call a big locomotive. The smallest one now would have been big fifty years ago. The biggest one now may be small fifty or even twenty years hence. The smallest one now might be big for certain purposes under certain (existing) conditions, and the largest one not large enough under conditions wholly possible through money outlay. I don't think the question of motive power can fairly be considered by itself.

2. Not on this road.

3. I do not permit overloading and cannot answer for those who do.

4. I do not think the question can be fairly or intelligently answered as one which applies generally. Over sections of roads almost anywhere "yes." Over other sections not "yes" and not "no" without knowledge of many other conditions than appear in your premises.

5. I should have to say, "not necessarily and perhaps yes."

My comment upon "1" involves principles applicable throughout,

PERE MARQUETTE RAILROAD COMPANY.

1. *Small* locomotives are not satisfactory.

2. I do not think locomotive failures are increasing by reason of the use of large locomotives in any greater ratio than the number of ton miles hauled per annum per engine.

4. I do not think it is as necessary to change the loading of engines when business is heavy as it is to consider the temperature and other conditions in giving the load.

5. I presume when you refer to the capacity of a road you mean the business moved by a greater or less number of trains over the road. As I view it, the real question is not how many trains can be moved over the road, but rather how much tonnage can be moved. Speaking generally, I believe the capacity of a road can be limited by having crews on the road too long; while, on the other hand, the capacity may be sacrificed by running below the point where a crew might get over the road in a little longer time with largely augmented tonnage.

M. J. CARPENTER, Vice-President and General Manager.

CHICAGO GREAT WESTERN RAILWAY.

1. Very large locomotives may be satisfactory in certain service, but I believe that their performance in general has been disappointing to most of the railroads which have bought them within the last few years. I believe that we have all gone ahead too fast in the way of big engines.

2. With us, locomotive failures are not increasing as the size of locomotives increases, although the nature of the failures has changed more or less. The principal trouble now comes from leaking flues.

4. Yes.

5. The distance between side tracks is certainly a limiting factor in the capacity of a single-track road.

TRACY LYON, Assistant General Manager.

UNION PACIFIC RAILROAD COMPANY.

1. Big locomotives are satisfactory, because they are made necessary by the increased demands of the public for improved facilities and reduced rates; and the employes for higher pay. Otherwise we would not be able to maintain the integrity of our securities.

2. Are locomotive failures increasing? Locomotive failures are more frequent with large power than with small. Locomotives with high steam pressure are most affected by poor water than the smaller locomotives.

3. The failures of large engines are not especially due to increased tonnage, but in a number of instances are caused by inferior material and workmanship.

4. It is good policy to give engines for slow freights their full complement of tonnage. The speed regulation is governed by the grades and the atmospheric conditions during different seasons of

the year, as well as water; and by the competition occasioned by other lines; and the necessity for operating perishable freight and live stock at different rates of speed.

5. To a certain extent, yes. In dull times more tonnage can be handled, under similar weather conditions, without overtime than in busier times, caused by the loss in meeting and passing trains. The economical "speed limit" can best be determined on each road according to its necessities and the character of fuel that it uses. The large locomotives are the means of reducing the number of trains—reducing the volume of accidents and the cost of the service.

The very decided increase in the cost of all kinds of material operates adversely, in connection with the increased cost of labor and reduction in rates, in producing the best results.

A. L. Moler, General Manager.

International & Great Northern Railroad Company.

1. Yes, I think the big locomotives are satisfactory.

2. I do not think there are any more failures in proportion to number of train miles than when we used the small locomotives.

3. The percentage of engine failures is due to overloading probably more than anything else.

4. Generally speaking, I believe it a good policy to load engines, when business is heavy, light enough so that they can make an average speed over the division of 12 to 15 miles an hour; and, when business is light, increase the load so that you can decrease your train mileage as much as possible.

5. It would depend a great deal as to how many slow trains you had moving as to whether or not the capacity of the road would be limited by time required by slowest train to make distance between side tracks of an average distance of six miles each.

G. L. Noble, Assistant General Manager.

X and Y Railway.

1. I consider big locomotives are, on the whole, satisfactory. I believe we have to adjust our shop and roundhouse work to new conditions and that some of the dissatisfaction with large engines is due to the fact that we did not realize immediately the necessity for this.

2. I believe locomotive failures have increased with the increase in the size of the locomotives, but not necessarily because the locomotives were larger. We did not immediately know how to take care of the large engines and some of their details were far from satisfactory. As defects in design are remedied and better attention is given to the large locomotives, I do not see any reason why these failures should be any greater in proportion to business handled than if the same amount was handled by small engines.

3. The answer to question 2 also answers this question. I do not think failures of large engines are, as a rule, due to overloading.

4. The load which engines should be required to haul, in my opinion, depends upon many matters. As a general policy I should say that your suggestion is right, namely, that when business is light they should be loaded heavily, but when business is heavy the engines should be loaded a little less heavily with a view of getting the maximum amount of freight moved by them in a given time. There can, however, be no fixed rule as to where the line on tonnage shall be drawn. I think it depends a good deal upon character of traffic and physical condition of the road. If one division had a few ruling grades not heavy enough for pusher service it would appear as if at all times the engines should be loaded with the maximum they will take over these grades, for on the other parts of the division they can make good time. On a low grade line the tonnage is seldom fixed by ruling grades, but is based upon the necessity for getting over the division in a reasonable time. The speed which the train shall be required to make under such circumstances may be further complicated by a heavy passenger service, as on our tracks, where we have to load the trains to a tonnage which will enable them to make a pretty high rate of speed while in motion; otherwise they could never get out of the way of passenger trains.

5. I think on a single track line one factor in limiting the capacity of the road is the *average* time required to cover the distance between side tracks. I do not think it is quite correct to say it is limited by the time of the *slowest* trains to make this distance. The number and schedule of passenger trains is also a factor. On a double-track railroad the time between side tracks will be a large factor or a small, and depend upon several other conditions; as for instance: The number and schedule of passenger trains, and the character of the freight traffic. If there were no passenger trains and all freight traffic was of a uniform character, and all trains could travel at the same speed, there would be no need for side tracks except to get out of the procession such trains as were in trouble, but with a large variety of freight traffic, some of it traveling at high speeds and some of it at slow speeds, freight trains must pass each other. A great many railroads are finding out that the limit of capacity of their roads is not so much due to the physical conditions between terminals as to the limits at terminals. Generally speaking, our terminals are not large enough and trains cannot be handled promptly upon arrival. This results in holding out trains, with the consequent loss of time of engines and also a congestion in the yards, which frequently involves serious loss of time in getting engines and their trains out of the terminals.

— — ————, General Manager.

———— ———— Railroad.

1. In a general way we believe that they are, when they can be loaded to their capacity. By large locomotives we refer to freight locomotives weighing not over 200,000 lbs., preferably of the consolidation type. We have had no experience with heavier ones. We do not consider these locomotives to be satisfactory where they are run much underloaded or at high speeds.

2. The wear of such locomotives is naturally much greater than that of the smaller ones which preceded, owing to the increasing weight of the parts; and owing to the great weight of the locomotives and of the parts forming them, the existing roundhouse organizations are less capable of making the small repairs, which, if neglected, require greater repairs. In addition to this, the tires and such parts with the heavier wheel loads give less life in service than did the lighter locomotives.

3. Probably to the first cause, rather than to the latter. In comparison to the tractive power, we should say that the large locomotives are not generally overloaded to the same extent that the smaller ones were.

4. We think that the conditions mentioned are not the governing ones. When the business is heavy it is very frequently unbalanced in direction from day to day, requiring light or partly loaded movements one way in order to balance the power. We think that this question will also be locally affected by the nature of the road and the number of tracks, and the same answer would probably not apply to single or double-track roads and those having more than two tracks.

— — ————, General Manager.

STEEL CAR DEVELOPMENT.

Pennsylvania Railroad.

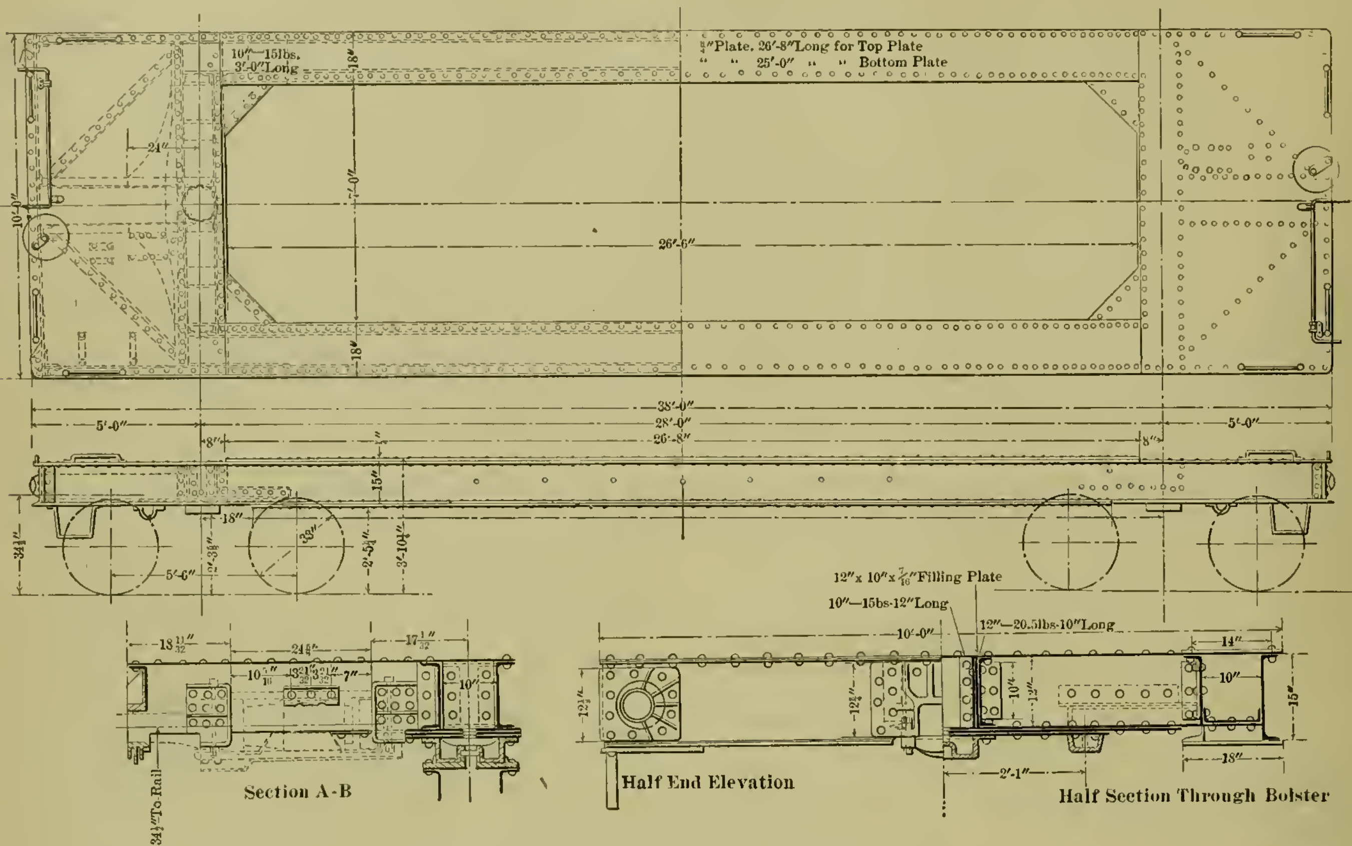
V.

(For previous article see page 3, January, 1904.)

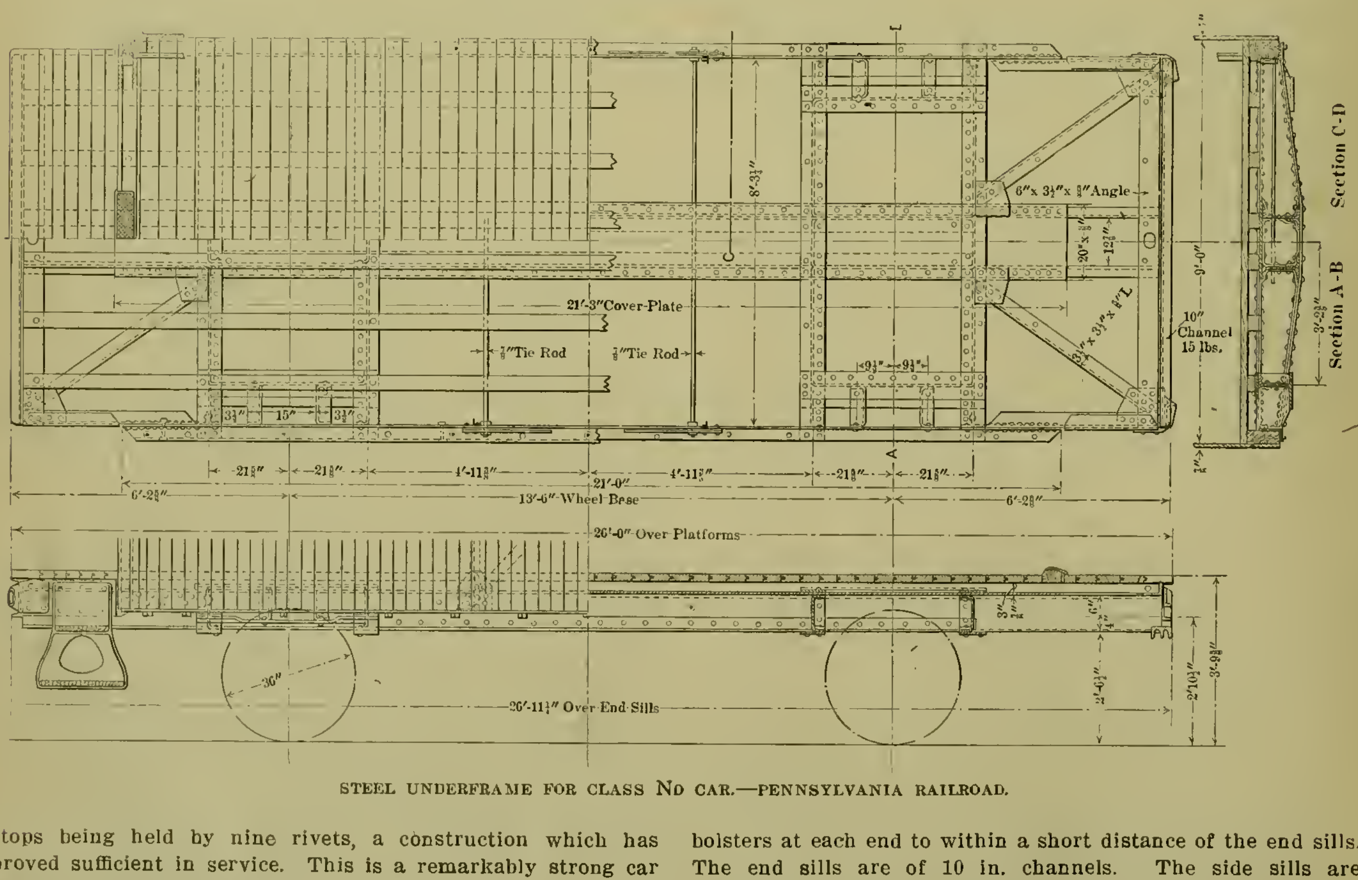
While it is out of chronological order, the special steel car known as class Fx is the next design to be described. This is a flat car built entirely of steel and has a carrying capacity of 100,000 lbs., the car weighing 34,800 lbs. It was specially designed for use in transporting large castings and electrical machinery, the floor of the car having a large opening through which the load may extend downward in order to come within clearance dimensions. This car is designed to carry the entire load, if necessary, concentrated within 4 ft. of each side of the center, or a distance of 8 ft. along the length of the car at the center. If a load is carried outside of this distance it may be 120,000 lbs.

The bolsters are connected by two box girders, one on each side, of 15 in. channels with ¾ in. cover plates 18 ins. wide, extending the full length of the opening. The bolsters are of 12 in. channels in pairs, with three bottom cover plates of different lengths and one top cover plate. The upper of the three bottom cover plates extends the full width of the car and the box girders are reinforced at the bolsters by short pieces of 10 in. channels laid flat. The upper of these three bolster cover plates extends towards the end of the car in the form of two gussets, which are cut away at the center to give room for the draft gear. The drawings show the corner bracing of the car and the heavy gusset bracings at the corners of the central opening.

The end sills are of 15 in. channels cut out for the coupler shanks and the openings reinforced by steel castings. The deck plates at the ends of the car form top cover plates for the bolsters. This car is mounted upon 100,000 lbs. capacity trucks. It is fitted with Westinghouse friction draft gear, the draft gear



CLASS FN CAR.—PENNSYLVANIA RAILROAD.



STEEL UNDERFRAME FOR CLASS ND CAR.—PENNSYLVANIA RAILROAD.

stops being held by nine rivets, a construction which has proved sufficient in service. This is a remarkably strong car and it has been in demand for special service, particularly for carrying large electric generators.

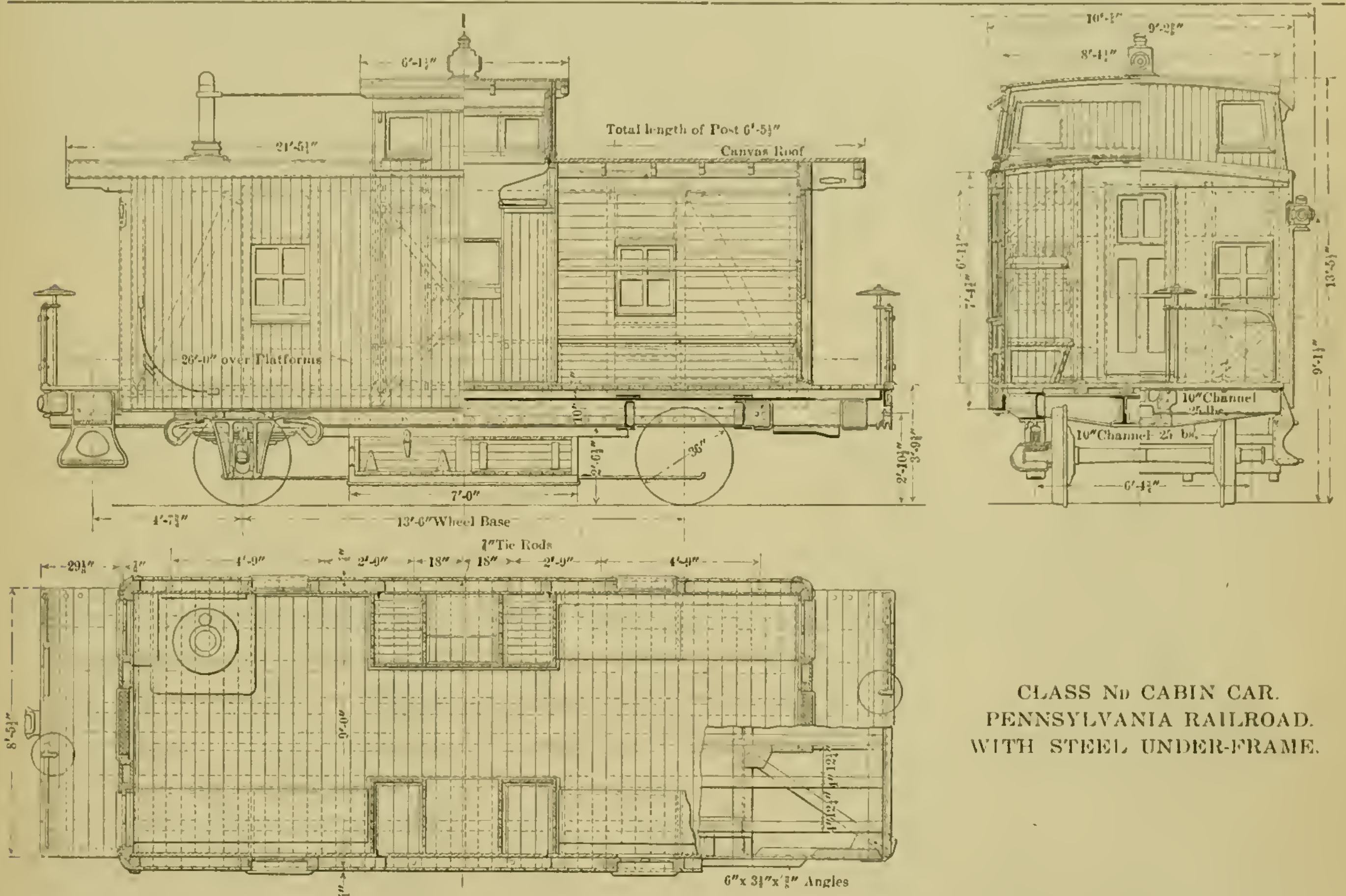
The other car described is the Class ND, cabin car.

Steel construction has been employed in the framing of this car, it having been found necesssary to strengthen the entire frames of cabin cars which are used in severe pushing service. This frame has a backbone of 10 in.-25 lb. channels, with a cover plate on top only and reinforced at the bottom by 3½x3½x⅜ in. angles. The cover plate extends beyond the bolsters at each end to within a short distance of the end sills. The end sills are of 10 in. channels. The side sills are 6x3½x⅜ in. angles, extending almost to the end of the car, where they are continued by shorter pieces of angles reaching to the end sills. The transoms are built up of three pressed diaphragms, of which there are two at each end of the car.

They have 6½x½ in. top and bottom cover plates. The pedestals are bolted to girders of the form of presssed steel diaphragms extending between the transoms, with top and bottom cover plates, forming footings for the pedestal castings.

The car is really an elongated four-wheeled truck with a house built on it. The steel frame carries 4x8 in. side sills and six nailing strips on which the house is built. The drawing of the frame shows the corner bracing angles to receive poling thrusts from the corner castings. Two ⅞ in. tie rods hold the light side sill angles together near the center of the car and these have nuts inside and outside of the side sill angles.

The central portion of the house is built over a steel frame riveted to the side sills, which serves to stiffen the cupola. It has diagonal braces and steel carlines of angles. The diagonals are of 3x⅜ in. flat steel. The cupola is braced by bent angles secured to the roof of the car and extending up the side walls, stiffening this part of the structure. The wheel base of the car is 13 ft. 6 in. Its coupled length is 277 ft. 10¼ in. The wheels are 36 in. in diameter. The car weighs 28,000 lbs. This cabin car is somewhat larger than has been used on this road previously, and affords more comfortable quarters for the men, who frequently live for some days at a time in the cars. This car has proved to be entirely satisfactory and capable of withstanding the force exerted by two class H6 locomotives pushing against it, and these are the heaviest freight locomotives on the road.



CLASS Nd CABIN CAR.
PENNSYLVANIA RAILROAD.
WITH STEEL UNDER-FRAME.

VAUCLAIN 4-CYLINDER BALANCED COMPOUND.

4-4-2 TYPE PASSENGER SERVICE.

CHICAGO, BURLINGTON & QUINCY RAILWAY.

In this journal in March, 1902, page 72, was illustrated the first four-cylinder balanced compound built by the Baldwin Locomotive Works, and in June, 1903, page 210, the construction of the further development of this type, as built for the Atchison, Topeka & Santa Fe, was presented. The present engravings show the construction of another example which is now being completed by the Baldwin Locomotive Works for the Chicago, Burlington & Quincy Railway, but has not yet been put into service. This locomotive embodies the principles of the other two designs which have been mentioned, and especially arranged, in the matter of detail, to meet the conditions of the Burlington. The following indicate some of the leading differences between the Burlington and Santa Fe designs:

	Burlington.	Santa Fe.
Diameter of driving wheels	78 ins.	73 ins.
Weight on drivers	100,000 lbs.	90,000 lbs.
Total weight	192,000 lbs.	187,000 lbs.
Total heating surface	3,216.9 sq. ft.	3,029 sq. ft.
Grate area	44.14 sq. ft.	49.4 sq. ft.
Largest diameter of boiler	64 ins.	66 ins.
Length of tube	19 ft.	18 ft. 1 in.

This indicates that with the same size cylinders, 15 and 25x26 in. in both engines, the tractive effort of the Burlington is less than that of the Santa Fe, the tractive effort of the former being 21,400 lbs., whereas that of the latter is 24,000 lbs. in compound working for both cases. In the Burlington design advantage is taken of the balancing of the reciprocating parts in order to increase the weight on driving wheels, which, in this case, is made 100,000 lbs., a rather unusual weight for four wheels, except on the Pennsylvania. It should be stated that the weights of the Burlington engine are estimated at the time of writing, the locomotive not having been completed. This engine has outside journals for the trailing wheels, the construction of the frames being the same as that illustrated on page 119 of our April number, 1902. The crank axles are forged, and 4½ in. pins are forced in through the crank pin portions. The crank cheeks are banded by tire steel hoops, finished all over, then heated, bent to shape and shrunk on. The following ratios and list of dimensions will be convenient for record:

VAUCLAIN BALANCED COMPOUND PASSENGER LOCOMOTIVE.

4—4—2 TYPE—C., B. & Q. R. R.

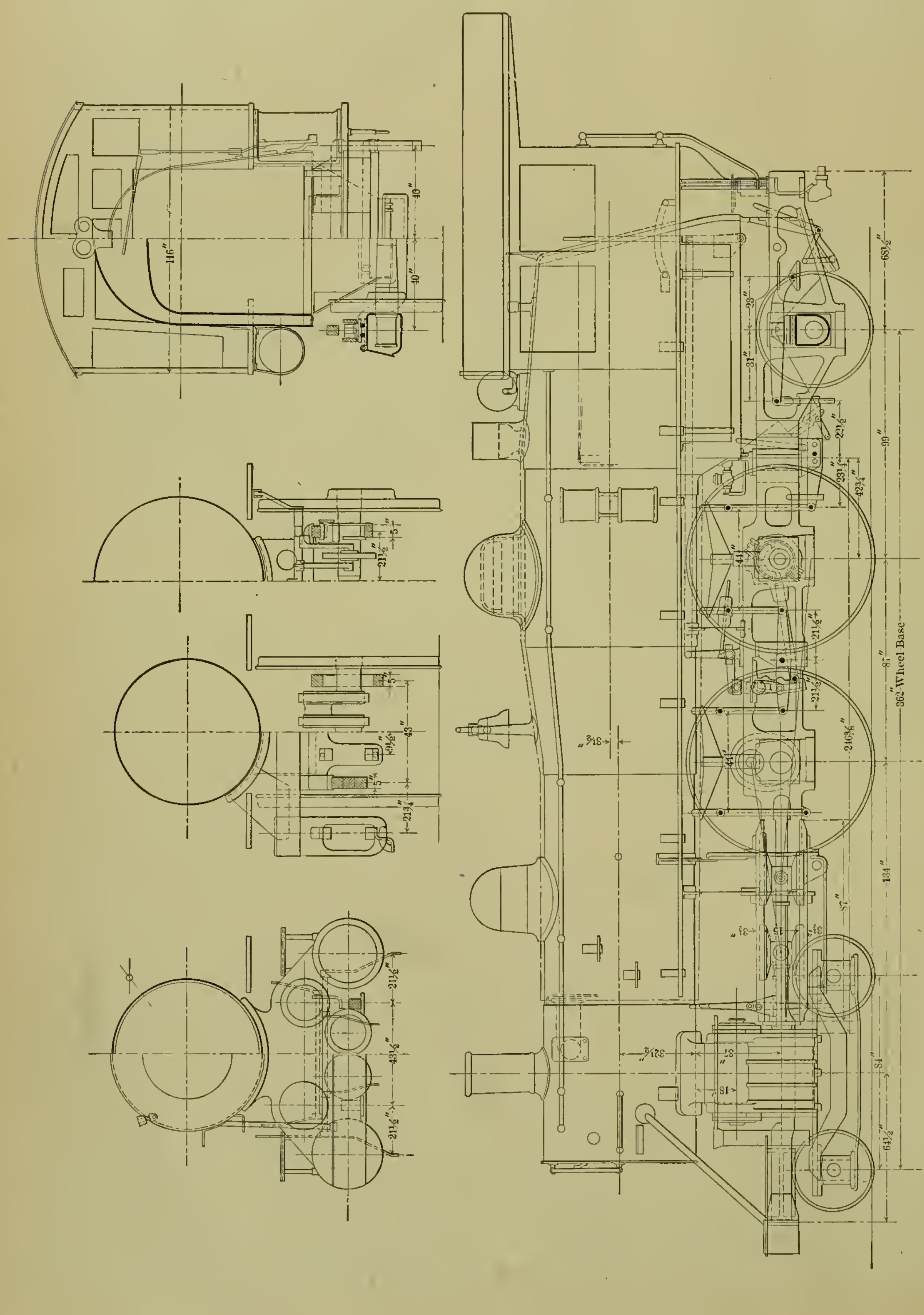
RATIOS.

Heating surface to volume of high-pressure cylinders	606.9
Tractive weight to heating surface	31.08
Tractive weight to tractive effort	4.67
Tractive effort to heating surface	6.65
Heating surface to grate area	72.88

Heating surface to tractive effort.......................... 15.03%
Total weight to heating surface............................ 59.68
Tractive effort × diameter of drivers to heating surface........518.8

GENERAL DIMENSIONS.

Gauge..4 ft. 8½ ins.
Cylinders..............................15 ins. and 25 ins. x 26 ins.
Valves...Balanced piston
Boiler—Type.......................................Wagon top
  Diameter..64 ins.
  Thickness of sheets........................11-16 in. and ¾ in.
  Working pressure.................................210 lbs.
  Fuel...Soft coal
  Staying...Radial
Firebox—Material...Steel
  Length...96⅛ ins.
  Width..66¼ ins.
  Depth...........................Front, 70⅜ ins.; back, 68⅜ ins.
  Thickness of sheets:
    Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube, ½ in.
  Water space.................Front, 4 ins.; sides, 4 ins.; back, 3 ins.
Tubes—Material..Iron
  Wire gauge..No. 11
  Number..274
  Diameter..2¼ ins.



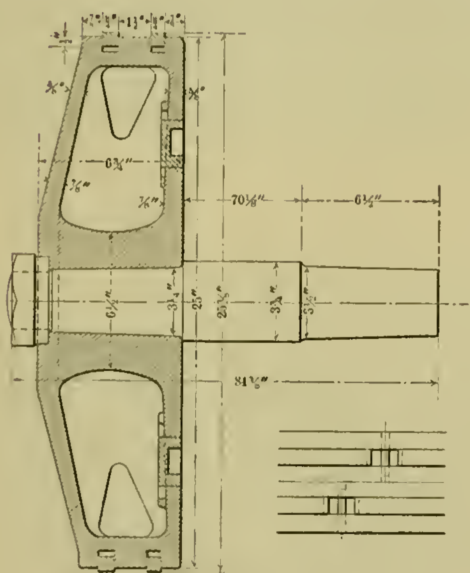
VAUCLAIN 4-CYLINDER BALANCED COMPOUND PASSENGER LOCOMOTIVE.

CHICAGO, BURLINGTON & QUINCY RAILWAY.

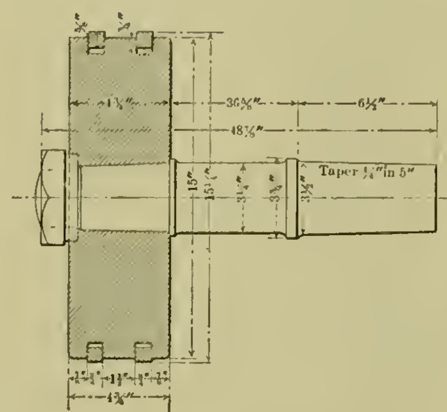
(For description see page 211.)

F. H. CLARK, *Superintendent Motive Power.* BALDWIN LOCOMOTIVE WORKS, *Builders.*

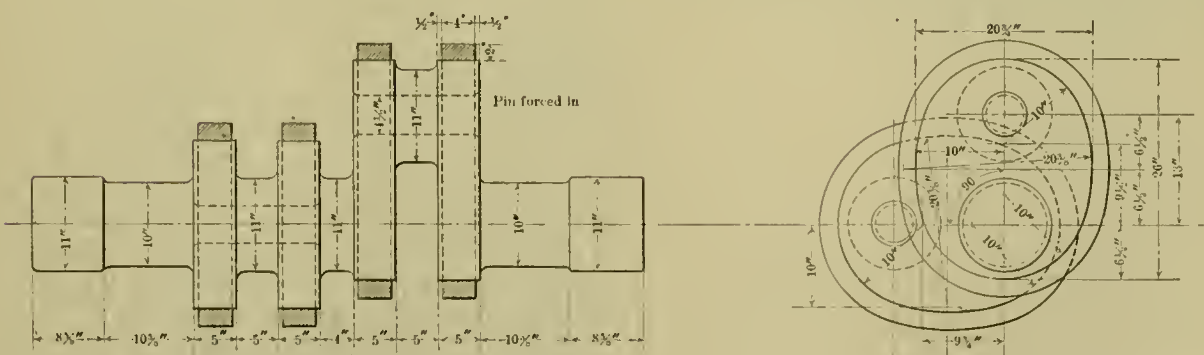
Length	19 ft.
Heating Surface—Firebox	166.4 sq. ft.
Tubes	3,050.5 sq. ft.
Total	3,216.9 sq. ft.
Grate area	44.14 sq. ft.
Driving Wheels—Diameter outside	78 ins.
Diameter of center	70 ins.
Journals	Front, 10 x 10½ ins.; back, 9½ x 12 ins.
Engine Truck Wheels (Front)—Diameter	33 ins.
Journals	6 x 10 ins.
Trailing Wheels—Diameter	48 ins.
Journals	8 x 12 ins.
Wheel Base—Driving	7 ft. 3 ins.
Rigid	15 ft. 6 ins.
Total engine	30 ft. 2 ins.
Weight—On driving wheels	100,000 lbs.
On truck, front	50,000 lbs.
On trailing wheels	42,000 lbs.
Total engine	192,000 lbs.
Total engine and tender	312,000 lbs.
Tank—Capacity	6,000 gals.
Tender Wheels	Number, 8; diameter, 37½ ins.
Journals	5 x 9 ins.
Service	Passenger



LOW-PRESSURE PISTON.



HIGH-PRESSURE PISTON.



CRANK AXLE SHOWING BANDING.

VAUCLAIN 4-CYLINDER BALANCED COMPOUND PASSENGER LOCOMOTIVE.

CHICAGO, BURLINGTON & QUINCY RAILWAY.

F. H. CLARK, *Superintendent Motive Power.* BALDWIN LOCOMOTIVE WORKS, *Builders.*

(For description see page 211.)

THE APPLICATION OF INDIVIDUAL MOTOR-DRIVES TO OLD MACHINE TOOLS.

BY R. V. WRIGHT, MECHANICAL ENGINEER.

XI.

Planers and Shapers.

McKees Rocks Shops.—Pittsburgh & Lake Erie Railroad.

Four of the planers that were used in the old shops at McKees Rocks were transferred to the new machine shop, and have been equipped with variable speed motor drives. These planers are called upon to handle quite a large variety of work, and on this account it was thought advisable to have them fitted so that the cutting speed could be varied. It did not, however, seem desirable to change the speed of the cutting stroke to any great extent by reducing the speed of the motor, since the speed of the return stroke would be reduced at the same time.

The belt driven type of planer has ordinarily only one cutting speed, and this is, of course, designed to suit average conditions. There are many cases where different cutting speeds could be used to advantage, but there is no reason why, if it is possible to provide it, a constant speed for the return stroke should not be used for all cutting speeds. The speed of the return stroke should, of course, be made as high as possible, and will depend on the design of the tool, the weight of the shifting pulleys, etc. Generally speaking, the shifting belts should not have a maximum speed of more than 4,000 ft. per minute. With higher speeds the weight of the pulleys will cause the bed to move too far, and the belts will wear out quite rapidly.

In some cases the speed of the return stroke in an old planer cannot be increased very much unless wider shifting belts are used, and this means that the shifting mechanism will have to be redesigned. The gearing must also be checked over, and in some cases cast iron gears may have to be changed to cast steel.

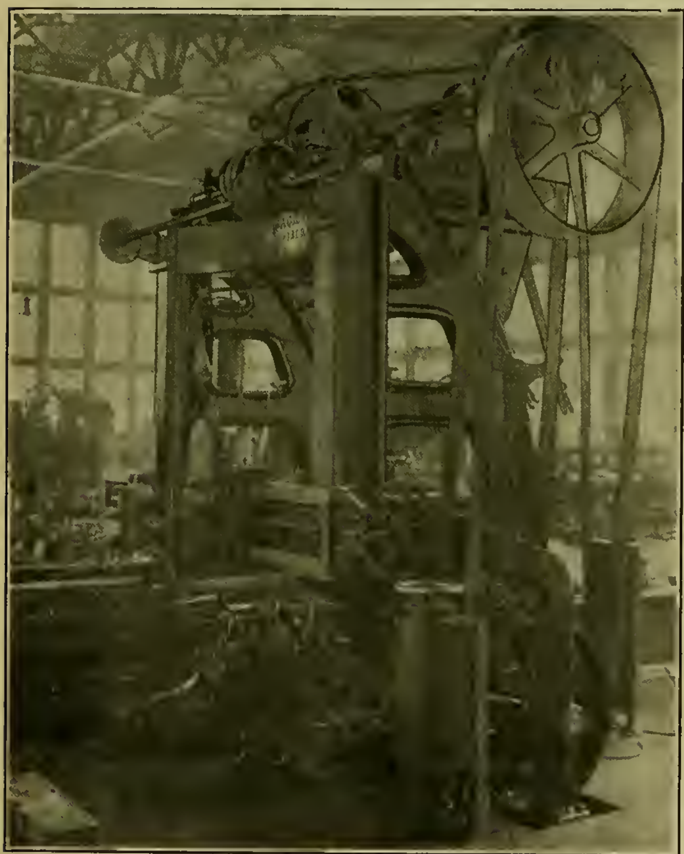


FIG. 52.—THE APPLICATION OF VARIABLE-SPEED MOTOR DRIVING TO THE 60-IN. POND PLANER, WITH SPECIAL GEAR CHANGES FOR 20 AND 30 FT. CUTTING SPEEDS.

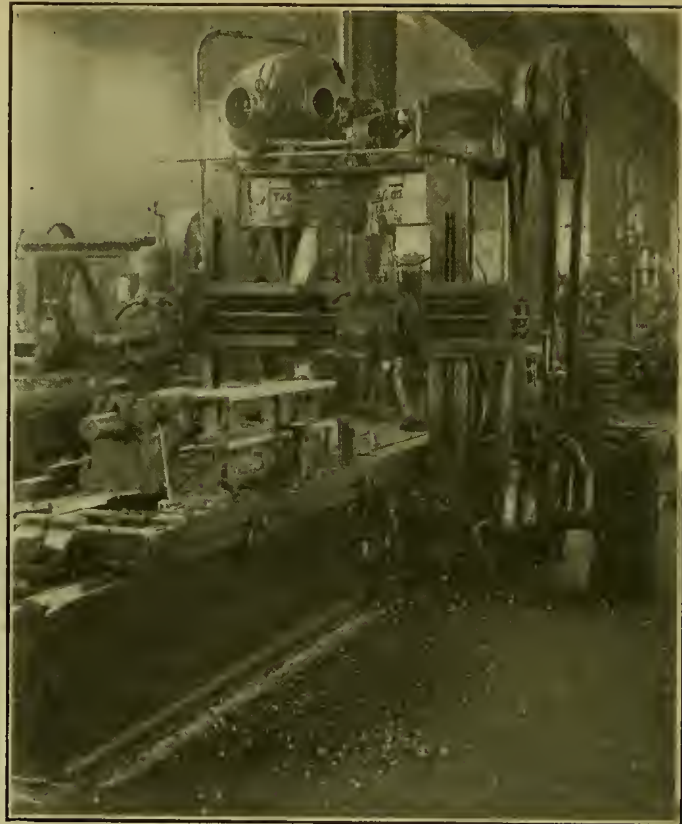


FIG. 53.—THE APPLICATION OF A VARIABLE-SPEED DRIVE TO THE 42-IN. CINCINNATI PLANER, WITH SPECIAL GEAR BOX GIVING CUTTING SPEEDS OF 15, 20, 25 AND 30 FT. PER MIN.

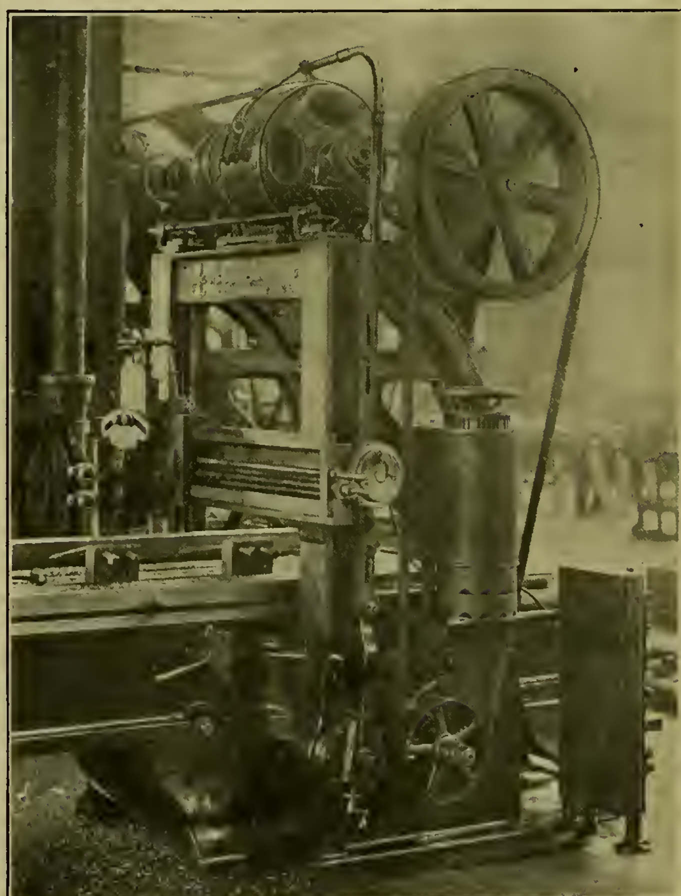


FIG. 54.—THE CHAIN DRIVE UPON THE 30-IN. POWELL PLANER, SHOWING CONVENIENT ARRANGEMENT OF CONTROLLER.—7½-H.-P. CROCKER-WHEELER MOTOR.

On one of our planers, a 60-in.x60-in.x20ft. Pond planer (Fig. 52), we have arranged for cutting speeds of 20 and 30 ft. per minute, with a return speed of 60 ft. per minute. Cutting speeds below 20 ft. per minute, and from 30 down to 20 ft. per minute, can be obtained by varying the speed of the motor, but the speed of the return stroke will, of course, in such cases, be changed at the same time.

The motor which drives this planer is, as shown in the engraving, carried on a cast iron table, which is supported by two brackets bolted to the housings. The motor armature shaft was extended by coupling on a piece of shafting, and on the end of this shaft was keyed a fly-wheel, which is also used as a pulley for the belt for the return stroke. A countershaft was added, which carried the pulley for driving the cutting stroke, and this countershaft can be driven from the motor-shaft by either one of two runs of gearing; change from one run of gearing to the other is made by means of a substantial jaw-clutch. The shifting belts were increased to 4 in. in width and the cast iron running parts were changed to steel.

The controller is, in this case, placed on the floor to the right of the tool and in front of the shifting mechanism, where it is within easy reach of the operator. The planer is driven by a Crocker-Wheeler 20-H.-P. compound-wound multiple-voltage motor, in connection with a type 80-M.F. controller, giving 18 speed changes.

The following data will give some idea of the power required to operate this tool. A roughing cut was taken by two round-nose tools on some mild-steel locomotive guide bars. The bars were tapered slightly toward the ends, and the heaviest cut, which was 5-16 of an in. full, was taken near the middle of the bar. The feed was 7-32 of an in. The power required in cutting varied from about 16-H.-P. at the ends of the guides to 25.6-H.-P. at the middle. The reversal from the cutting stroke to the return required 29-H.-P.; moving the platen on the return, 8.2-H.-P.; and the reversal after the return, 20.7-H.-P. When running light, 6.4-H.-P. was required to move the platen on the forward stroke.

The cutting speed throughout these trials was about 23½ ft. per minute, and the speed of the return stroke 50 ft. per minute. Although the controller was set at point No. 19, at which the nominal power of the motor is about 16-H.-P., no trouble was experienced in carrying the above overload as it was, of course, intermittent.

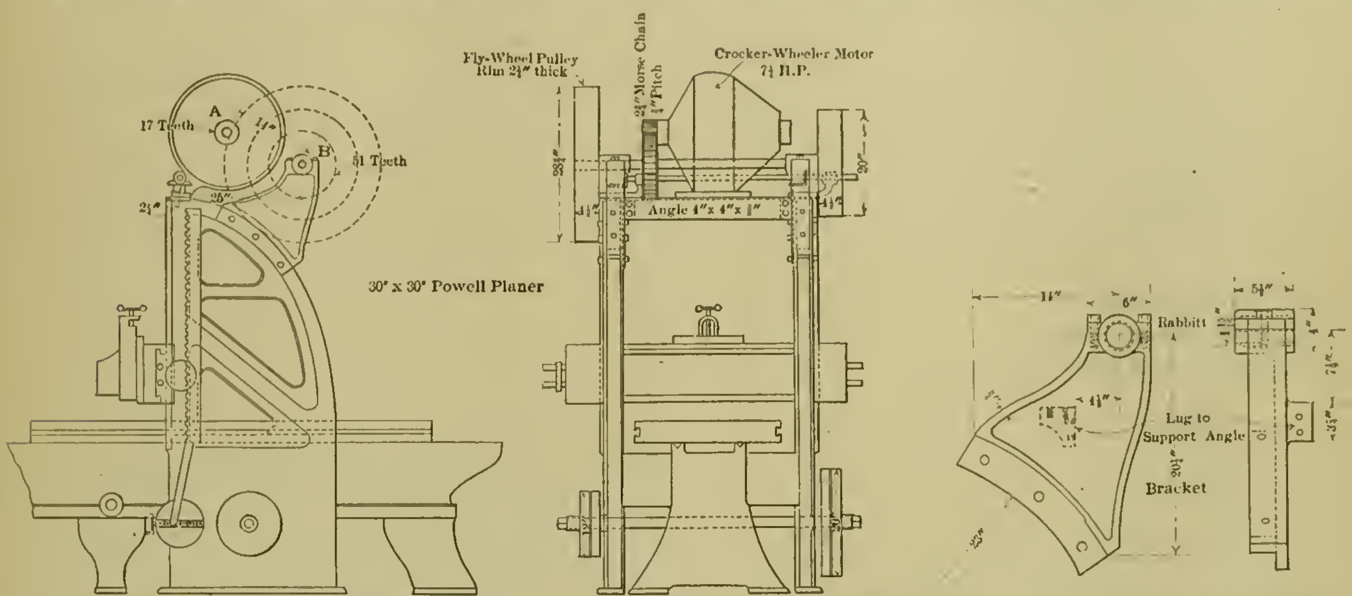


FIG. 55.—DETAILS OF THE MOTOR ARRANGEMENT AND OF THE COUNTERSHAFT SUPPORTING BRACKETS, USED UPON THE POWELL PLANES.

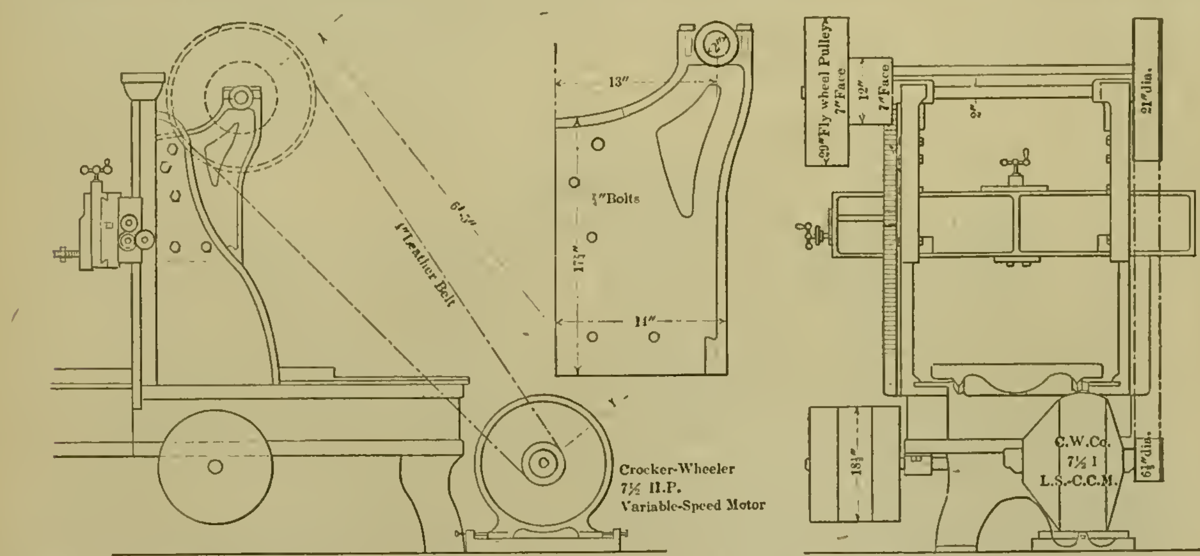


FIG. 56.—DETAILS OF THE BELTED MOTOR-DRIVE THAT WAS APPLIED TO THE NEW HAVEN PLANER, SHOWING STYLE OF COUNTERSHAFT SUPPORTING BRACKET USED.

Another interesting drive which is in service at the McKees Rocks Shops is that used on an old 42-in. x 42-in. x 15-ft. planer (Fig. 53), built by the Cincinnati Planer Company, Cincinnati, Ohio. This tool is fitted with a gear-box furnished by that company, which allows cutting speeds of 15, 20, 25 and 30 ft. per minute, with a constant return speed for the platen of 75 ft. per minute. By making reductions in the motor speed practically any cutting speed between 14 and 30 ft. per minute can be obtained with only slight reductions of the return stroke.

The arrangement of driving, as well as that of the motor, is practically the same as that illustrated in Fig. 7 of the article upon motor-driven planers appearing upon page 71 of the February, 1904, issue of the AMERICAN ENGINEER AND RAILROAD JOURNAL. A Crocker-Wheeler 15-H.-P. compound-wound multiple-voltage motor and a type 80-M.F.-18 controller are used in connection with this drive.

Figs. 54 and 55 illustrate an interesting application of a variable-speed motor-drive to an old 30-in. x 30-in. x 8-ft. Powell planer. This planer has a maximum cutting speed of 30 ft. per minute, with a return speed of 72 ft. per minute.

The motor rests partly upon the crossbrace at the top of the housings and partly upon a 4-in. x 4-in. x ⅝-in. angle, bolted in between the cast iron brackets, which are fastened to the housings to carry the countershaft. The countershaft is driven from the motor by means of a Morse silent chain, as is clearly shown. The fly-wheel, which is also used as a belt pulley, is on the countershaft, and is made quite heavy, since the speed of the shaft is comparatively low. A better action could of course be obtained by placing the fly-wheel on an extension of the armature shaft, but in this case such an arrangement could not have been made conveniently.

The planer is driven by a Crocker-Wheeler 7½-H.-P. compound-wound multiple-voltage motor in connection with a type 40-M.F.-18 controller. The controller is bolted to the side of the housing of the planer as shown. It is thus up out of the way, and yet convenient for the operator. The floor stand, or panel board, which is used to carry the switch, fuses and circuit-breaker, is here placed on the floor to the right and close to the tool. On the larger planers it is placed at the rear of the shifting mechanism, and is thus entirely out of the way, although within easy reach if the operator finds it necessary to use the switch or throw in the circuit-breaker.

Another interesting application, one that is remarkable for its inexpensiveness, is that made to an old 30-in. x 30-in. x 8-ft. planer, built by the New Haven Manufacturing Company, New Haven, Conn. The housings of this planer did not appear stiff enough to carry the motor on top, and so two brackets were bolted to the housings to carry the countershaft (see Fig. 56). The motor was set on the floor at the rear of the planer-bed, and is connected to the countershaft by a 4-in. belt, as shown.

The drive on this planer (Fig. 56) was arranged for a cutting speed of 30 ft. per minute, with a return speed of 72 ft. per minute. It is driven by a Crocker-Wheeler 7¼-H.-P. compound-wound motor, which is operated in connection with a type 40-M.F.-18 controller, located upon a floor stand at the right of the planer housing, as shown.

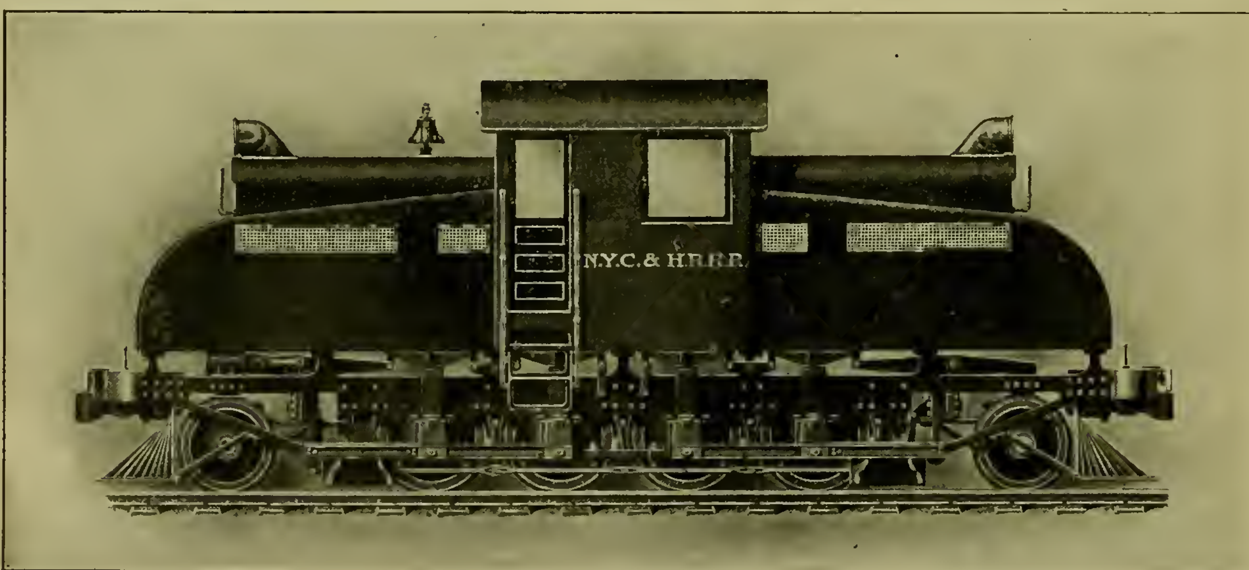
No rule was followed for determining the size of the fly-wheels on these planers. For the first two, which are here described, the Pond and the Cincinnati planers, fly-wheels were applied, as recommended by the tool builders. In the case of the last two, the fly-wheels were made very heavy for the reason that, although the planers were light, the fly-wheels were placed on a countershaft, the speed of which was in each case comparatively low.

NEW ELECTRIC LOCOMOTIVES.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

The new electric locomotives which are being built at Schenectady for the New York Central & Hudson River Railroad Company by the General Electric Company and the American Locomotive Company, differ radically in their electrical features from any electric locomotive hitherto constructed. This design was submitted in accordance with specifications prepared by the Electric Traction Commission, appointed by the railroad company, the members of which are Messrs. William J. Wilgus, fifth vice-president, N. Y. C. & H. R. R. R.; John F. Deems, general superintendent of motive power of the railroad company; Bion J. Arnold, Frank J. Sprague and George Gibbs. The secretary of this commission is Mr. Edwin B. Katte, electrical engineer of the railroad company. This commission, after careful deliberation, had prescribed the conditions which must be fulfilled by electric locomotives taking the place of steam locomotives as far as Croton on the Hudson River Line, and as far as North White Plains on the Harlem Division, distances of 34 miles and 24 miles respectively.

These conditions required an electric locomotive capable of making two regular successive trips of one hour each between Grand Central Station and Croton, with a total train weight of 550 tons, a single stop in each direction, and a lay-over not to exceed 20 minutes. In addition to this, it was provided that a similar schedule should be maintained with somewhat lighter trains making more frequent stops. Finally, it was provided that with a total train weight of 435 tons, the electric locomotive should be able to run from Grand Central Station to Croton, without stop, in 44 minutes, and, with one hour lay-over, be able to keep up this service continuously. This last schedule is the equivalent of the present timing of the Empire State Express, though the latter has a somewhat lighter train.

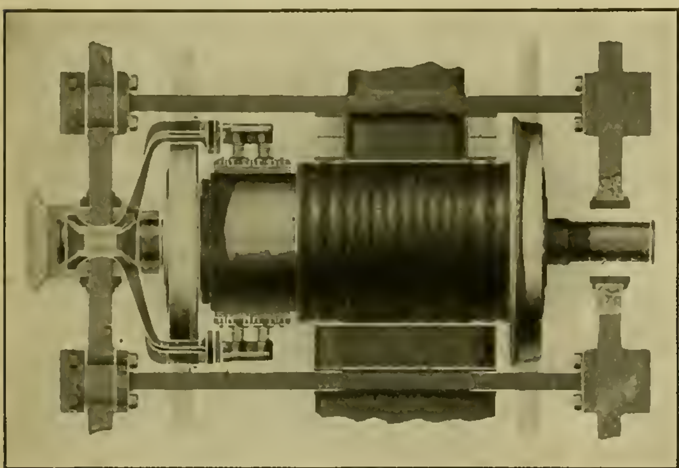


NEW ELECTRIC LOCOMOTIVE, NEW YORK CENTRAL RAILROAD. BY GENERAL ELECTRIC COMPANY AND AMERICAN LOCOMOTIVE COMPANY.

The successful bidders were the General Electric Company, in conjunction with the American Locomotive Company. The choice of a direct-current type of locomotive was dictated largely by its known reliability of service, owing to the amount of experience which had been accumulated with the direct-current motor.

The new electric locomotives will be 37 ft. in length over all. The wheel base will consist of four pairs of motor wheels and two pairs of pony truck wheels, the length of the total wheel base being 27 ft., and of the rigid wheel base, consisting of four pairs of motor wheels, 13 ft. The diameter of the driving wheels will be 44 ins. and of the truck wheels 36 ins. The driving axles will be 8½ ins. in diameter. It will be what is known as a double-ender, and will weigh approximately 190,000 pounds. The frames will be of cast steel, the side and end frames being bolted together at machined surfaces and stiffened by cast steel cross transoms. The journal boxes and axles will be designed to permit sufficient lateral play to enable the locomotive to pass easily around curves of 230 ft. radius. The superstructure of the locomotive is to be of such form and so designed as to offer the least practicable wind resistance consistent with the adequate housing of the apparatus and its convenient operation. The cab is designed so as to afford a clear view of the track. The whole of the superstructure is to be of sheet steel with angle iron framing, and the doors and windows of the cab are to be fireproof.

Four 600 volt direct-current gearless motors, each of 550-H.-P. will be used. This will make the normal rating of the locomotive 2,200-H.-P., with a maximum rating of about 2,800-H.-P. The armatures will be mounted directly on the axles, and will be centered between the poles by the journal boxes, sliding within finished ways in the side frames. The armature core will be of the iron-clad type, the laminations being assembled on a quill, which will be pressed on the axle. The winding will be of the series drum-barrel type. The conductors



ARRANGEMENT OF ARMATURE, COMMUTATOR AND FRAMES.

will be designed so as to avoid eddy currents, and will be soldered directly into the commutator segments. The commutator will be supported on the quill. The commutator segments will be made of the best hard-drawn copper, with integral ears. The brush-holders will be of cast bronze and mounted on insulated supports attached to the spring saddle over the journal, maintaining a fixed position of the brush-holder in relation to the commutator. Unlike the ordinary four-pole motor, where the magnetic circuit is made througn a separate box casting, the magnetic circuits in this type of electric locomotive are completed through the side and end frames. The pole pieces are cast in the end frames, and there are also double pole pieces between the armatures, carried by bars which act as part of the magnetic circuit. The pole pieces will be shaped so that the armature is free to move between them with ample clearance on the sides. As tne poles move up and down with the riding of the frame on the springs, they will always clear the armature, and provision is made so that the armature will not strike the pole pieces even if the springs are broken. The field coils will be wound on metal spools bolted to the pole pieces, and will consist of flat copper ribbon.

The Sprague-General Electric multiple unit control will be used. Two master controllers in the cab will be so placed that the operating engineer looking ahead will always have one of these under his hand. The control system will permit two or three locomotives to be coupled together in any order in which they happen to come and to be operated as one unit by the engineer in the leading cab. The control system will also be semi-automatic in its action, as it will provide a check on the rate of acceleration of the train, which the engineer cannot exceed, while he may accelerate at any lower rate if he so desires. Should two locomotives break apart the control current will be automatically and instantly cut off from the second locomotive without affecting the ability of the engineer in charge to control the front locomotive under his charge. The control system is designed for a minimum of 300 volts and a maximum of 750 volts.

The weight which will rest upon each of the driving wheels of the electric locomotives will be about 17,000 lbs. Proper distribution and division of the weight among axles will be accomplished by swinging the main frames from a system of elliptical springs and equalizing levers of forged steel, the whole being so arranged as to cross-equalize the load and furnish three points of support.

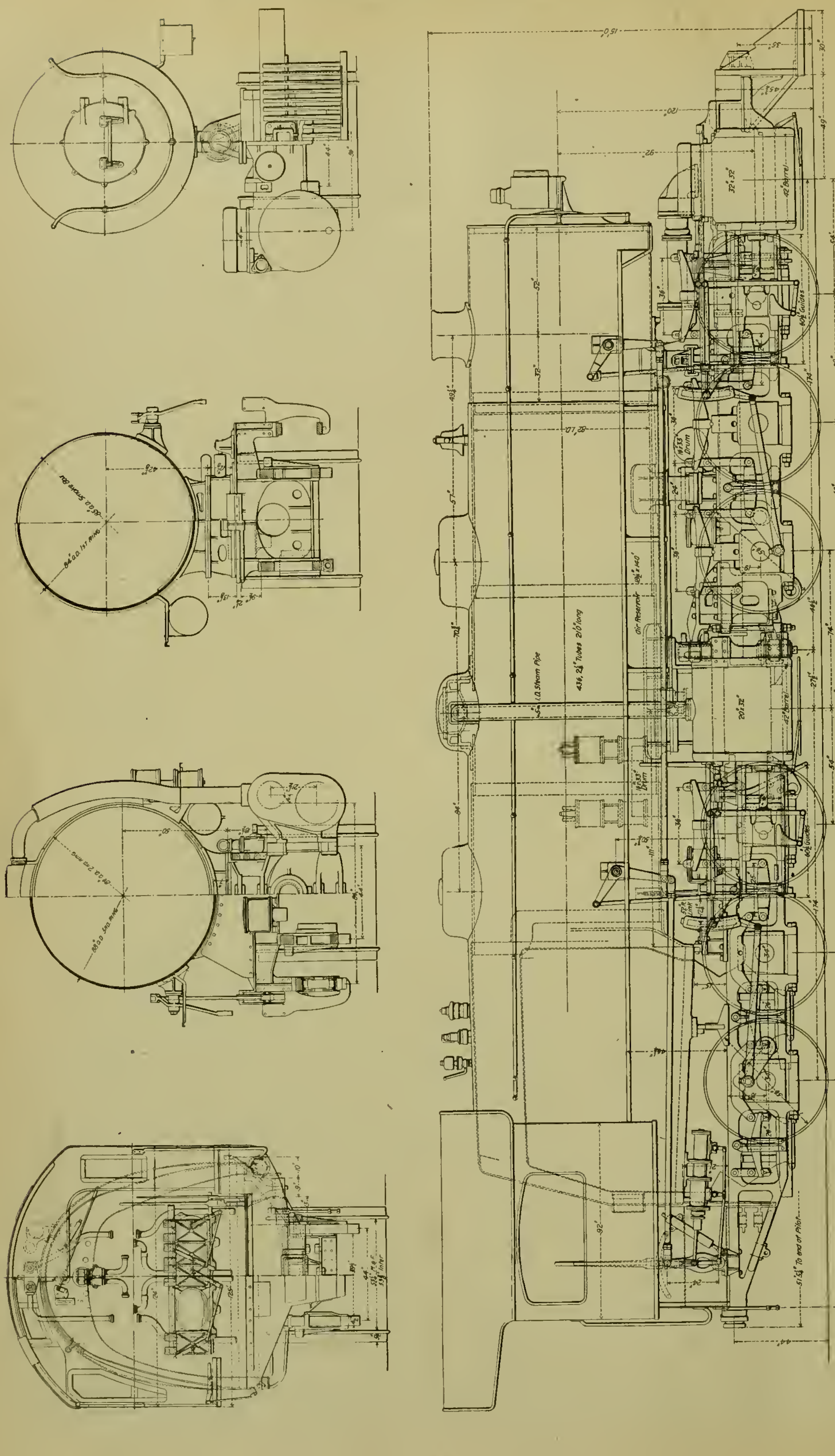
The locomotive will be provided with all the usual accessories of a steam locomotive, including an electric air compressor to furnish air for the brakes; it will have whistles, a bell and an electric pneumatic sanding device and electric headlights at each end. The interior of the cab will also be heated by electric coils.

In actual performance this locomotive is expected to give better results than any engine hitherto placed upon rails. With a light train the locomotive is expected to give speeds up to 75 miles an hour, and with heavier trains similar speeds can be attained by coupling two locomotives together and working them as a single unit. Its tractive force will be greater than that of any passenger locomotive now in existence, and it is believed that in the simplicity and accessibility of its parts and in the provision made in its design to insure continuous operation with the minimum chances of failure, that it marks an entirely new and successful type of electric locomotive.

Mr. S. L. Bean, heretofore master mechanic of the Atchison, Topeka & Santa Fé Railroad, Albuquerque, New Mexico, has been appointed mechanical superintendent of the Coast Lines, with office at Los Angeles, Cal., succeeding Mr. G. R. Joughins, recently resigned.

Mr. David Van Alstyne has been appointed superintendent of motive power of the Northern Pacific Railroad, to succeed Mr. A. E. Mitchell. Mr. Van Alstyne is a graduate of the Massachusetts Institute of Technology. He had his early experience on the Louisville & Nashville, and has, for a number of years, been in the motive power department of the Chicago Great Western Railway, where, for the last five years, he has held the position of superintendent of motive power. He is thoroughly equipped by training and experience for the important position which he is now taking, and this journal congratulates Mr. Van Alstyne and the Northern Pacific Railroad upon the appointment.

Samuel R. Callaway, president of the American Locomotive Company, died at his home June 1 after a surgical operation. He was born in 1850 in Toronto, Ontario, and began railroad service at the age of 13 years. For six years he was a clerk in the offices of the Grand Trunk; in 1871 he was private secretary to the general manager of the Great Western Railway; in 1874 he was appointed superintendent of the Detroit & Milwaukee Railway; in 1878 general superintendent of the Detroit, Saginaw & Bay City Railway; in 1881 general manager of the Chicago & Grand Trunk and president of the Chicago & Western Indiana; in 1884 he went to the Union Pacific as second vice-president and general manager; in 1887 he was president of the Toledo, St. Louis & Kansas City; in 1895 president of the Nickel Plate; in 1897 president of the Lake Shore & Michigan Southern, and April 27, 1898, he was appointed president of the New York Central & Hudson River R. R., succeeding Chauncey M. Depew. He was active in organizing the American Locomotive Company and had been its president from its inception. He was well known as a railroad officer, strong as a financier, and had hosts of friends.



MALLET ARTICULATED COMPOUND LOCOMOTIVE.—BALTIMORE & OHIO RAILROAD.

J. E. MUHLFELD, *General Superintendent Motive Power.* AMERICAN LOCOMOTIVE COMPANY, SCHENECTADY WORKS, *Builders.*

(FOR PHOTOGRAPH AND LIST OF DIMENSIONS SEE PAGE 237.)

The Largest and Most Powerful Locomotive in the World.

AN IMPORTANT TEST OF ELLIPTIC SPRINGS.

MADE FOR THE INTERBOROUGH RAPID TRANSIT RAILWAY.

TO DETERMINE PERMANENT SET AND PROPER WORKING FIBER STRESS.

BY S. A. BULLOCK.

The object of this test was to ascertain the greatest possible set this spring would receive under successive applications of light, heavy and excessive loads; and also to determine whether 106,000 pounds per square inch is an efficient fiber stress for the working load of plate springs.

Dimensions of spring before test:

Free height over bands	13¾ ins.
Free height between bands	6½ in.
Length of spring over all	31½ ins.
Length of spring, center to center	29½ ins.
Plates	3½ x 5-16 ins.

The first test (Fig. 1), consisted in giving 383 successive applications of the light load of 12,500 pounds, equivalent to a fiber stress of 91,400 pounds. (We have considered L one-half the length of spring under load P, to be equal to 15 ins.)

It is interesting to note that after the first application of the light load, and up to a certain number of applications (207), the spring grew 3-16 in. in the loaded height, the free height remaining constant. After this limiting number of applications, the successive applications of the load produced no further change.

The reason for this growth of spring, or increase of efficiency, is due to a decrease of friction between the plates. For in the manufacture of plate-springs there is always scale between the plates and the frequent application and release of this load pulverizes the scale, which then acts as a lubricant, and reduces the friction.

The second test (Fig. 2) consisted of 12 applications of

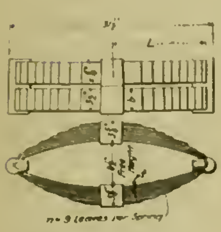


DIAGRAM OF SPRING.

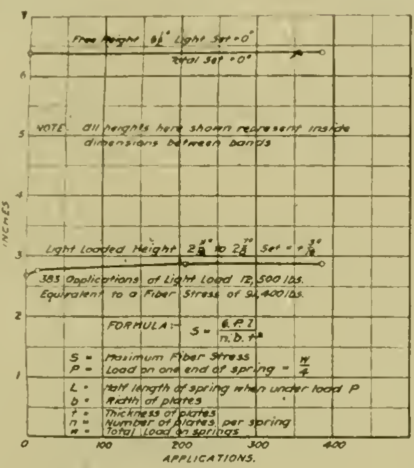


FIG. 1.

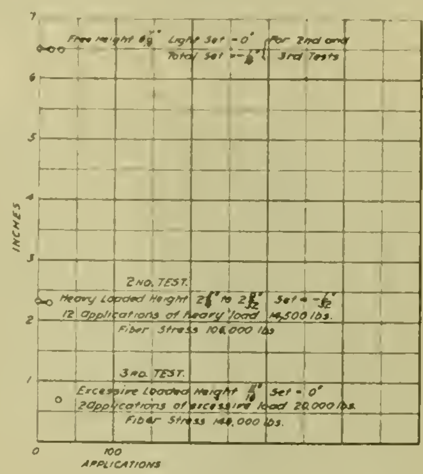


FIG 2.

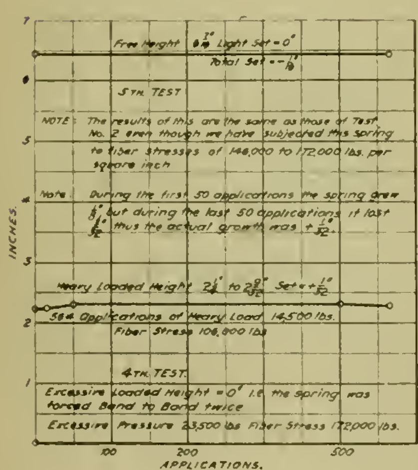


FIG 3.

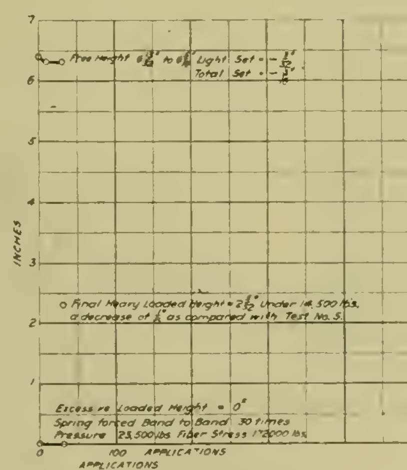


FIG 4.

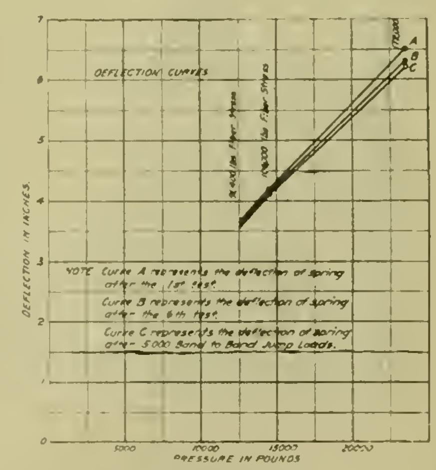


FIG 5.

Number of springs per set	4
Number of plates per spring	9
Style of spring	Double elliptic

During the first six tests the loads were gradually applied and released by a screw testing machine, traveling at the rate of 3 ins. per minute. But in the last test, as shown by curve C (Fig. 5), an hydraulic testing machine was used. The weight-beam was so adjusted that the load could be partially released, and then suddenly forced band to band by moving the lever up and down by hand. For the use of their testing machines we are indebted to the Baldwin Locomotive Works.

This last test was made on a different spring of the same class as the one used in the first six tests, and we have shown it in Fig. 5 for the sake of comparison.

The spring steel was furnished by the Crucible Steel Company of America, and made into springs by the Standard Steel Works, from whom we have the following chemical analysis:

Carbon (combined)	1.01 per cent.
Manganese	.310 per cent.
Phosphorus	.033 per cent.
Sulphur	.025 per cent.
Silicon	.170 per cent.

14,500 pounds, or a fiber stress of 106,000 pounds, producing a set in the free height of minus 1-16 in. and a set of minus 1-32 in. in the loaded height.

The third test (Fig. 2) consisted of two applications of 20,000 pounds (fiber stress 146,000). No additional set was found.

In the fourth test (Fig. 3), the spring was forced band to band twice, requiring an average pressure of about 23,500 pounds, or a fiber stress of 172,000 pounds per square inch. No appreciable set was discovered.

The fifth test (Fig. 3) consisted of 564 applications of the heavy load of 14,500 pounds, producing a fiber stress of 106,000 pounds. During the first 50 applications the spring grew ⅛ in., but lost 3-32 in. during the last 50 applications. Thus the actual growth was 1-32 in., the free height remaining constant.

The sixth test (Fig. 4) consisted of forcing the spring band to band ten times, then applying the test load of 14 500 pounds. This operation was repeated three times.

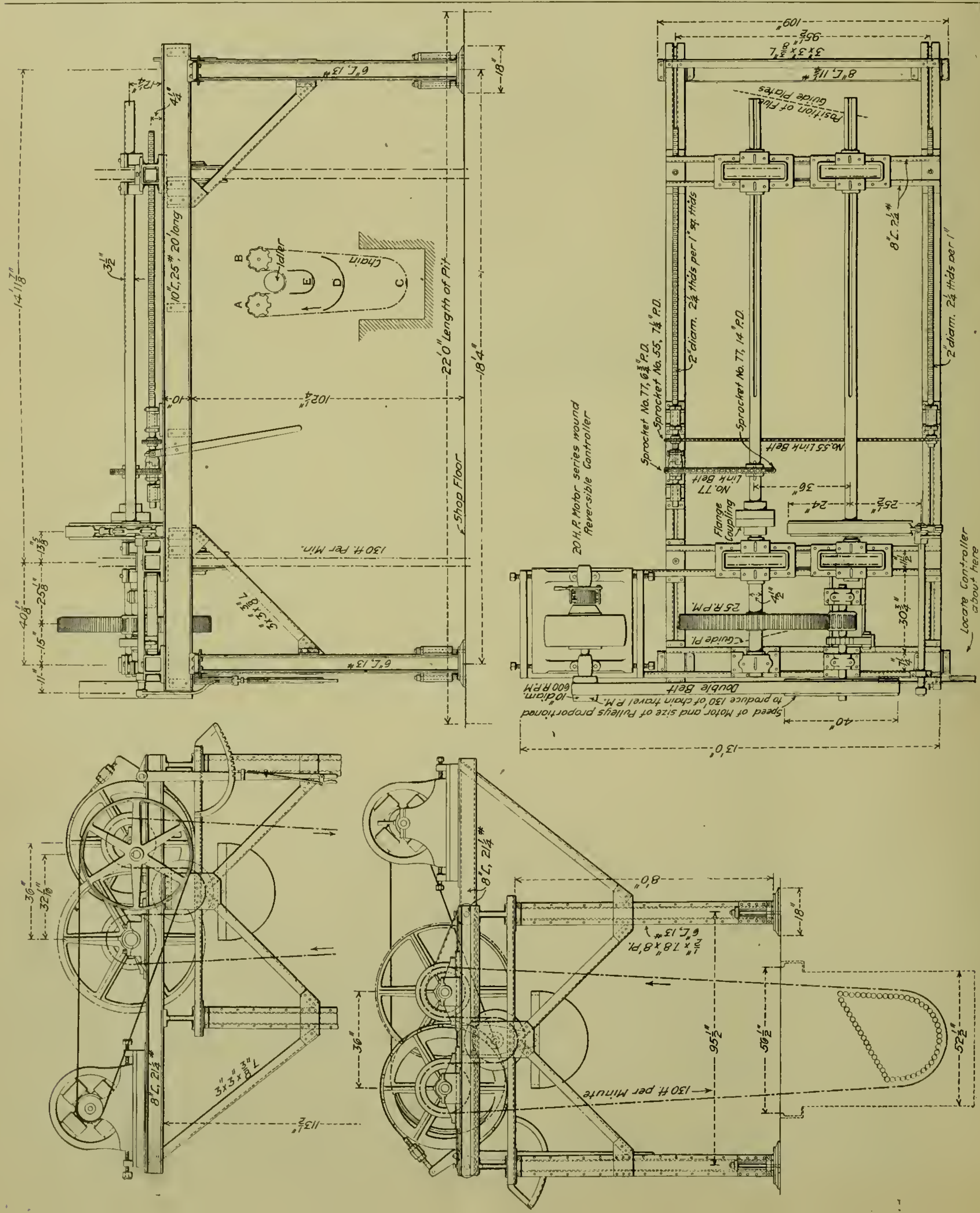
The first average pressure required to bring the spring band to band was 23,000 pounds, the successive average pressures required an additional 500 pounds to bring the spring band to band (i. e., 23,500, pounds or fiber stress of 172,000 pounds). The free height additional set was minus 3-32 in. The total light set was minus 3-16 in.

CONCLUSIONS.

Now, from these six tests, we note that 30 band to band applications produced a total set of minus 3-16 in. In the jump test between the 25th and the 5010th application the additional light set was minus 3-32 in. Accordingly, we may infer that the first spring could not receive a total set greater than minus 9-32 in., or that during the life of the spring, curve B (Fig. 5) would never fall below curve C.

Accordingly, it is evident that 106,000 pounds per square inch is allowable for the working fiber stress. The maximum allowable fiber stress can only be determined by more exhaustive experiments upon this subject.

Since all springs are at times subjected to excessive pressures which tend to produce a deformation from which the spring can never recover, we would suggest that when plate springs are tested they shall first be given two applications of that load which would be equivalent to a fiber stress of 146,000 pounds per square inch. Such a pressure to be quickly applied and released, the object being to relieve the spring of most of its set while under the testing machine, and thus insure ourselves against the annoyance of having the spring receive any permanent set when under the car.



NEW MACHINE FOR CLEANING FLUES.—TOPEKA SHOPS, ATCHISON, TOPEKA & SANTA FE RAILWAY.

NEW MACHINE FOR CLEANING FLUES.

Atchison, Topeka & Santa Fe Railway.

The flues are cleaned in a concrete pit built under the floor this road, was designed to clean a large number of flues at a time, clean them quickly and noiselessly and to reduce to the lowest terms the cost of handling in and out of the machine.

The flues are cleaned in a concrete pit built under the floor of the shop, the size being 4 ft. 8½ in. by 22 ft. by 6 ft. 8 in. deep. It is connected with the sewer and may be filled with water to any desired depth. Flues while being cleaned are suspended in the water by two specially wide-faced, case-hardened wrought-iron chains forming continuous loops, in which the flues roll over and over upon themselves as the chains are driven at a speed of 130 ft. per minute by the gearing overhead, to which a 20-horse-power series wound motor is connected. The motor is furnished with a suitable reversible controller and resistances. To keep the flues in position fenders are provided in the pit and are adjustable to flues from 8 to 20 ft. in length. The rear chain is supported by a traversing carriage which is moved toward or away from the front chain by screws driven by the main driving motor through a clutch. (This is clearly indicated in the drawing.) Thus the rear chain is adjusted to the length of flues. A small diagram shown in the line engraving illustrates the run of each chain and the method of raising and lowering the flues. The sprocket A is keyed to its shaft and drives the chain when the motor is started. The sprocket B is keyed to its shaft, which is independent of the shaft A, and receives its motion from the weight of the chain when it is in motion. If the chain moves in the direction of the arrow and the shaft B is prevented from moving by means of the powerful strap brake, the loop at C will be shortened into the position D. This will raise the flues out of the pit for loading upon a push car which may then be run under them. By this arrangement flues are lowered and raised by the machine itself, and independently of the crane service of the shop.

A lot of flues to be cleaned are brought over the pit on a push car; they are lifted from the car by the chains, the car is removed, the flues lowered into the pit and the machine is started. To place the flues in position to lower requires four minutes and the labor of enough men to push the car. To lower them ready for rolling requires one man one minute. For rattling the flues in this machine about the same time is required as in the barrel forms of rattlers, but this machine saves expense in handling them in and out and it will take from two or three times as many flues as an ordinary rattler. With this machine, the cost to handle flues at the rattler is less than 6 cents per 100 flues. The one in operation at Topeka cleans all of the flues at these shops in the hours from 7 a. m. to 6 p. m., whereas two old-style rattlers were running all day and often at night to keep up with the work, and this was before the capacity of the shops was increased.

To rattle flues when entirely submerged in water requires 28 amperes at 220 volts. When the water level is 14 in. below the top of the pile of flues 34 amperes at the same voltage or 10 electrical horse-power are required. To raise the flues out of the pit requires 68 amperes or 20 electrical horse-power. This machine rattles 200, 2¼-in. flues, 20 ft. long at a time and this requires a 20-h.p. motor.

These drawings and figures were supplied by Mr. Frank H. Adams, superintendent of shop construction of this road, who states that steps have been taken toward securing patent protection. It is understood that the plan was worked out by Mr. Adams and Mr. G. R. Henderson, when Mr. Henderson was superintendent of motive power of this road.

The Society of Engineers of Eastern New York was organized in Albany, April 21, with H. G. Hammett president and Prof. O. S. Landreth vice-president. After a short business session a lecture on aluminum-thermit was presented by Mr. E. Stutz. The idea of this organization was conceived at a meeting of the American Society of Mechanical Engineers at Saratoga, last summer.

NEW LOCOMOTIVE AND CAR SHOPS.

McKees Rocks, Pa.

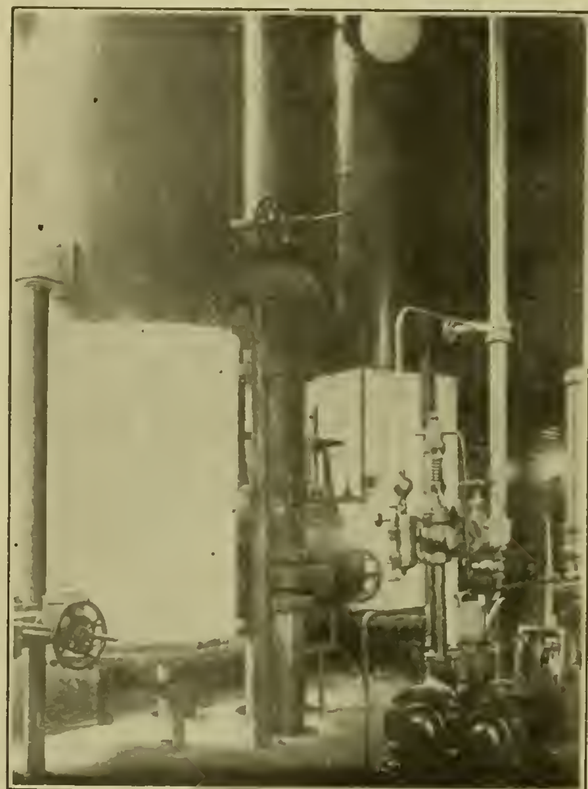
PITTSBURGH AND LAKE ERIE RAILROAD.

VI.

The Heating System.

An interesting and very important feature of the new repair shops installation at McKees Rocks is the system provided for heating the shop buildings. The particular system used here is worthy of special notice as it involves a departure from the usual methods of shop heating; in it is embodied fixed heating surfaces at the heating points in the buildings, the method of adjusting the shop temperatures being that of varying the temperature of the hot water at the power plant.

A description of this system is of particular interest at the present time on account of the very severe test that it was



VIEW OF THE WATER HEATERS AND PIPING CONNECTIONS IN THE BOILER ROOM OF THE POWER PLANT.

given during the past extremely cold winter. Inasmuch as the system was designed without the precedent of similar practice in heating buildings of the types used at these shops, there was necessarily some apprehension felt as to the successful working of all its many interesting features, but its entirely successful operation throughout has not only removed all doubt, but it has also served to give this system of heating a new and prominent place in questions of railroad shop design. The record of actual results in heating the buildings, which is presented herewith, is of special interest to those concerned with shop problems.

This system of heating embodies the essential features of the ordinary hot water system of heating, in which cast iron or pipe radiators are used in the rooms to be heated, to provide direct radiation. In this system, however, the circulation of the hot water is forced mechanically and made positive, and also the very novel method of adjusting the building temperatures by varying the temperature of the circulating water is resorted to. This permits of maintaining the amount of radiator heating surface constant at all times and places the entire control of the shop temperatures in the hands of an attendant in the power plant. The system has proven itself the most flexible and most complete arrangement for heating shop buildings that has ever been devised—it is successful because it places the responsibility and control systematically in the hands of one man, whose sole duty it is to look after and operate it.

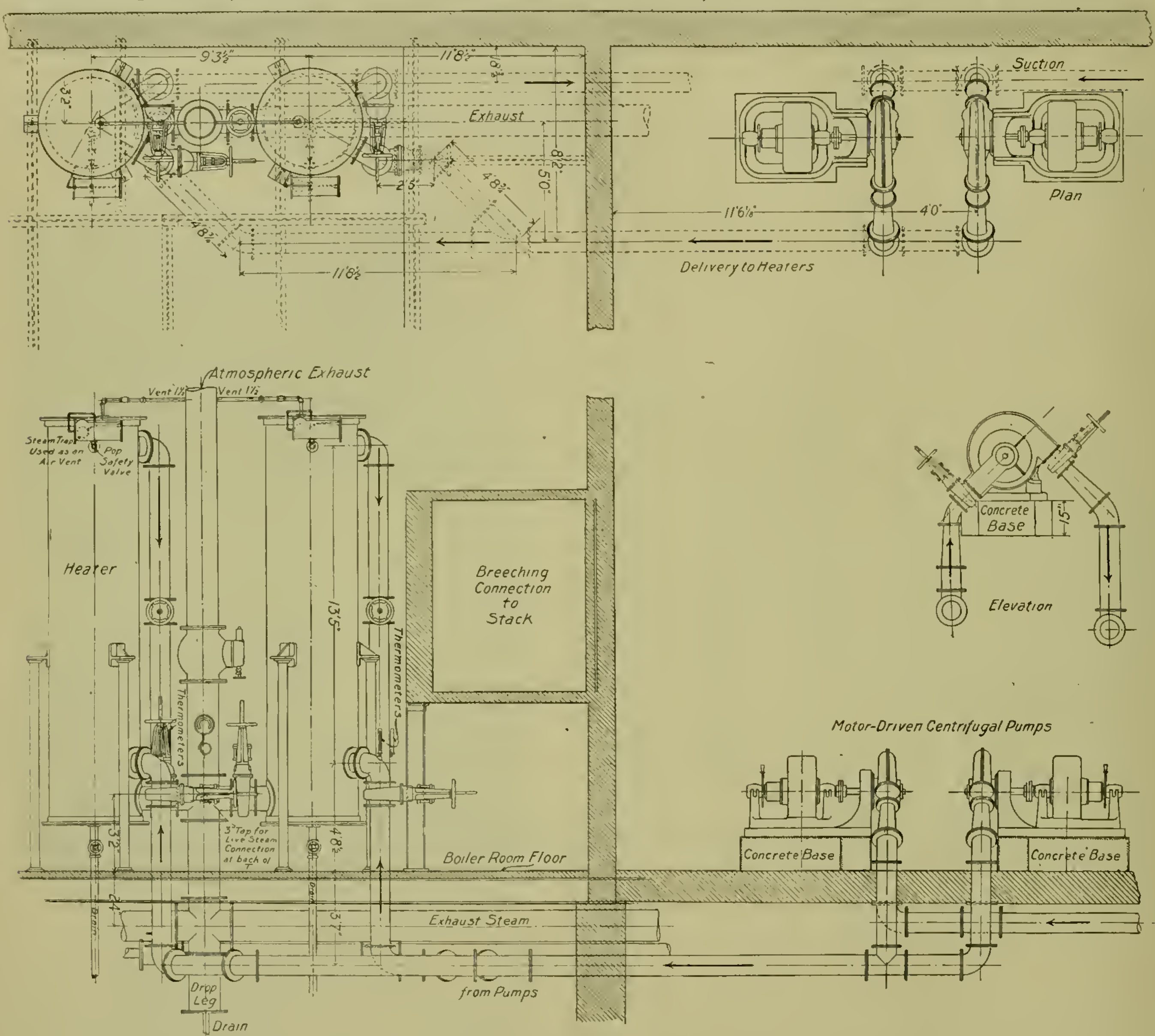
APPARATUS IN POWER PLANT.

The heating and varying of the temperature of the circulating water for the system is accomplished at the power plant, a very complete equipment having been installed for the purpose. There are two centrifugal circulating pumps, which are located in the engine room, as indicated in the accompanying engravings. These are 7-in. Morris centrifugal pumps of 1,500 gallons per minute capacity, and are each driven by a direct connected 35-h.p. Crocker-Wheeler motor. They are connected in multiple so that either or both may be coupled into the system, and entirely without interference with each other. They take their suction from the return side of the system, which leads the water back from the shop radiators, and force it through the hot water heaters and then out into the radiator system again. These connections for the pumps are clearly shown both in the pump detail drawing and in the heater piping drawing for the power plant.

The circulation water is heated and reheated in either one or both of two large vertical condensing water heaters of the closed-tube type, which in construction very closely resembles the closed-tube type of feed-water heater. Each heater contains 235 tubes, 16 ft. long, which give a total heating surface of 1,850 sq. ft. In these heaters the usual procedure is, however, reversed. The water to be heated surrounds the outside of the tubes and the steam is admitted inside of them. Trouble from scaling of the tube surfaces is not met, however, as the water used is not only chemically treated for removal of impurities, but is also used over and over again. Each heater is supported upon pipe struts, as shown in the photograph and drawing, thus making all parts and connections very accessible.

Steam is ordinarily supplied to these heaters from the exhaust mains, from which it enters and gives up its latent heat by condensing upon the cooler tube surfaces. The connections to the exhaust system from the engines, compressors, pumps, etc., are made at a cross in the atmospheric exhaust riser, just below the back pressure relief valve, as shown in the elevation drawing of the heaters. Under ordinary operating conditions and weather, sufficient heating will be available from a natural continuous condensation of the exhaust steam in the heaters, but a live steam connection, operated by a special automatic thermostat, is also provided to supplement the exhaust, if found necessary, or in emergency live steam may be used exclusively for this purpose. A 1½-in. pipe vent connection leads from the top of the steam space to the atmosphere and prevents the same from becoming "air-bound" and inoperative.

The circulation water enters the bottom of the water space in each heater and flows upward, the delivery to the heating



CROSS SECTION AND PART PLAN OF THE POWER HOUSE, SHOWING ARRANGEMENT OF CIRCULATING PUMPS, HEATERS AND PIPING FOR THE HEATING SYSTEM.

M'KEES ROCKS SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

system being taken from near the top. These connections, as well as the directions of flow, are clearly shown in the drawing of the power plant and of the heating system piping. It is also obvious that either one or both of the heaters may be connected or cut out of service by means of the valves and connections which are liberally supplied. In this way the service may be made most reliable. At times of ordinary operating conditions one of the heaters may be held as a reserve unit for repairs, etc., but in case of severe weather conditions it is perfectly feasible to operate both in parallel, electric lamps which is in such common use. The flow divides itself proportionately between each radiator unit and the heating effect is thus distributed proportionately to the flow.

The pipes, both delivery and return, leading out from the power plant, are 10-in. wrought iron pipes with flanged connections. They are carried to the various buildings through the piping and wiring tunnel, which was referred to in one of the previous articles of this series, descriptive of the erecting shop. The sizes of pipe used for the branches leading to the paint shop, boiler shop and other buildings vary, of course,

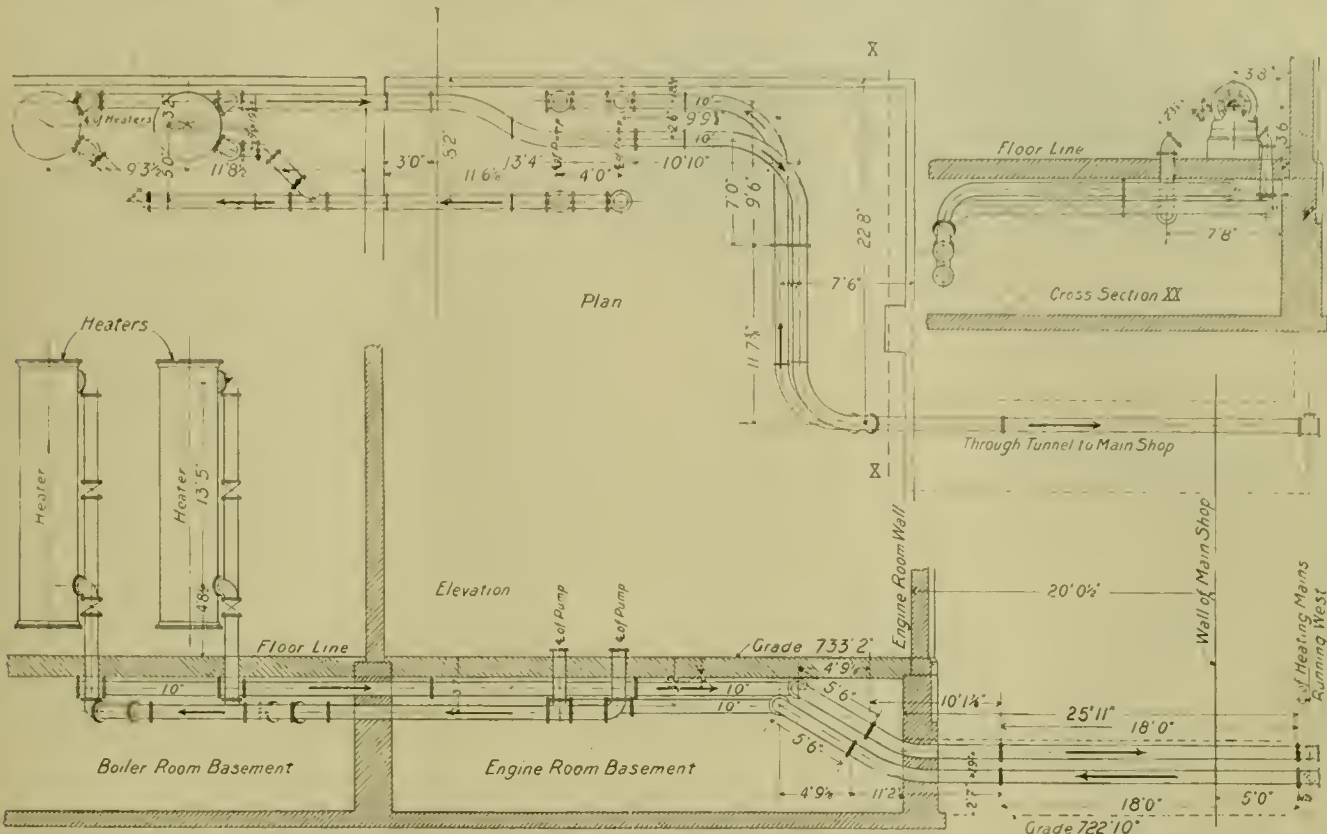


DIAGRAM OF PIPING ARRANGEMENT OF HEATING SYSTEM, SHOWING CONNECTIONS IN THE POWER PLANT, AND DIRECTIONS OF FLOW.

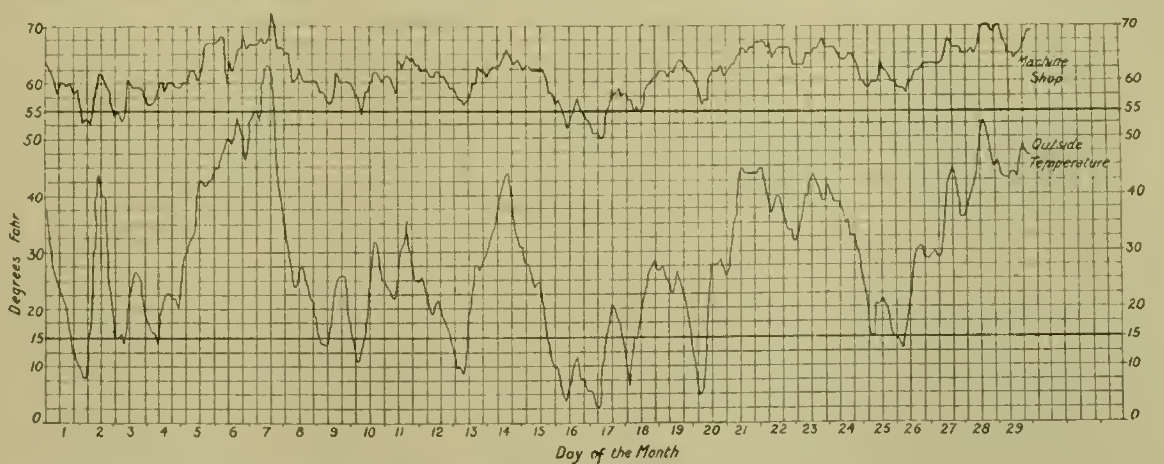


CHART SHOWING HEATING RESULTS PRODUCED DURING MONTH OF FEBRUARY, 1904. UPPER CURVE INDICATES SHOP TEMPERATURES, THE LOWER CURVE OUTSIDE TEMPERATURES.

and thus considerable excess of heating capacity is provided in the power plant equipment.

SHOP HEATING APPARATUS.

As previously stated, the return circulation from the heating system, extending through the shop buildings to supply the radiators, is drawn back to the power house and forced through the water heaters, to again raise its temperature to that required for heating, and then on out into the heating system again, making a closed circuit through the radiators. Thus the piping system consists merely of two mains, a delivery and a return, between which two every heating radiator is connected; and in this way it resembles in general principle the multiple-arc, or parallel, system of operating incandescent according to the service. This piping system was installed with great care to provide for expansion; swinging pipe supports of durable and effective designs, as shown in accompanying detail drawings, were used at all points of support. The arrangement of the entire system in the tunnel and in the ducts with removable covers makes the piping most accessible for inspection and repairs, which is thus possible without disturbance of the machinery, and entirely without interference to operations upon the shop floors.

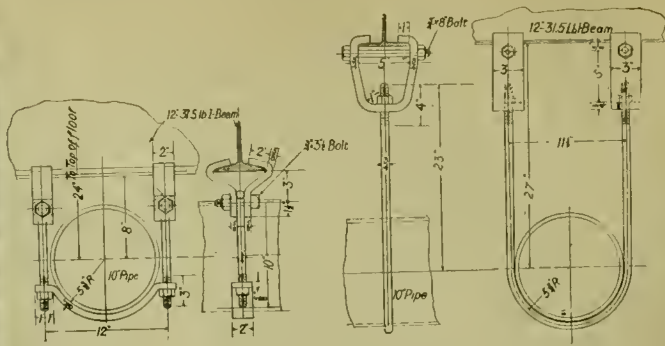
In the shop buildings the heat is transmitted to the air, in all cases, by means of radiators, of either the cast-iron sectional type or of the manifold pipe coil type; in the larger shops, namely the erecting and machine shop, the boiler shop and

VIEW OF THE HEATER AND BLAST FAN IN THE BOILER SHOP (TAKEN DURING PROCESS OF CONSTRUCTION), SHOWING METHOD OF MOUNTING HEATER COILS.

the paint shop buildings and the roundhouse, the convection method of heating is made use of—that is, blowers are used to distribute the heat in the usual way by forcing air over the hot water radiators, which heated air is delivered around the shops by hot air ducts. In the smaller buildings, however, direct radiation, without the fan blast, is depended upon; these buildings include the storehouse, the color shop, the office buildings, and all office and tool rooms, and the lavatories in the main shop buildings.

For the blower and hot blast systems of heating the radiators are mounted in stacks within a sheet metal casing, through which the air is drawn into the fan; in this way the construction does not differ materially from that used with similar hot-blast systems using steam for the heating medium. A special form of cast-iron radiator is used for this work, which is similar in construction to those used in house heating systems; these have the two important advantages of cheapness in first cost and a maximum durability. The arrangement of the radiator coils, as well as of the construction of the casing-framework, is well shown in the accompanying view, which we were fortunately enabled to obtain of the boiler shop heater while in process of constructiou. The total number of radiator coils used are arranged in eight groups, of fifteen each, each of which may be cut in or out by a suitable arrangement of valves outside the casting.

The fans distribute the hot air through the shops by ducts, overhead galvanized iron pipes being used in the boiler and paint shops, and masonry ducts beneath the floor in the machine and erecting shop; this latter system of delivering heat was illustrated and described fully on pages 454 457, of the December, 1903, issue, in connection with the description of the main shop building. In the latter installation the heating equipments, of which there are two, are located in separate fan room additions to the building at opposite corners, as shown in the ground plan.



DETAILS OF PIPE HANGERS USED FOR HEATING SYSTEM PIPES.

RESULTS.

Interest will naturally center in the results that have been obtained from the actual use of this system in heating the shop buildings during the past severe winter. The diagram on page 222 is a valuable record in this connection, as it illustrates graphically the remarkable performance of the heating system during the month of February of this year, having been prepared especially for this purpose from the regular series of readings of interior and exterior temperatures.

The lower curve of this chart was plotted to indicate the variation of the outdoor temperature continuously from day to day throughout the month; while the upper curve shows the range of temperatures recorded in the main shop building in similar manner continuously. These temperatures were ascertained and recorded hourly by the heating system attendants in the power plant, throughout the 24 hours of each day, and thus present a very close record of events. A careful inspection of the curves will show a remarkably good average temperature for the shops throughout this time, and indicates the possibilities of this method of controlling the building temperatures from a central point with direct reference to the outside temperature. The most notable feature of this diagram is the close resemblance which the upper curve bears to the lower in form; this indicates the dependency of the capacity of this or, in fact, any heating system upon outside weather conditions.

It should be here noted that the system was designed to maintain the temperature of the main shop at 55 degrees F., when the temperature of the outside air is as low as 15 degrees F. This diagram shows how uniformly the system has accomplished this, and even better, as in no case has the shop temperature fallen even as low as the guarantee. This comparison will be facilitated by the heavy horizontal guide lines upon the chart, the upper heavy line referring to the designed shop temperature of 55 degrees F., and the similar heavy line below indicating this chosen average winter temperature of 15 degrees F., upon which the design was based.

Great credit is reflected upon the engineering department of the road for the selection and installation of this interesting and efficient system. It was designed under the direction of Mr. A. R. Raymer, assistant chief engineer, the actual details of designing and construction having been carried out by Westinghouse, Church, Kerr & Co.

INCREASE IN NUMBER AND CAPACITY OF FREIGHT LOCOMOTIVES AND COST OF FUEL AND REPAIRS BY YEARS FROM 1897 TO 1903.

NORFOLK & WESTERN RAILWAY.

Year	No. of Frt. Engines in Use.	P. Ct. Increase.	Total Tractive Power.	P. Ct. Increase.	Average Tractive Power per Engine.	P. Ct. Increase.	Freight Ton Mileage.	P. Ct. Increase.	Freight Ton Mileage per Engine.	P. Ct. Increase.	Freight Ton Mileage per Lb. of Tractive Power.	P. Ct. Increase.	P. Ct. Decrease.	Freight Engine Mileage.	P. Ct. Increase.	P. Ct. Decrease.	Average Mileage per Eng.	P. Ct. Increase.	P. Ct. Decrease.
1897	316	....	6,928,932	....	21,927	....	1,949,450,487	....	6,169,147	....	281.35	....	...	7,753,183	....	....	24,535	....	....
1898	322	1.90	7,171,584	3.51	22,272	1.57	2,301,312,744	18.05	7,146,934	15.86	320.89	14.05	...	8.645,847	11.50	....	26,850	9.46	....
1899	337	4.66	7,959,940	11.00	23,620	6.05	2,456,096,895	6.74	7,288,121	1.97	308.55	....	3.85	8,836,731	2.21	....	26,224	....	2.35
1900	354	5.04	8,693,178	9.20	24,557	3.97	2,732,536,626	11.03	7,719,030	5.90	314.33	1.87	...	9,761,741	10.46	....	27,575	5.15	....
1901	367	3.67	9,508,603	9.37	25,909	5.50	2,864,370,760	4.79	7,804,825	1.11	301.23	....	4.16	8,521,931	....	12.69	23,220	....	15.76
1902	386	5.18	10,181,522	7.08	26,377	1.81	3,151,911,924	10.05	8,165,575	4.63	309.57	2.77	...	10,426,600	22.30	....	27,010	16.60	....
1903	433	12.09	12,411,945	21.90	28,665	8.70	3,639,684,856	15.45	8,405,738	2.94	293.24	....	5.23	12,023,637	15.30	....	27,768	2.48	....
1897 to 1903	...	37.00	....	79.10	.....	30.70	....	86.70	....	35.20	.....	4.23	...	....	55.00	....	.....	13.18	....

INCREASE IN CAPACITY OF LOCOMOTIVES.

Those who have not taken the trouble to compare figures showing the capacity of locomotives during the last few years will find the statement in the accompanying tables startlingly instructive. These tables are presented through the courtesy of Mr. W. H. Lewis, superintendent of motive power of the Norfolk & Western Railway. They indicate the advance which has been made upon that road in seven years. The story told in these figures should be impressed upon every railroad management as indicating the real problem of the motive power department.

The tables are arranged with footings, indicating the per cent. increase and decrease in the various items, and it is noteworthy that whereas the number of freight engines has increased in this period 37 per cent., the total tractive power has increased 79 per cent., and the average tractive power, per engine, has increased 30 per cent. Along with these developments freight ton mileage has increased 86 per cent.; ton mileage per engine, 35 per cent., and freight ton mileage per pound of tractive power, 4 per cent. With 37 per cent. more engines, freight engine mileage has increased 55 per cent., and the average mileage per engine, 13 per cent.

In the matter of fuel there has been an increase of 79 per cent. in the coal used by freight engines, and a decrease of 4 per cent. in the amount of coal used per ton mile. With all the increase in work done the average increased cost of repairs, in terms of 100 freight engine miles, has been but 2 per cent., and the repairs per 1,000-ton miles of freight has actually decreased 15 per cent. During this time the average tons per train has increased 5 per cent., and the average tons per engine 21 per cent.

This statement not only contains a fund of information, which is worthy of study from a commercial standpoint, but it constitutes a most admirable record for the motive power department, considering the fact that during these seven years so little has been added to the facilities for maintenance of these equipments as to amount to practically nothing. The force of these remarks would be appreciated if it were possible to indicate how comparatively little has been added to the shop and roundhouse facilities for the maintenance of the enormously increased equipment of large American railroads.

INCREASE IN NUMBER AND CAPACITY OF FREIGHT LOCOMOTIVES AND COST OF FUEL AND REPAIRS BY YEARS FROM 1897 TO 1903.

NORFOLK & WESTERN RAILWAY.

Year.	Total Coal Used by Freight Engines.	P. Ct. Increase.	Pounds of Coal Used per M. Ton Miles.	P. Ct. Increase.	P. Ct. Decrease.	Average Cost of Repairs per 100 Frt. Engine Miles.	P. Ct. Increase.	P. Ct. Decrease.	Frt. Engine Repairs per M. Ton Miles of Freight.	P. Ct. Increase.	P. Ct. Decrease.	Freight Train Mileage.	P. Ct. Increase.	P. Ct. Decrease.	Average Tons per Train.	P. Ct. Increase.	Average Tons per Engine.	P. Ct. Increase.	P. Ct. Decrease.
1896........	....	....	.....	...	...	7.89	....	....	...	....	....	....	....	...	.....	....	.....	....	...
1897........	1,192,568,532	....	611.84	...	...	6.41	....	....	.254	....	....	6,055,660	....	...	321.92	....	251.43	....	...
1898........	1,366,013,700	14.60	593.58	...	2.98	6.36	....	.78	.239	....	5.91	6,483,290	7.07	...	354.97	10.25	266.17	5.86	...
1899........	1,483,307,500	8.57	603.92	1.73	...	6.04	....	5.04	.217	....	9.28	6,392,973	....	1.39	383.87	8.17	277.96	4.42	...
1900........	1,540,123,500	3.84	563.63	...	6.66	6.05	.16	....	.216	....	.46	6,281,258	....	1.73	435.03	10.70	279.92	.72	...
1901........	1,590,626,900	3.28	555.31	...	1.47	6.82	12.72	....	.203	....	6.01	6,215,897	....	1.05	460.81	5.93	336.11	20.05	...
1902........	1,841,112,400	15.80	584.12	5.19	...	5.88	....	13.79	.182	....	10.35	6,625,432	6.60	...	475.73	3.24	322.95	....	3.90
1903........	2,132,954,500	15.90	586.02	.33	...	6.54	11.22	....	.216	18.68	....	7,484,929	13.00	...	486.00	2.16	302.71	....	6.25
1897 to 1903..	....	79.00	.....	...	4.09	...	2.03	....	...	....	14.96	....	23.60	...	.....	50.90	.....	21.00	...

FAST RUN ON THE MICHIGAN CENTRAL.

Through the courtesy of Mr. E. D. Bronner, superintendent of motive power of the Michigan Central Railroad, details of a fast run made by President Ledyard's special train, from Niagara Falls to Chicago, have been received. This train left Niagara Falls at 5:57 A. M., April 27, and ran over the Michigan Central to Chicago, a distance of 509.71 miles, in 9 hrs. 13 mins., an average speed of 55.31 miles per hour, not deducting stops or the delay of 20 mins. in ferrying across the river at Detroit. Deducting for stops and this delay the running speed averaged 60.87 miles per hour, which is one of the fastest runs for this distance which has been recorded. On the division in Canada, of 225.66 miles, the average speed, excluding stops, was 70.7 miles per hour. From Detroit to Jackson, 75.58 miles were made at 56.6 miles per hour, and from Jackson to Niles, 115.91 miles were made at 62.9 miles per hour, excluding stops in both cases. The remaining division, from Niles to Chicago, 92.62 miles were made at an average speed of 46.7 miles per hour, also excluding stops.

The train was hauled by Atlantic type engines all the way through: Engine No. 483, from Niagara Falls to Windsor, engine No. 263 from Detroit to Jackson, and engine No. 261 from Jackson to Chicago. These engines were all built at the Schenectady works of the American Locomotive Company, the first one in 1901, and the other two in the following year. On this run some remarkable bursts of speed were made, particularly on the Canadian division. As these speeds, however, are all given in even minutes and half minutes, and are taken from the dispatchers' train sheets, they are not sufficiently accurate to justify presentation as indicating the actual speeds. Two of these items record spurts of over 100 miles an hour.

Mr. H. D. Taylor, who recently resigned as superintendent of motive power of the Lehigh Valley Railroad, has been appointed superintendent of motive power of the Philadelphia & Reading Railway, with headquarters at Reading, Pa., to succeed Mr. S. F. Prince Jr., resigned.

Mr. H. B. Hunt and Mr. T. Rumney have been appointed assistant mechanical superintendents of the Erie Railroad, with headquarters at Meadville, Pa. Mr. Rumney is succeeded as master mechanic at Jersey City, N. J., by Mr. William Schlofge.

Mr. J. J. Thomas, Jr., has been appointed master mechanic of the Àtlantic Coast Line, with headquarters at South Rockey Mount, N. C., to succeed Mr. J. W. Oplinger, promoted.

Mr. W. A. Nettleton, who for a number of years was superintendent of motive power of the Kansas City, Fort Scott & Memphis Railroad, and afterward assistant superintendent of motive power of the Atchison, Topeka & Santa Fe, has been appointed general superintendent of motive power of the St. Louis & San Francisco system, with headquarters at St. Louis, Mo. Mr. Nettleton began railroad service as a rodman in the engineering department of the Kansas City, Fort Scott & Memphis, in 1885. About a year later he became connected with the Westinghouse Air Brake Company, and in 1887 returned to the Kansas City, Fort Scott & Memphis as air brake inspector. Later he became engineer of tests of that road, and in 1892 was made superintendent of terminals of the Kansas City, Fort Scott & Memphis Bridge Company at Memphis, Tenn. In August, 1893, he returned to the Kansas City, Fort Scott & Memphis, and in April, 1895, was appointed superintendent of motive power and machinery of that road. This position he held until January 30, 1901. In 1902 he was appointed assistant superintendent of motive power of the Atchison, Topeka & Santa Fe, which position he occupied for a short time. Until his recent appointment as general superintendent of motive power of the Frisco system he has been engaged in private business.

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EDITORIAL ANNOUNCEMENTS.

Advertisements. - *Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

Mr. C. W. Obert, who joined the staff of this journal as associate editor May 1, 1902, retires with the appearance of this number to become associate editor of the *Street Railway Journal*, of New York. His work, especially in connection with machine tools, powerhouses, shops and electrical equipment, has been greatly appreciated, and we wish him the best of success in his new undertaking. Mr. R. V. Wright, mechanical engineer of the Pittsburgh & Lake Erie Railway, joins our staff as associate editor. Mr. Wright comes to us after a thorough technical training and with a number of years of practical railroad experience in connection with locomotives, cars, machine tools and other shop equipment. He has been intimately associated with the design, construction and equipment of the new shops of the Pittsburgh & Lake Erie Railroad at McKees Rocks, Pa., and our readers are already familiar with a portion of his work on the machine tools of that plant through his articles in this journal. We know of no one as well qualified as Mr. Wright to fill this position.

No one can read the letters published in this issue from operating officers and presidents on the subject of big locomotives without clearly seeing how well modern locomotives have met the requirements of heavy traffic in spite of tendencies to overload them and in the absence of adequate facilities for maintaining them. Of course, it is not to be expected that anyone will admit that he has been overloading his locomotives, but it is interesting to see that the general opinion of these gentlemen favors loading lightly enough to maintain average speeds of fifteen or more miles per hour, instead of loading them so heavily that they can scarcely crawl. These letters throw an occasional side light upon the immediate necessity for bringing other road factors up to the big locomotives. The general inadequacy of side track facilities is admitted. Mr. Delano, in reference to lap sidings controlled by interlocking, touched on the question of the vital importance of keeping engines moving when on the road. What the Burlington has accomplished in this direction is worth studying. It is significant that Mr. Kendrick, of the Santa Fe, who has the biggest locomotive in the world, is most outspoken in praise of big engines. The closing remarks of his letter, concerning facilities for dealing with these engines, should be considered by every railroad management in the country. The letters generally indicate that if, instead of merely made bigger, locomotives were really improved in design as they increase in size, there would be fewer failures in spite of the greatly increased duty.

NEW SPECIFICATIONS FOR CAR WHEELS.

An exceedingly important contribution to the subject of car wheels is printed on another page of this issue, in the new proposed specifications presented by Dr. Dudley before the International Association for Testing Materials. These specifications are believed to embody the best information at present known on the subject. Chemical and drop test requirements are included, but the interest in the new specification centers in the part played in the manufacture of wheels by the heat treatment as finally indicated by the tape sizes of the wheels. The tape size permeates the whole specifications. These specifications provide that wheels shall be inspected in groups of three tape sizes and, as explained by Dr. Dudley in his comments upon the specifications, this is a much fairer method of examination than that whereby large numbers of wheels may be rejected unfairly by the old method. In these specifications each tape number will have either a drop or a thermal test. The thermal test is the most important test in this specification and that which tells the most about the wheels as it is designed to simulate conditions of long continued application of the brakes.

These specifications should receive immediate attention by the Master Car Builders' Association, and the fact that they did not originate with that organization should not prevent an immediate study of the subject in the hope of adopting requirements which will not only tend to improve cast iron wheels, but also be fairer than the present requirements to those who are developing the manufacturing side.

A BUSY DAY IN AMERICAN LOCOMOTIVES.

Within an interval of only a few days a group of locomotives has gone on to the rails in this country which constitutes what seems likely to be the most radical and promising improvement which has ever been brought out in the history of the American locomotive. Almost simultaneously the Pennsylvania road puts into service a De Glehn compound, the New York Central the new Cole balanced compound; the Chicago, Burlington & Quincy a Vauclain balanced compound, and the Baltimore & Ohio brings out its enormous freight locomotive of the Mallet type. Appearing at practically the same moment, this is strong medicine, but the patient seems to need it, and those who have watched the development of these types to this point are confident that the result will be a radical improvemen in locomotive practice. It is believed that the appearance of these four engines at the St. Louis World's Fair will in the future be looked upon as an epoch-making event.

The De Glehn compound stands as the most successful type of locomotive in the world, and has been accepted as such by the leading railways of France; this is shown by the fact that the locomotive men of that country have waived their own practice in its favor. The Cole balanced compound stands for an adaptation of many of the successful ideas of the De Glehn system, and the result, so far as it can be shown in trial runs, has surprised those who have been looking for a successful and powerful machine. The Vauclain balanced compound is the latest development of the builders of more compound locomotives than have been turned out by any other concern, and it has already been cordially accepted by other prominent roads. The Baltimore & Ohio, in its new Mallet pushing engine, while working in a somewhat different line, has taken an audacious step which seems likely to have equally important results in influencing freight locomotive design.

To properly assimilate this remarkable collection of designs, new to our practice, will require the utmost thought and ability of American railroad men. If these designs had come singly they would have been sufficient to indicate a desire to see the locomotive problem attacked scientifically, but to have these four come at once from different directions is very overwhelming proof that those have not been far wrong who have urged the importance of attacking the locomotive problem with a view of placing its development on a plane equal with those of recent years of stationary and marine practice.

These efforts all point in one general direction: that of permitting the use of weight at its best advantage and departing from the principle of developing along the line of increased size and weight alone.

It is unnecessary and in fact impossible to draw comparisons between the three systems for passenger locomotives, or to critically dissect that of the Mallet compound. This will be done through the St. Louis testing plant and road service. Whether or not one shows superior advantages over another is not the important point. Through the influence of these locomotives, practice is sure to take a new turn in the direction of more scientific design, and in addition to this a lesson will be learned which is more immediately important than even that of locomotive improvement.

These locomotives are sure to do more for their weight than any others have ever done. They take a long step in the direction of increased complication, and this means that the engines must be cared for; complication which brings no adequate return has no place in mechanical development, but complication which is incidental to such returns as these locomotives are sure to give will compel attention to running repairs and methods of operation, two factors of the locomotive situation which have been neglected in this country too long. Methods which are not adequate for the maintenance of ordinary simple locomotives must give place to those which are adequate, and while we are about it, why not take a little step in advance and build locomotives which will accomplish more than those in present service?

The opinions expressed in this issue by the best railroad operating men in the country indicate their feelings toward the question of overloading and caring for locomotives. Those who go at all under the surface of the locomotive problem today will agree to the following conclusions:

First. The American locomotive is worthy of more intelligent designing. *Second.* It is worthy of the care and maintenance which is necessary to keep it up to a fair approach to its maximum service capacity. *Third.* It is worthy of intelligent methods of operation which will enable it to do its work upon the road to the best advantage from a commercial standpoint. The skill and good judgment involved in these three principles will surely not now be lacking among men who have brought American railroads to their present high state, and when things and methods are outgrown they will surely turn to that which promises relief.

TIME TO SIT AND THINK.—"An economy which I think railroads overlook more often than private corporations is that of providing sufficient supervision of work. The majority of railroad men who are advanced to positions of responsibility have not sufficient time to sit down occasionally and take a deliberate survey of the general situation in their departments, and the result is that while they are driving away at matters which are urgent and to which they are absolutely obliged to give first attention, they overlook economies which might be effected if they had sufficient expert help to relieve them of some of the details which they now have to handle in person."—*M. K. Barnum, before the Western Railway Club.*

RAILWAY SHOPS.

BY R. H. SOULE.

XIV.

CONCLUSIONS.

The several subdivisions of the general subject which have been dealt with will be mentioned seriatim, in order that each may be commented on, and additional information (if any) introduced.

The Erecting Shop.—Table I in the original article gave 24 ft. 9 in. as the greatest spread (centre to centre) of tracks in the longitudinal shops there listed, but attention was called to the fact there had been a tendency towards progressive increase in that spread. Since that time several shops of 25 ft. track spread have been mapped out, and it is known that one road has at least considered a spread of 30 ft. (the building being 90 ft. wide) for the three main longitudinal tracks, intermediate dummy tracks being provided simply for use in wheeling and unwheeling engines. This arrangement would bring into permanent use for standing engines the entire length of each of the three main tracks, and would require only about 1,350 (30x45) sq. ft. of floor space per engine, as compared with the minimum of 1,300 sq. ft. given in Table IV for a transverse shop even under the most favorable conditions.

In the case of transverse shops it was stated that a width of 65 ft. between crane runway columns was sufficient, but this statement should be qualified. If in the design and arrangement of the erecting shop suitable and sufficient space has been reserved for engine truck repairs at one end of the building, but still under the main crane runway, so that engine trucks may be dropped into that space by the crane, then a span of 65 ft. between crane runway columns is quite sufficient; but if, as in some recent new shops, the whole floor space is given over to stalls in which engines are to be stood, it then becomes necessary to repair each engine truck on the track where its engine is standing, and under those circumstances a span of 65 ft. will be found too scant, and it should be increased to, say, 70 ft. In the evolution of the modern transverse shop from the old one there has been a tendency to reduce the width below a comfortable working limit, as by so doing the length and depth (and therefore the cost) of the over-head crane or cranes is kept down to a minimum, and similarly the height of the building up to the lower chord of the roof truss. In the case of the old-style transverse shop, with its cheap timber truss roof, always with minimum head room for any span, there was not the same incentive to curtail the span, and therefore those old shops are remembered as comfortably roomy.

The U. P. shops at Omaha, Neb., and the O. S. L. shops at Pocatello, Ida., afford an interesting comparison of erecting shops, the same cross section of building (combined erecting and machine shops) being used at both places, but the Omaha erecting shop is longitudinal, while that at Pocatello is transverse.

New longitudinal erecting shops have been put up by the Pennsylvania Lines to replace old transverse shops at Columbus, O., and Ft. Wayne, Ind.; in the latter the overhead cranes have a capacity of 75 tons each (with two auxiliary 10-ton hoists), a notable advance from the previous 65 ton-limit. Another valuable feature of the Ft. Wayne arrangement is that the wheel lathes and similar tools are located between the erecting and boiler shops under the sweep of the erecting shop cranes; this practice, originally introduced at the Juniata (Altoona) locomotive building shop, is being incorporated into the design of the latest Pennsylvania repair shops, as at Ft. Wayne and Wilmington, Del. Ft. Wayne also differs from Columbus in having longitudinal storage pits under the floor between tracks.

The new transverse erecting shop of the New York Central at West Albany has a span of nearly 70 ft. between crane runway posts and therefore has ample room for both an engine and its truck on each track, besides which there is an additional space of 20 ft. under a gallery, the building having a span of 90 ft. The crane arrangement is peculiar, as there are two 60-ton cranes instead of the more usual single 120-ton crane. When engines are being wheeled or unwheeled both are in requisition, and at other times each may work separately, giving double service and quicker movement. As far as known this is the first case where this arrangement has been adopted in a completely new transverse shop, although it had previously been resorted to (as at Bloomington, Ill., on the C. & A.) to make possible the introduction of overhead traveling cranes in an old shop where the head room was limited; with this arrangement, when the two cranes are lifting an engine only bottom yokes are required, and vertical space is saved.

The new double transverse shop of the Lehigh Valley at Sayre, Pa., will probably be put in use late this year and will attract a great deal of attention on account of its great size (48 stalls), the provision of covered yards, and the extension of the erecting shop and machine shop crane service into the boiler shop; it will also have a system of pits (in the covered yards) for the storage of engine strippings.

The new Moline, Ill., erecting shop of the C., R. I. & P. is unusual in many respects; it has a span of 95 ft., the unusually wide shop of the N. Y. C. at West Albany being 90 ft. as above mentioned. It has separate systems of pits for respectively stripping, repairing and wheeling engines, the first and last being longitudinal, while the repair pits (38 in number) are neither longitudinal nor transverse, but are of a sort between these two types and on the herring-bone plan. This arrangement constitutes a new type of erecting shop, and the output results will be a valuable guide to future practice.

The new plant of the Locomotive & Machine Co. of Montreal (now belonging to the American Locomotive Co.) has an erecting shop of the longitudinal type, and stands alone in this respect among American locomotive building shops which are engaged in manufacturing for the railways in general, although a similar shop is found at the Juniata (Altoona, Pa.) construction shop of the Pennsylvania.

At Jackson, Mich., on the M. C., is found both a transverse and a longitudinal erecting shop, in the form of a T, which are worked jointly as one shop.

The new Danville, Ill., shop of the C. & E. I. has a transverse erecting shop with both a heavy (80-ton) overhead crane and a transfer table, an unusual arrangement; in this case the overhead crane is used only for wheeling or unwheeling engines, or handling boilers, or any lighter work, the engines being moved in and out of their stalls over the transfer table. The shop has a span of about 74 ft. between crane runway posts, but a considerable portion of this is taken up by a fringe of heavy tools and a longitudinal track, so the actual working space in the width of the shop is reduced accordingly.

The Machine Shop.—It was stated that average conditions did not suggest the necessity of covering more than about one-third of the floor space with traveling crane service, but it is proper to state that some examples of very recent practice greatly exceed that limit; for instance, Sayre, Pa. (L. V.), 77 per cent., and Moline, Ill. (C., R. I. & P.), 54 per cent. On the other hand, in a large new shop which an Eastern line has under consideration this ratio is 40 per cent., while at Danville, Ill. (C. & E. I.), it is about 33 per cent.

Several complete tool lists have been published, and the data thus supplied, together with additional data which is probably forthcoming, will form a basis from which new lists may be compiled in the future.

The new St. Paul, Minn., shop of the Great Northern has no traveling crane service whatever, and as the roof trusses are inclined from the horizontal (lower chord included) the shafting is hung almost entirely from three lines of wooden posts.

The Moline machine shop tool layout at once attracts attention on account of the large proportion of tools which are placed transversely to the longitudinal axis of the shop; this is made possible by the individual drive and the group drive, as in the latter case a single transverse shaft can serve a considerable number of small tools. This arrangement often gives much better access (from the main longitudinal aisles) to individual tools than under the old system (before electric driving was introduced), when all tools had to be ranged in lines parallel to the main shaft.

The Sayre machine shop will be notable on account of its liberal proportions and its superb day lighting, as its entire floor area, together with the two adjacent covered yards, the whole forming a rectangle 240 ft. by 620 ft., is to be covered by a saw-tooth roof; tire shrinking floors and lye vats, with proper drainage features, are introduced at two central points. In very large plants it becomes burdensome to have to handle work of this character outside of shop buildings; at Sayre these lye vats being of ample size and coming under traveling cranes, it is to be expected that driving wheels on their axles can be treated as readily as smaller parts.

The Boiler Shop.—The capacity of a traveling crane for general floor use was assumed to be 35 tons, and that for a riveting tower crane 25 tons; recently, however, the American Locomotive Co. has finished the boiler for the new B. & O. Mallet articulated compound, and it is found to weigh completed with flues 42 tons, and without flues 28½ tons, which suggests a readjustment of crane capacities if such engines are to be reproduced in the future.

In the extended and re-arranged boiler shop of the Juniata (Altoona, Pa.) plant of the Pennsylvania the re-located 17-ft. stake hydraulic riveter is placed in a pit as before, with ram at a convenient height above floor level, but the old hydraulic crane has been replaced by an electric crane; the operator stands alongside of the riveter and with his left hand works the ram valve lever, his right hand being available for working the handles of three adjacent controllers (of the street car type) by which he can control the three movements (two horizontal and one vertical) of the tower crane to a nicety.

Sayre is almost the only transverse shop which has its boiler shop arranged as a prolongation of the erecting and machine shops with joint crane service throughout; this will give the Sayre boiler shop the use of two 120-ton cranes and six 15-ton cranes, and it will be unique, as regards crane facilities, among American railway repair plants.

Moline, a longitudinal shop, with erecting shop bay in the centre and machine and boiler shops on either side, divides its boiler and tank work, placing its riveter in one end of the erecting shop bay so as to get joint crane service between the two, and reserving the wing (which is served by an independent through track) for tank repairs, and work on the lighter attachments of boilers.

The new boiler shop of the C. & E. I., at Danville, Ill., has traveling cranes covering its entire floor surface; the main bay has a two-trolley 20-ton crane which would seem rather light for heavy boilers even now in use; the crane in the side bay, for light work, is of 3 tons capacity; the stalls are reached by the transfer table which is joint to erecting and boiler shops, the two being in separate buildings.

The Smith Shop.—It was stated that on account of the general use of swing cranes in smith shops it was advisable to provide head room (from floor to lower chord of roof truss) of at least 22 ft. and attention was called to the fact that Collinwood was 24 ft.; since then a tendency to increase this height has been noted, probably to secure better results in the way of clearing the shop of smoke, Moline being 25 ft. 6 ins. and Wilmington, Del. (P. R. R.), being made 33 ft. in imitation of Juniata; the new smith shop at Sayre is, however, 20 ft.

A fine example of smith shop roof construction, with horizonal bracing fully developed, is found in the case of the new Topeka, Kan., shop of the A., T. & S. F.; this feature is so often overlooked and neglected that this particular case is worthy of note (see illustration on page 378 of the American Engineer for October, 1903).

A very complete equipment of 14 oil furnaces of various sizes and for different purposes has been installed at Moline; the building is not fully occupied at present, as it is proportioned to take care of the work of both the locomotive shops and the car shops, the latter not yet having been built, however.

The Wilmington smith shop has very broad and very high windows, and a large proportion of doors; in this case the object was not so much to secure light as to make it possible to keep the shop comfortably cool in hot weather.

(*To be Concluded.*)

SPECIFICATIONS FOR CAR WHEELS.

By C. B. Dudley.

[These specifications were prepared for the American Society for Testing Materials. They contain exceedingly important improvements, which are explained by Dr. Dudley in extracts from his comments which follow the specifications.—Editor.]

The wheels furnished under these specifications must be made from the best materials, and in accordance with the best foundry methods. The following pattern analysis is given for information, as representing the chemistry of a good cast iron wheel. Successful wheels, varying in some of the constituents quite considerably from the figures given, may be made:

Total carbon	3.50 per cent.
Graphitic carbon	2.90 per cent.
Combined carbon	0.60 per cent.
Silicon	0.70 per cent.
Manganese	0.40 per cent.
Phosphorus	0.50 per cent.
Sulphur	0.08 per cent.

1. Wheels will be inspected and tested at the place of manufacture.

2. All wheels must conform in general design and in measurements to drawings, which will be furnished, and any departure from the standard drawing must be by special permission in writing, and manufacturers wishing to deviate from the standard dimensions must submit duplicate drawings showing the proposed changes, which must be approved.

3. The following table gives data as to weight and tests of various kinds of wheels for different kinds of cars and service:

Wheel.	33-in. Diameter Freight and Passenger Cars.			36-in. Diameter.	
Kind of Service.	60,000 Lbs. Capacity and Less.	70,000 Lbs. Capacity.	100,000 Lbs. Capacity.	Passenger Cars.	Locomotive Tenders.
Number	1	2	3	4	5
Weight, maximum	500 lbs.	650 lbs.	720 lbs.	705 lbs.	760 lbs.
Weight, minimum	560 lbs.	610 lbs.	670 lbs.	680 lbs.	720 lbs.
Height of drop (feet)	12	12	12	12	12
Number of blows	10	12	15	12	15

4. Each wheel must have plainly cast on the outside plate the name of the maker and place of manufacture. Each wheel must also have cast on the inside double plate the date of casting and a serial foundry number. The manufacturer must also provide for the guarantee mark, if so required by the contract. No wheel bearing a duplicate number, or a number which has once been passed upon, will be considered. Numbers of wheels once rejected will remain unfilled. No wheel bearing an indistinct number or date, or any evidence of an altered or defaced number, will be considered.

5. All wheels offered for inspection must have been measured with a standard tape measure and must have the shrinkage number stenciled in plain figures on the inside of the wheel. The standard tape measure must correspond in form and construction to the "Wheel Circumference Measure" established by the Master Car Builders' Association in 1900. The nomenclature of that measure need not, however, be followed, it being sufficient if the graduating marks indicating tape sizes are ¼ in. apart. Any convenient method of showing the shrinkage or stencil number may be employed. Experience shows that standard tape measures elongate a little with use, and it is essential to have them frequently compared and rectified. When ready for inspection, the wheels must be arranged in rows according to shrinkage numbers, all wheels of the same date being grouped together. Wheels bearing dates more than thirty days prior to the date of inspection will not be accepted for test, except by permission. For any single inspection and test only wheels having three consecutive shrinkage or stencil numbers will be considered. The manufacturer will, of course, decide what three shrinkage or stencil numbers he will submit in any given lot of 103 wheels offered, and the same three shrinkage or stencil numbers need not be offered each time.

6. The body of the wheels must be smooth and free from slag and blowholes, and the hubs must be solid. Wheels will not be rejected because of drawing around the center core. The tread and throat of the wheels must be smooth, free from deep and irregular wrinkles, slag, sand wash, chill cracks or swollen rims, and be free from any evidence of hollow rims, and the throat and thread must be practically free from sweat.

7. Wheels tested must show soft, clean, gray iron, free from defects, such as holes containing slag or dirt more than ¼ in. in diameter, or clusters of such holes, honeycombing of iron in the hub, white iron in the plates or hub, or clear white iron around the anchors of chaplets at a greater distance than ½ in. in any direction. The depth of the clear white iron must not exceed ⅞ in. at the throat and 1 in. at the middle of the tread, nor must it be less than ⅜ in. at the throat or any part of the tread. The blending of the white iron with the gray iron behind must be without any distinct line of demarcation, and the iron must not have a mottled appearance in any part of the wheel at a greater distance than 1⅝ in. from the tread or throat. The depth of chill will be determined by inspection of the three test wheels described below, all test wheels being broken for this purpose if necessary. If only one of the three test wheels falls in limits of chill, all the lot under test of the same shrinkage or stencil number will be rejected and the test will be regarded as finished so far as this lot of 103 wheels is concerned. The manufacturer may, however, offer the wheels of the other two shrinkage or stencil numbers, provided they are acceptable in other respects as constituents of another 103 wheels for a subsequent test. If two of the three test wheels fail in limits of chill, the wheels in the lot of 103 of the same shrinkage or stencil number as these two wheels will be rejected, and, as before, the test will be regarded as finished so far as this lot of 103 wheels is concerned. The manufacturer may, however, offer the wheels of the third shrinkage or stencil number, provided they are acceptable in other respects, as constituents of another 103 wheels for a subsequent test. If all three test wheels fail in limits of chill, of course the whole hundred will be rejected.

8. The manufacturer must notify when he is ready to ship not less than 100 wheels; must await the arrival of the inspector; must have a car, or cars, ready to be loaded with the wheels, and must furnish facilities and labor to enable the inspector to inspect, test, load and ship the wheels promptly. Wheels offered for inspection must not be covered with any substance which will hide defects.

9. A hundred or more wheels being ready for test, the inspector will make a list of the wheel numbers, at the same time examining each wheel for defects. Any wheels which fail to conform to specifications by reason of defects must be laid aside, and such wheels will not be accepted for shipment. As individual wheels are rejected, others of the proper shrinkage, or stencil number, may be offered to keep the number good.

10. The inspector will re-tape not less than 10 per cent. of the wheels offered for test, and if he finds any showing wrong tape marking, he will take the whole lot and require them to be restenciled, at the same time having the old stencil marks obliterated. He will weigh and make check measurements of at least 10 per cent. of the wheels offered for test, and if any of these wheels fail to conform to the specification, he will weigh and measure the whole lot, refusing to accept for shipment any wheels which fail in these respects.

11. Experience indicates that wheels with higher shrinkage or lower stencil numbers are more apt to fail on thermal test; more apt to fail on drop test, and more apt to exceed the maximum allowable chill than those with higher stencil or lower shrinkage numbers; while, on the other hand, wheels with higher stencil or lower shrinkage numbers are more apt to be deficient in chill. For each 103 wheels apparently acceptable, the inspector will select three wheels for test—one from each of the three shrinkage or stencil numbers offered. One of

these wheels chosen for this purpose by the inspector must be tested by drop test as follows: The wheel must be placed flange downward in an anvil block weighing not less than 1,700 pounds, set on rubble masonry 2 ft. deep and having three supports not more than 5 in. wide for the flange of the wheel to rest on. It must be struck centrally upon the hub by a weight of 140 pounds, falling from a height as shown in the accompanying table. The end of the falling weight must be flat, so as to strike fairly on the hub, and when by wear the bottom of the weight assumes a round or conical form, it must be replaced. The machine for making this test is shown on drawings which will be furnished. Should the wheels stand, without breaking in two or more pieces, the number of blows shown in the above table, the 100 wheels represented by it will be considered satisfactory as to this test. Should it fail, the whole hundred will be rejected.

12. The other two test wheels must be tested as follows: The wheels must be laid flange down in the sand, and a channelway 1½ in. in width at the center of the tread and 4 in. deep must be molded with green sand around the wheel. The clean tread of the wheel must form one side of this channelway, and the clean flange must form as much of the bottom as its width will cover. The channelway must then be filled to the top from one ladle with molten cast iron, which must be poured directly into the channelway without previous cooling or stirring, and this iron must be so hot, when poured that the ring which is formed when the metal is cold shall be solid or free from wrinkles or layers. Iron at this temperature will usually cut a hole at the point of impact with the flange. In order to avoid spitting during the pouring, the tread and inside of the flange during the thermal test should be covered with a coat of shellac; wheels which are wet or which have been exposed to snow or frost may be warmed sufficiently to dry them or remove the frost before testing, but under no circumstances must the thermal test be applied to a wheel that in any part feels warm to the hand. The time when pouring ceases must be noted, and two minutes later an examination of the wheel under test must be made. If the wheel is found broken in pieces, or if any crack in the plates extends through or into the tread, the test wheel will be regarded as having failed. If both wheels stand, the whole hundred will be accepted as to this test. If both fail, the whole hundred will be rejected. If one only of the thermal test wheels fails, all of the lot under test of the same shrinkage or stencil number will be rejected, and the test will be regarded as finished, so far as this lot of wheels is concerned. The manufacturer may, however, offer the wheels of the other two shrinkage or stencil numbers, provided they are acceptable in other respects, as constituents of another 103 wheels for a subsequent test.

13. All wheels which pass inspection and test will be regarded as accepted, and may be either shipped or stored for future shipment, as arranged. It is desired that shipments should be, as far as possible, in lots of 100 wheels. In all cases the inspector must witness the shipment, and he must give, in his report, the numbers of all wheels inspected and the disposition made of them.

14. Individual wheels will be considered to have failed and will not be accepted or further considered, which: 1st, do not conform to standard design and measurement; 2nd, are under or over weight; 3rd, have the physical defects described in Section 6.

15. Each 103 wheels submitted for test will be considered to have failed and will not be accepted or considered further, if: 1st, the test wheels do not conform to Section 7, especially as to limits of white iron in the throat and tread and around chaplets; 2nd, one of the test wheels does not stand the drop test as described in Section 11; 3rd, both of the two test wheels do not stand the thermal test as described in Section 12.

Comments by Dr. Dudley.

A good deal might be said in explanation of Section 5 concerning tape sizes. It will, perhaps, be sufficient to say that no foundry is able to make its total output all of the same circumferential size, and that experience has shown that there is an intimate relation in any good foundry between successful wheels and tape sizes. There are several reasons why the output of a foundry varies in diameter or circumferential measurement. First, although the moulds are supposed to be of the same size, yet, as a matter of fact, this is not the case. Moreover, a mould which has been used a number of times is apt to increase a little in diameter, and also to wear a little. This cause for variation in tape sizes is not a very serious matter, however, as efforts are usually made to keep the moulds fairly uniform in size. Another cause for variation is temperature of pouring. It will be readily understood that greater shrinkage is characteristic of metal cast at high temperatures. Furthermore, difference in chemical composition makes some difference in the shrinkage. However, the most important cause for variation in tape sizes is the effect of the annealing pit. It is well known that as fast as the wheels are taken out of the moulds, while they are still red hot, they are put in annealing pits, containing 15 wheels, or more. The annealing pits are made of metal tubes, lined with fire brick, the interstices between the pits being filled with sand, the object of the whole device being to allow the wheel to cool slowly. It is common practice to allow the wheels to remain in the pits four days. While in the pits certain changes take place in the metal, and it is well known that the usual effect of annealing is to increase the tape size of the wheel a little. Experiments have been made which indicate that a re-annealing—that is, putting a wheel into the pit a second time, between a number of freshly cast hot wheels—will increase the tape size up to sometimes two numbers. Furthermore, the wheels at the top and bottom of the pit do not increase the same as those in the middle of the pit. It is perhaps not necessary at this time to go into the changes which take place in the annealing pit further than to say that those wheels which come out of the pit nearest to the size which they had when put into the pit—or, what amounts to the same thing, those wheels which are less annealed—are found by experience to be most likely to fail on drop test, and also less likely to stand the thermal test. It will be seen, therefore, that there is a very intimate relation between tape sizes and successful output, and this will explain why so much reliance is placed on the tape sizes.

Section 7 has to do with the chill. As already explained, the tape number is an important element in the wheel, and in addition to strength and ability to stand thermal test, the chill, likewise, is a function of the tape number. The lowest tape numbers in any foundry will be apt to have the highest chill, and may fail on test from having too much chill, while the higher tape numbers, which mean the greater circumference, have the least chill, and may fail from having too little chill. The requirements of Section 7 in regard to rejections are based on a good deal of experience. It was formerly the custom to reject a whole 100 wheels if the test wheels failed from any cause. This was believed to be a hardship by the manufacturers, and in view of the intimate relation between tape sizes and successful wheels there has been introduced into these specifications, as is seen, authority only to reject out of each 100 wheels tested, the other wheels of the same tape number as the wheel which failed allowing the other tape numbers to come up again.

Taken as a whole, it is perhaps safe to say that for ordinary service, by which is meant for all service except under 40 and 50-ton freight cars, wheels which will pass the tests of these specifications will be safe and give fairly good results in service. There are some points in connection with the failure of wheels under heavy cars that need further study, and it is more probable that as this study progresses it may be found essential to change or modify some of the requirements of the specifications. The special failure of wheels under heavy cars is a circumferential crack either in the tread or in the throat of the wheel, resulting sometimes in the breaking off of the flanges. The causes leading up to this failure are complicated, and it is probable that modifications in the design of the cars themselves may very greatly diminish the number of failures of this kind.

NEW LOCOMOTIVE AND CAR SHOPS.

COLLINWOOD, OHIO.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

XIV.

THE WOOD MILL.

The preceding articles of this series have described the essential and interesting features of the yard layout plan and of the building construction used in the Collinwood car department repair shops. In this article will be discussed that important department of the car repair work, the wood mill. This wood mill is of particular interest to railroad shop men on account of the many new features and radical departures from existing practice that are involved: it represents an advanced stage of the art of arranging and operating wood-working tools that is unequaled in any other similar shop.

The location of the wood mill building was selected in accordance with the most approved practice in this line, and provides a very convenient arrangement for ease of handling both rough and finished work. As indicated in the layout plan of the car shops (see page 408 of the November, 1903, issue), this shop is located between the lumber storage department, including the dry kilns and dry lumber storage building, at the east end of the shop yard, and the points of lumber consumption, the car repair shops and freight car repair yard, on the other side. This results in a centralization of the work around this important focal point of the department, making it very convenient to prepare and deliver finished lumber to the repair jobs where it is needed.

This building is conveniently served by tracks, which give ready access for delivering rough lumber and also removing dressed and sized stock. As may be seen from the layout plan above referred to, two inside track connections, supplemented by two outside tracks lead to the eastward to the lumber yard, where access is provided by conveniently-arranged longitudinal tracks to the long lumber piles; in this way sills and other car timbers, as well as smaller stock, can be quickly delivered to the dry kilns or wood mill ready for milling. A track connection is also made with the dry lumber shed, in which the lumber is stored after being kiln-dried, until delivery to the wood mill is necessary.

The delivery of dressed lumber from the wood mill to points of consumption for repairs is made easy by its convenient location alongside the freight car repair yard and close to the freight and passenger car repair shop buildings. Track connections are liberally provided by the general transfer table arrangement, while the planking in the freight car repair yard permits of delivery to any part by trucks. The cabinet shop, which occupies the north end of the heavy freight repair shop building, has track connection with both the wood mill and the dry lumber shed for facility in receiving material.

Perhaps the most important feature of the wood mill is the arrangement of its machinery, which was worked out to provide easy combinations for handling the bulky and heavy pieces of stock. The arrangement was so designed that all work will progress naturally from the entering (east) end of the mill westward in the course of the milling operations. This may be studied by reference to the accompanying floor-plan drawing of this shop. All sills and heavy timber work is brought in on stub-track A, and is unloaded alongside the two 4-side timber sizers; after passing these machines the work is laid down naturally in front of the gainers and tenoning machine, which constitute the next following step. After passing the latter machines the work is next laid down, naturally, in front of the multiple-spindle vertical boring machine for the completing operation. This arrangement of handling heavy stock absolutely avoids the necessity of moving timber backward in the courses of its milling, all steps coming in a natural, progressive order through the shop.

Track B leads through the shop from end to end, as shown, it being intended to serve the various machines used in light lumber dressing. The arrangement of these machines is obviously less important than that necessary in the heavy section, but still it may be seen to be such as to bring the roughing machines first, such as the matchers, supplemented by the rip and cut-off saws, at the incoming end of the building, after which are to be found the finishing machines, such as the dado, boring and tenoning machies, band saws, etc., although their exact arrangement is here of less importance. The selections of tools used in this shop may be learned from the following tool list, which also includes those for the cabinet shop:

TOOL LIST.—CAR DEPARTMENT SHOPS.

WOOD MILL.

No.	Tool.	Builder.	Size of Motor.
321	Four-side timber planer	Fay & Egan	35 h.p.
322	Four-side timber planer	Amn. W. W. Mach. Co.	35 h.p.
323	"Lightning" matcher	Fay & Egan	25 h.p.
324	No. 27 matcher	S. A. Woods Machine Co.	35 h.p.
325	No 6 automatic cut-off saw	Greenlee Bros.	20 h.p.
326	No. 4 vertical end tenoner	Greenlee Bros.	15 h.p.
327	No. 4 rip saw	S. A. Woods Machine Co.	20 h.p.
328	No. 4 cut-off saw, automatic	Greenlee Bros.	15 h.p.
329	No. 8 vertical saw and gainer	Fay & Egan	20 h.p.
332	No. 3 automatic cut-off saw	Greenlee Bros.	15 h.p.
333	No. 3 rip saw	Greenlee Bros.	20 h.p.
334	Automatic saw and dado	Greenlee Bros.	15 h.p.
335	40-in. bevel band saw	Williamsport Mach. Co.	10 h.p.
336	42-in. band saw	Fay & Egan	7½ h.p.
337	H. C. horizontal mortiser	Fay & Egan	15 h.p.
338	No. 7 vertical mortiser and borer	Greenlee Bros.	15 h.p.
339	No. 3 gainer	Fay & Egan	15 h.p.
340	No. 70 tenoner	Fay & Egan	7½ h.p.
341	Four-spindle horiz. boring mach.	Greenlee Bros.	10 h.p.
342	Jointer	Fay & Egan	7½ h.p.
344	24-in. pony planer	S. A. Woods Machine Co.	10 h.p.
345	No. 3 gainer with 4-spin. borer	Greenlee Bros.	{ 10 h.p. 15 h.p.
346	Double-head shaper	Grosvenor	7½ h.p.
430	Automatic saw filer		
431	Automatic knife grinder		7½ h.p. (431–437)
432	Automatic saw grinder		
433	Band-saw filer		
437	Wood lathe	Fay & Egan	

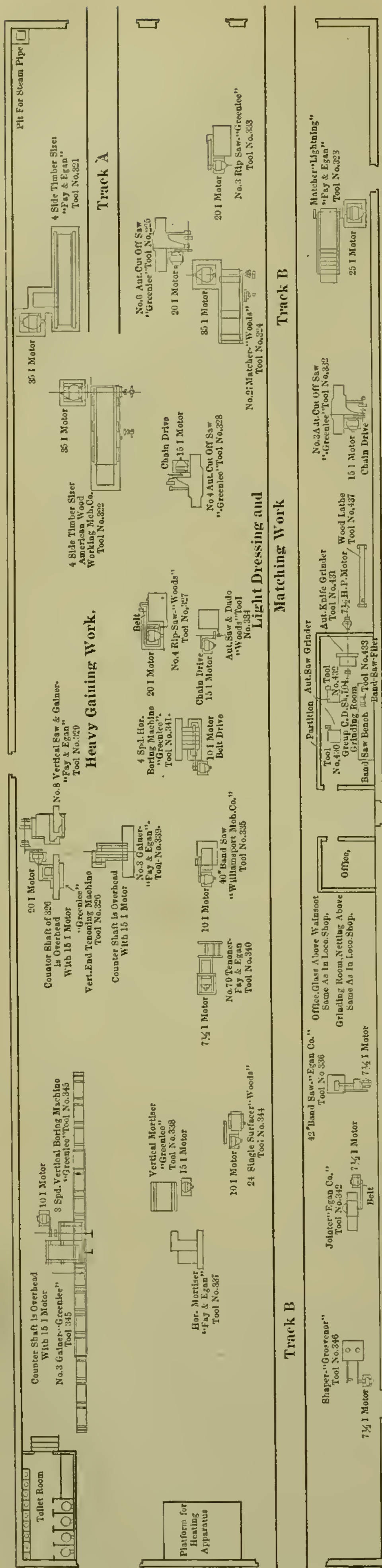
CABINET SHOP.

No.	Tool.	Builder.	
451	Sticker	R. & H.	Group-Driven (451–466)
452	Jointer	Clement	
453	42-in. band saw	Fay & Egan	
454	3½-in. tenoner	Fay & Egan	
455	No. 3 shaper	Clement	
456	7 x 24-in. surfacer	Whitney	
457	No. 6 scroll saw	Fay & Egan	
458	84-in. sander		
459	Wood-carving machine		
460	Wood lathe		
461	24-in. pattern lathe	Fay & Egan	
462	Universal saw bench	Amn. W. W. Mach Co.	
463	Sash mortiser	Greenlee Bros.	
464	Combination rip and cut-off saw	S. A. Woods Machine Co.	
466	No. 3 self-feed rip saw	Greenlee Bros.	

Some representative views are presented herewith of the machines with which this shop is equipped, which will also serve to indicate the general character of the arrangement of the mill. A noticeable feature of this shop is the absence of belting and countershafting, all the machines being individually driven by motors, with the exception of five tools at the south side of the shop, which are driven in a group; with the latter exception, however, scarcely a belt is to be seen in the entire building, making a very clean and light shop arrangement. The absence of belts and countershafting enables the full effect of the sky-lighting to be gained—an important factor in shop operation, which is highly conducive to the comfort and convenience of the workmen.

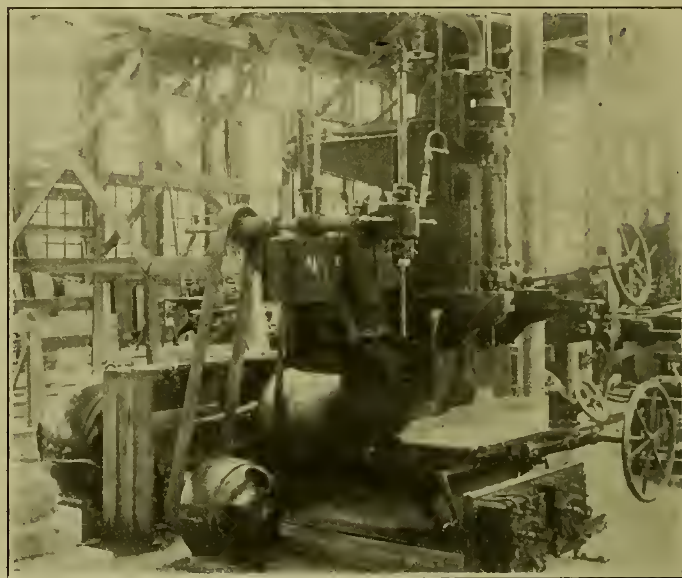
An important tool in this class of work is the hollow-chisel mortiser (tool No. 338), which is shown in the first view. This machine has a wide range of adjustments, providing for any mortising work that may be required for car repairs, and they are all easily and quickly controlled from the front. It has also a very convenient attachment in the form of a special boring spindle, mounted upon its left-hand side for ease of locating holes in work while mortising, thus avoiding the necessity of removal to a boring machine in many cases. This tool was built by Greenlee Bros. & Co., Chicago, Ill. It is driven through a Morse silent chain by a 15-H.P. Crocker-Wheeler constant speed motor, the special boring attachment being separately belt-driven by a similar motor of 5-H.P. capacity. A feature of its driving arrangement is the location of the two starting boxes for the motors, conveniently for the operator near the front of the table, so that the tool is thoroughly under his control.

The following engraving illustrates an interesting design of 4-spindle horizontal boring machine (tool No. 341) for boring car sills, beams and other heavy work. This machine, which

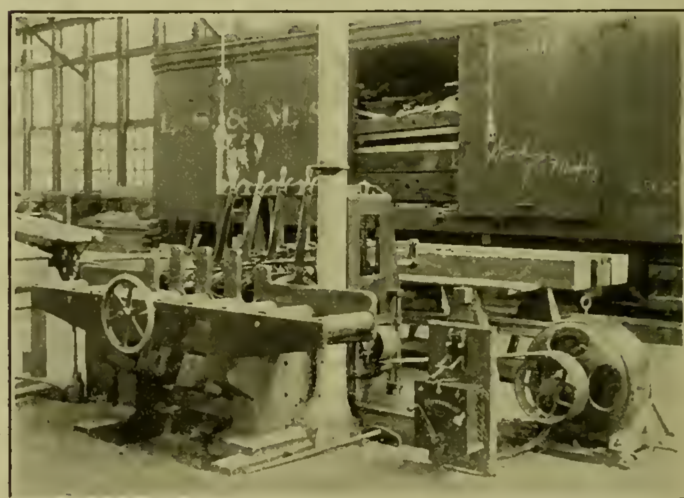


FLOOR PLAN OF THE WOOD MILL, SHOWING TRACK FACILITIES AND ARRANGEMENT OF MACHINERY.—COLLINGWOOD CAR SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILROAD.

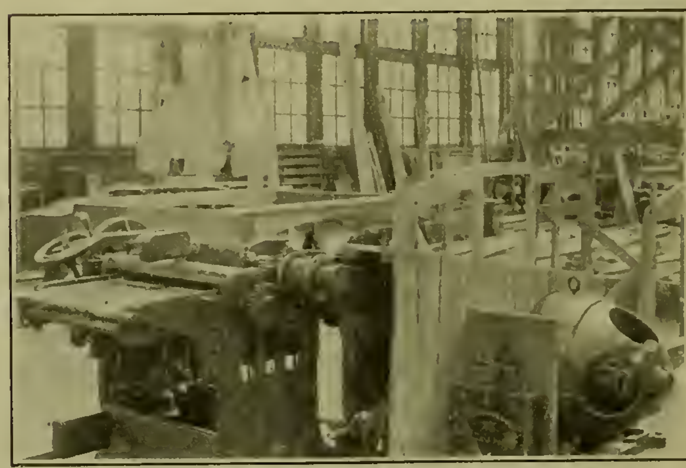
was also built by Greenlee Bros. & Co., Chicago, Ill., is specially arranged for ease of manipulation, and is rapid and accurate; the table is especially arranged for quick adjustments, and is very convenient. It is driven through belt connection by an individual motor (Crocker-Wheeler), mounted upon the floor at the right of the tool, which is of 10-H.-P. capacity, operating at constant speed. This would seem to be



GREENLEE HOLLOW CHISEL MORTISER, WITH BORING ATTACHMENT.—DRIVEN BY CROCKER-WHEELER CONSTANT-SPEED MOTORS.



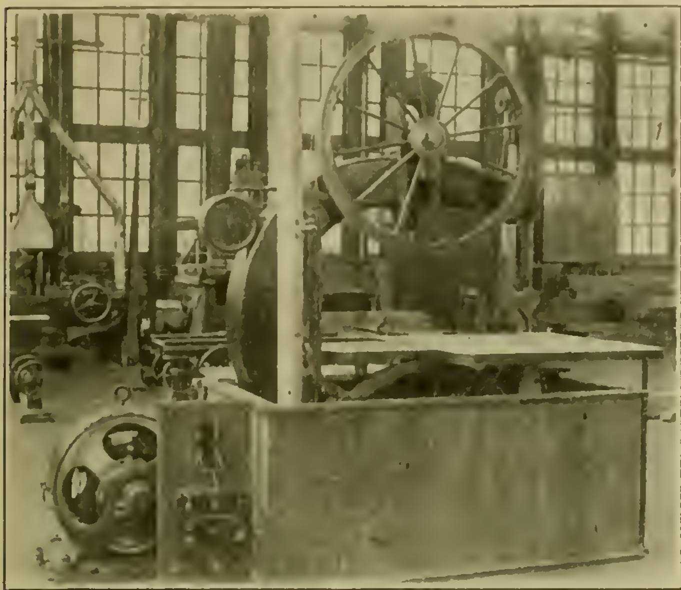
MOTOR-DRIVEN GREENLEE 4-SPINDLE HORIZONTAL BORING MACHINE.—10 H.-P. C.-W. MOTOR.



24-IN. SINGLE SURFACER.—S. A. WOODS MACHINE COMPANY.—DRIVEN BY A 10-H.-P. C.-W. MOTOR.

a rather large motor for a tool of this class, but it was intended to provide ample power for rapid and effective work.

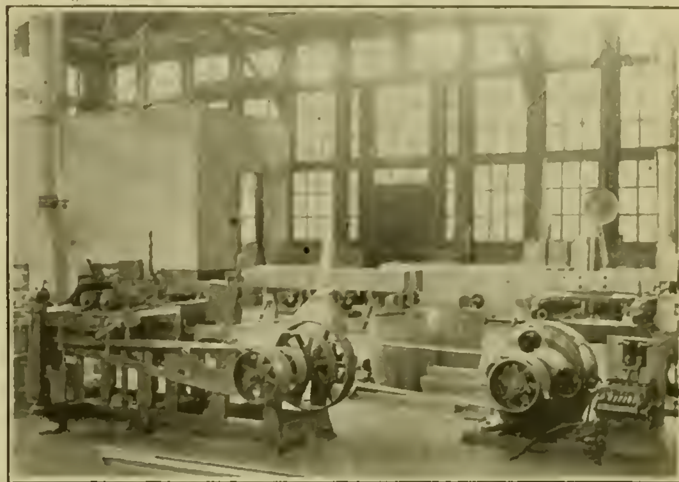
In another view is shown a 24-in. single surfacer (tool No. 344), that was installed for use in handling light stock and special classes of work. This tool is the well known surfacer built by the S. A. Woods Machine Company, Boston, Mass., which has many important advantages for mill work, principally its simplicity of construction and convenience of operation. It is, like the others, driven by a constant-speed motor (Crocker-Wheeler), which is here of 10-H.-P. capacity. A wooden belt-enclosure, or guard, is used at this tool to protect workmen from the belt on account of its proximity to the working space at the rear of the tool.



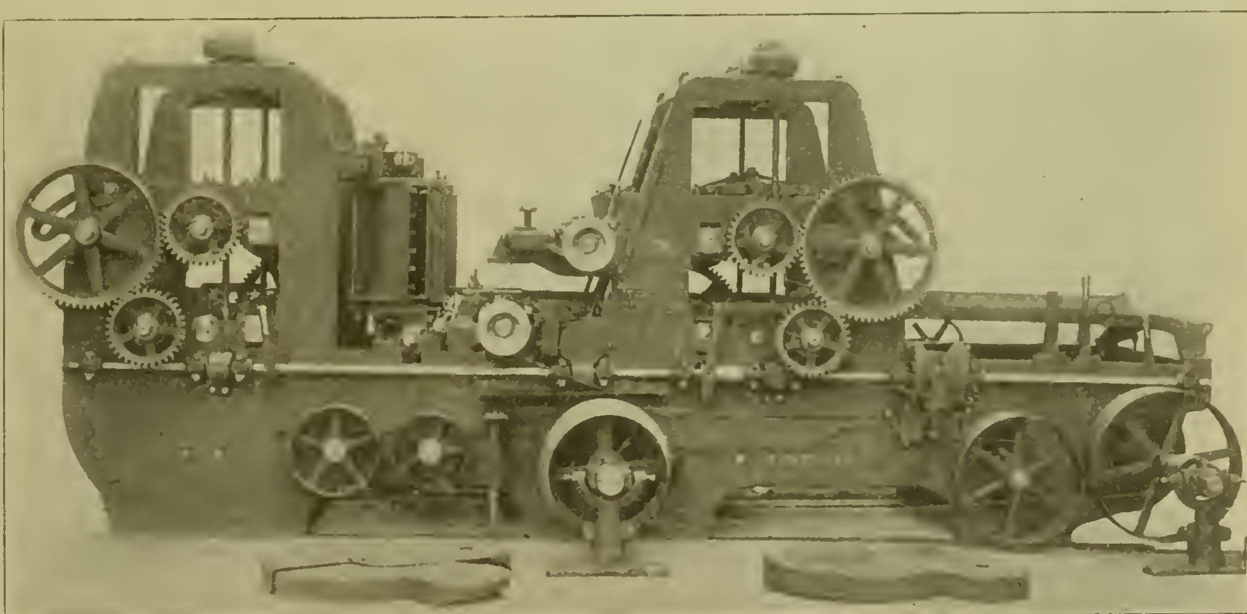
TYPICAL HAND SAW DRIVE.—10-H.P. C.-W. MOTOR BELTED TO DRIVE.

Crocker-Wheeler constant-speed motor, the motor being conveniently located at the rear, outside the fencing; the driving belt passes through an opening in the rear panel to the driving pulley of the machine.

The two following tools, which were supplied by the American Woodworking Machinery Company, New York, are of interest in their use at this shop on account of their strong and efficient, as well as convenient, design. They are, perhaps, the most interesting tools of the shop, as they involve unusual features in many ways. The 4-side sizer is the largest and most rapid machine of this type that is built by the American Woodworking Machinery Company, and is used here for heavy and rapid work in dressing sill stock. It has a capacity for work 30 x 16 ins. in size, and is adjustable for any combination of the four cutting heads; any one may be cut out of service, the side heads being easily swung out of the way, or replaced by matcher or other style of heads, while the top and bottom cutters are easily raised or lowered by power gearing. The various feeding and other adjustments are complete. This machine, as installed in the wood mill (tool No. 322), is direct-driven by a 35-H.-P. constant-speed motor (Crocker-Wheeler).



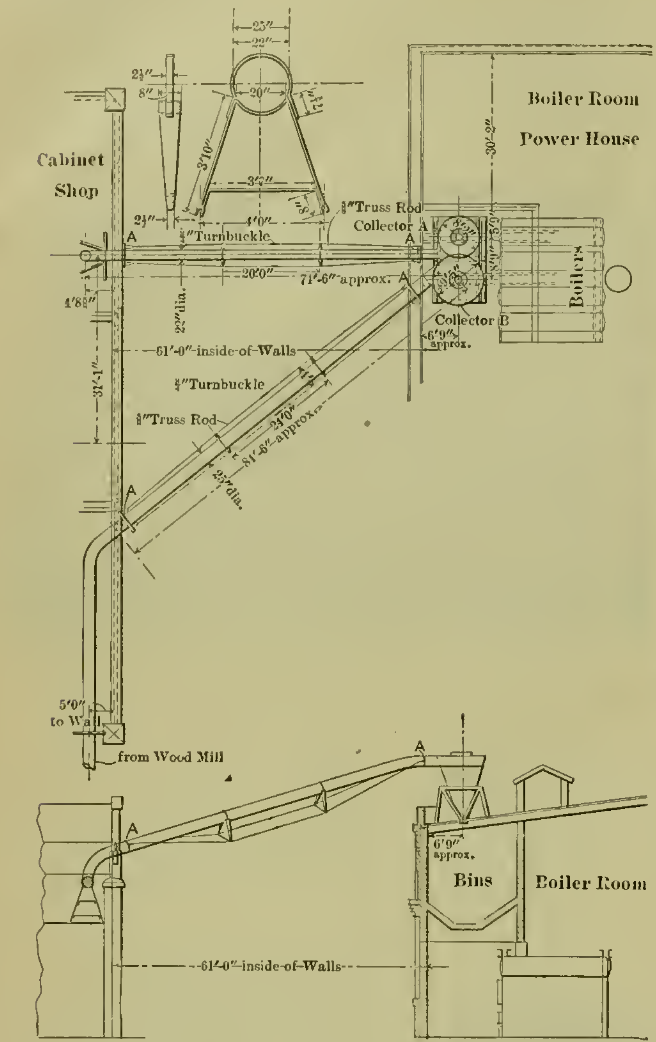
BELTED DRIVE FOR THE "AMERICAN" PLANER AND MOULDER (AMERICAN WOODWORKING MACHINERY CO.)—20-H.-P. C.-W. MOTOR.



A NEW DESIGN OF 4-SIDE SIZER IN USE AT THE COLLINWOOD MILL.—AMERICAN WOODWORKING MACHINERY CO.

A representative band-saw arrangement may be seen in the next view. The entire tool is fenced in for the protection and convenience of the workmen, which partition is not only of service in case of breakage of the saw, but also serves to retain the sawdust from the table for delivery to the collector-pipe opening, thus assisting in keeping the surrounding floor clean. This tool (No. 335), which was built by the Williamsport Machine Company branch of the American Woodworking Machinery Company, New York, is belt-driven by a 10-H.-P.

The remaining tool is the "American" planer and moulder, built by the well known Rowley & Hermance branch of the American Woodworking Machinery Company, at Williamsport, Pa. This tool, which is not shown located in the floor plan of the shop, is driven by a 20-H.-P. constant-speed Crocker-Wheeler motor, located at the right of the tool, at a distance which affords protection from dust and dirt. This tool is an unusually convenient machine to operate, as all adjustments, both vertical and horizontal, are controlled from a plate at the front side of the machine, convenient to the operator. It is also provided with numerous lever adjustments for quickly changing cutter pressures, starting and stopping the machine, etc.

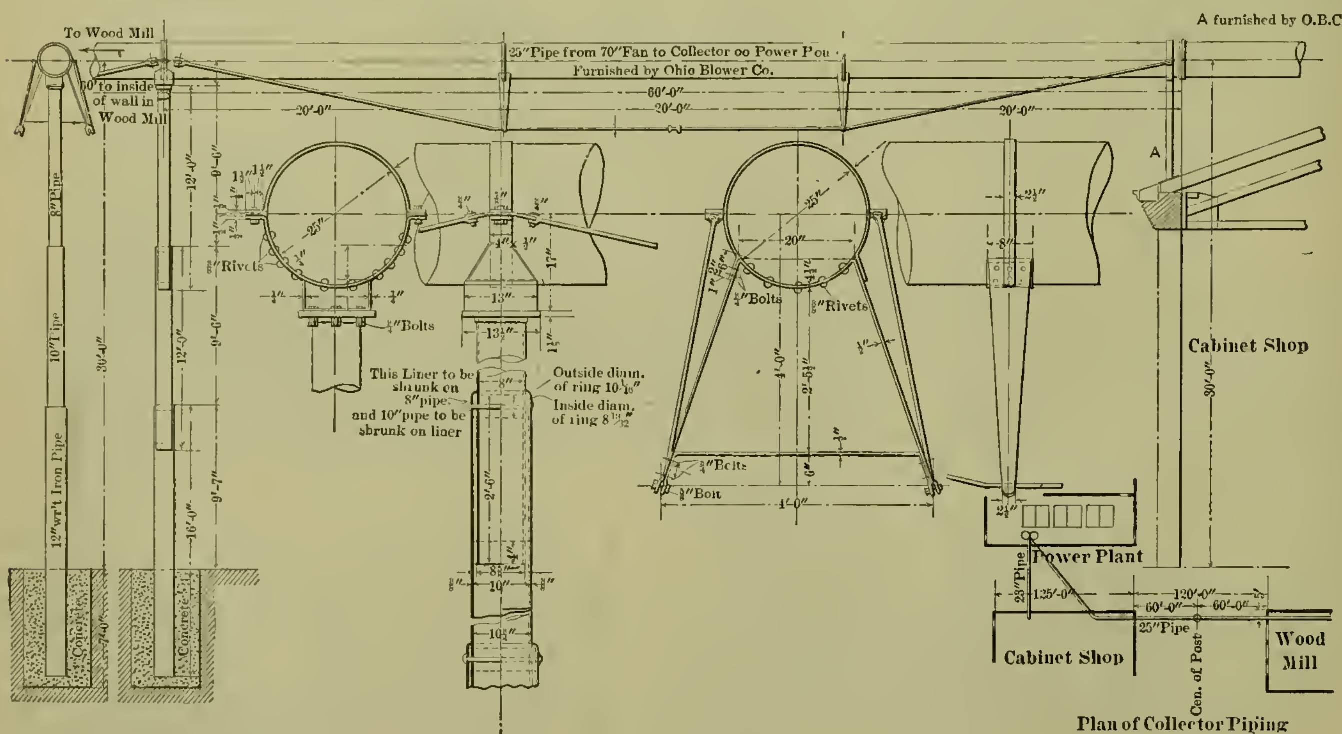


DETAILS OF THE EXHAUSTER-COLLECTOR SYSTEM FOR THE DELIVERY OF SHAVINGS TO THE POWER PLANT FOR FUEL.

A noticeable feature of all these motor-driven equipments is the neat and convenient arrangement of the main controlling switches and starting box for each motor upon a small, hardwood floor-stand at a point near the tool, which is

VIEW OF THE EXHAUSTER LEADS DELIVERING SHAVINGS FROM THE CABINET SHOP AND WOOD MILL TO THE BOILER ROOM STORAGE BINS.

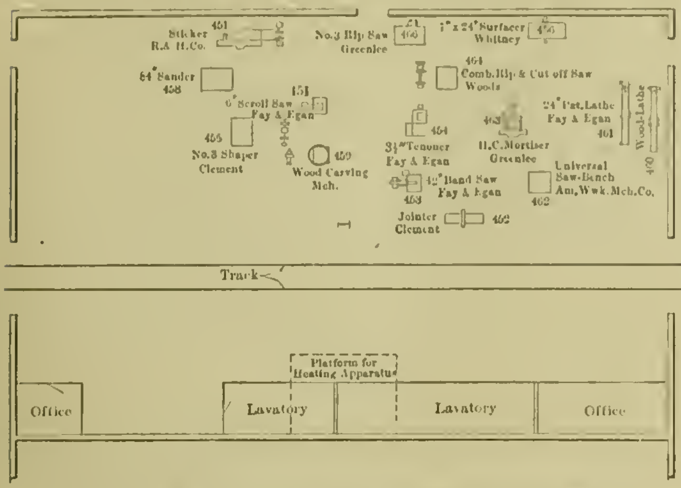
convenient for the operator. These motor-control equipments differ from those used in the main machine shop in that these are operated at constant speeds throughout, for which reason the 4-wire multi-voltage system is not required here. The distribution system is thus greatly simplified, requiring only a 2-wire system of wiring. This system is distributed through the shop from two panel boxes, one of which is shown in the view of the band saw (at the right upon the rear wall). A circuit-breaker in each branch circuit to the machines protects the motors from overloads, while the starting box at each motor is arranged to open the supply circuit in



DETAILS OF THE EXHAUSTER PIPING LEADS FOR THE DELIVERY OF SHAVINGS TO THE POWER PLANT, SHOWING SUPPORTING STRUT AND TRUSSING FOR OVERHEAD PIPE LINE.

case of no load from the current supply being in any way shut off.

An essential feature of the wood mill is the exhauster collector system, which is installed to remove sawdust from the machines and from the floor as it accumulates, and deliver it to the power plant for use as fuel under the boilers. Two



FLOOR PLAN OF CABINET SHOP, SHOWING ARRANGEMENT OF APPARATUS.

exhauster blowers are used, located inside the wood mill, upon wall brackets, from which suction pipes lead to hoods covering the cutters or saws of the various tools, so as to instantly draw in any chips or sawdust produced; floor sweep openings are also provided at the band saws, boring machines, etc., so that all shavings accumulating on the floor may be raked or swept to them, when they will be drawn away quickly by the suction. With the elaborate provision of a collector-opening at each machine an unusual opportunity is presented for maintaining a cleanly condition in the shop; the unusual advantages to the men resulting from a reduction of dust and the consequently lighter shop will surely make themselves known in the form of increased production. The effectiveness of this system is evident when it is learned that it removes quite large sticks and blocks of wood with the greatest facility.

The accompanying drawings present general details of the connections between the shavings collector at the mill and the storage bins in the boiler room of the power-house, where they are burned for fuel. From the discharge of the centrifugals on the wood mill roof, a 24-in. pipe connection is made, leading to the boiler room exhauster, which removes the shavings to the bins as fast as accumulated. The erection of the connecting pipe presented some difficulties, but these were worked out in the manner shown in the drawings; a special strut in the area between the wood mill and the cabinet shop was used to support the pipe, while from there to the boiler-room roof a truss frame is used. The photograph shows this construction clearly.

The cabinet shop equipment is very complete, as shown by the tool list. It is provided with the best and most efficient tools possible for the work, and is provided with a shavings collector system also, which removes sawdust, chips, etc., from the machines and delivers also into a connecting pipe leading over to the boiler room. On account of their usually smaller sizes these tools are not individually driven, but are group driven from two line shafts. The effect of overhead belts is not troublesome here on account of the light class of work handled, and also on account of the greater part of the work consisting of bench work. The accompanying photograph shows the interior of this shop.

Jacob N. Barr, assistant to the president of the Chicago, Milwaukee & St. Paul Railroad, died last month at his home in Libertyville, Ill. He was 52 years of age, and was one of the best known motive power officials in the country. He was a graduate of Lehigh University, and began his railroad career at the Pennsylvania shops, at Altoona. He went to the Chicago, Milwaukee & St. Paul in 1886, and was soon placed in charge of the motive power department. Subsequently, he had charge of the motive power department of the Baltimore & Ohio, and later of the Erie, and afterward returned to the Chicago, Milwaukee & St. Paul as general superintendent. He was one of the pioneers in the improvements made in chilled cast iron wheels, and was very active all through his career in developing and improving this part of railroad equipment. His death is a distinct loss to the railroads, and removes an able and intelligent man, whose life stood for uprightness and integrity. It is a loss to an unusually wide circle of friends who were endeared to him by unusual personal traits.

Mr. T. B. Purves, Jr., has resigned as superintendent of motive power of the Boston & Albany Railroad, and is succeeded by Mr. John Howard, formerly division superintendent of motive power of the New York Central & Hudson River Railroad. Mr. Howard is succeeded by Mr. C. H. Hogan, master mechanic of the New York Central at East Buffalo, and

VIEW IN THE CABINET SHOP, SHOWING SHAVINGS COLLECTOR CONNECTIONS.

Mr. Hogan is succeeded at East Buffalo by Mr. William Smith, heretofore master mechanic at Mott Haven, N. Y.

Mr. W. L. Davis has been appointed assistant master mechanic of the Buffalo Division of the Pennsylvania Railroad at Buffalo, N. Y.

Mr. E. H. McHenry, who recently resigned as chief engineer of the Canadian Pacific, and was for nineteen years connected with the Northern Pacific Railroad, has been appointed fourth vice-president of the New York, New Haven & Hartford, with headquarters at New Haven, Conn., where he will have charge of all new construction work.

Mr. W. S. Morris, who recently resigned as mechanical superintendent of the Erie Railroad, was surprised on May 16th by a delegation of his former subordinates, who presented him, as a token of esteem and affection, with a beautiful Turkish chair and a large hall clock. He had been but two years on the road, and in that time had endeared himself to his associates in a way which only men like Mr. Morris can do.

TRACK ARRANGEMENTS IN LOCOMOTIVE SHOPS.

BY C. A. SELEY.

The arrangement of the erecting department of railroad shops has been interesting in the various modifications used to accomplish the purpose of the shop which is to receive the engine, house it during the various operations in dismantling, repairing, erecting and testing. For large shops it is not feasible to use spur tracks for entrance to the pits, and transfer tables or overhead traveling cranes are used for placing the engines. Prior to the common use of cranes, the transfer table was frequently used, serving a transverse arrangement of pits, one of which was usually rigged with a drop table for removing drivers. This use of a pit cut it out from general use so that the engine capacity of the shop in pits should not include the drop pit. This arrangement generally provides certain pits for boiler and tender work and the machine and boiler shop machines are placed back of the engines with a longitudinal track and runway separating the departments. This is a general description of many railroad shops, some with and more without cranes over the engines. The Chicago, Great Western shops at Oelwein, Ia., present an interesting example of the transverse pit arrangement, served by a transfer table, with an overhead crane traversing the erecting shop and the heavy machine tools which has, no doubt, proved immensely valuable in dismantling and erecting work. An electric lift is also used for lifting engines to allow taking out and getting in wheels. This lift runs on the erecting crane runways and is towed to place as required. This arrangement makes every pit available as a working pit, but at times must limit the field of usefulness of the erecting crane. The new Great Northern shop, at St. Paul, is of the same general type, but with a different crane arrangement. Light, hand-operated cranes cover the front ends of engines and a locomotive jib crane back of the engines has a radius of action to carry it within reach of the cranes in front. While these cranes will greatly facilitate erecting operations it is not believed they possess the flexibility and speed of a full overhead crane arrangement. One pit is equipped as a drop table. The Lake Shore & Michigan Southern shops at Collinwood, the Philadelphia & Reading shops at Reading, Lehigh Valley shops at Sayre (under construction) and some others present a modification of the transverse track arrangement by omitting the outside transfer table, using instead a heavy overhead traveling crane with ways sufficiently high to traverse engines over one another. This requires the use of one space for entrance and exit. The usual winter troubles of an outside transfer table with snow and ice are avoided. These cranes are so heavy that they are not useful for comparatively light erecting operations, and lighter capacity cranes are installed for that purpose with separate runways on a lower level. The total investment for such an arrangement is large, as it includes the cost of a heavy crane, which is used only for transferring engines, and may make very few movements per day; also the cost of heavy steel work and walls of very considerable height and the cost of lighter capacity cranes, making this as costly an arrangement as can be put in. Available room and the arrangement of other shops may necessitate the plan just described in some localities, but that it is the best possible arrangement to be had for a given sum of money is a question.

Many roads have erecting shops with longitudinal tracks and pits, and in these one end is frequently used as the boiler shop. In these shops two cranes are necessary in handling engines, one at either end. The center track is generally used for dismantling and also for the wheeling and final erection work, and a pit is needed to facilitate these operations. The engines during repairs are placed on blocking on the side pits, sometimes in a straight line and sometimes on a slight angle, to allow engines to be placed closer together and yet provide room for flue work and cross communication. The pits in the straight three-track shops hinder cross communication unless a number of blanks and crossing planks are provided. Some have questioned the necessity for pits, but it is believed that they are necessary. Without them the engines have to be blocked higher to do the work under them, and this necessitates also blocking up the men to work outside. Many boilers are not removed and need washing out, which would involve transferring during repairs.

Close watching is necessary to prevent pits becoming the repository of junk, scrap and refuse, yet it can be done and the pits kept clean and properly drained with a good sewerage system. With these longitudinally arranged shops we find various modifications in regard to the location of the machine shop. The Norfolk & Western machine shop at Roanoke is a separate building, parallel with the erecting shop, with a number of connecting passages and truck tracks. At Fort Wayne, Ind., the P. R. R. machine shop is at a right angle to the erecting shop, and the runways of the machine shop crane extend within the erecting shop for convenient transfer of heavy articles. The "Santa Fe" at Topeka, the Central Railroad of New Jersey at Elizabethport, Philadelphia, Wilmington & Baltimore at Wilmington, and others, have the machine shop in the same building with tools on one or both sides of the erecting bay.

The designer of the Rock Island system shops at East Moline, Ill., has departed somewhat from all the above described arrangements. The erecting shop begins and ends like the last described shops, with longitudinally arranged pits for dismantling and final erecting work and with a center through track and passage way.

The pits for receiving engines during repairs are at an angle with the center track, or arranged "herringbone fashion" may express it more clearly. The angle of the pits should be such as would be made by an average length engine, hanging from the hooks of two cranes when the cranes are about to approach each other, the trolleys being moved meantime to accommodate the distance between the hooks. A little more skill is necessary in handling the crane for placing an engine in this manner than the straight lift and traversing in the other plans, but experience shows that this is easily attained. While this plan requires a rather daring width of space (95 ft.), advantages which accrue seem to justify the arrangement. Two cranes are used, and when not employed in transferring engines they are available for assistance in erecting, being speedy in traveling and traversing, and having an auxiliary drum and fast hoisting hook for light lifts. Practically 100 per cent. of the erecting shop is under service of these cranes, and if the future develops the need for them, additional cranes can be placed on the runways. Cross communication on the floor is greatly facilitated by the diagonal arrangement of the pits as compared with the straight longitudinal plan. The machine shop is on one side and the boiler and tank shop tools on the other, therefore the matter of cross communication is important. The center track has no pit, except at the ends of the shop beyond the end diagonal pits. The bays on either side of the erecting shop hay have runways, and cranes of various capacities are provided for the various operations carried on in the different sections of the shop.

The day lighting of the erecting shop, a matter of great importance, has been accomplished with a perfectly diffused light without shadows, contributing to the successful operation of what appears to be an ideal shop. The matter of cost is always interesting, and in many cases a vital question. In a building which includes more than one department of locomotive repair work it is not feasible to separate the costs of each, except in the proportion of the respective areas of each department, which does not give an altogether fair comparison.

At East Moline the erecting shop occupies 36 per cent. of the area covered by the one building, which includes also the machine, boiler and tank shops as well as a number of minor departments, such as copper, tin and sheet iron work, air brake, cab, pilot, tender frame and truck work. The cost of the entire building, at the present time the largest individual railroad shop building on record, is less than $1.40 per sq. ft. of area covered. This cost includes not only the walls, roof and floors, but also the crane runways for serving the erecting shop, 50 per cent. of the machine shop and 66 per cent. of the boiler and tank shop, fan houses, heating tunnels and engine pits, and shows a very economical construction.

MALLET ARTICULATED COMPOUND LOCOMOTIVE.

0—6—6—0 TYPE.

BALTIMORE & OHIO RAILROAD.

This locomotive, which will exert a tractive effort of 70,000 lbs. as a compound, and 85,000 lbs. in starting, as a simple engine, is entitled to the distinction of being the most powerful locomotive in the world. This locomotive is designed on the Mallet system, employing the Mellin system of compounding, which has been used so successfully in the Richmond compounds, built by the Richmond Works of the American Locomotive Company. It is intended for very heavy pushing service on mountain grades of the Baltimore & Ohio Railroad, and is the first locomotive of this type to be built for American service. The type has become very popular in Europe for heavy grades and sharp curves. The design merits special attention because in a very large locomotive the work is divided up among four crank pins and four separate valve gears.

The boiler of this remarkable locomotive was illustrated in this journal last month. Through the courtesy of Mr. J. E. Muhlfeld, general superintendent of motive power of the Baltimore & Ohio, and the American Locomotive Company, builders, a photograph, general drawings and additional information are now presented, and further description and illustrations will be presented later.

ARTICULATED COMPOUND LOCOMOTIVE.

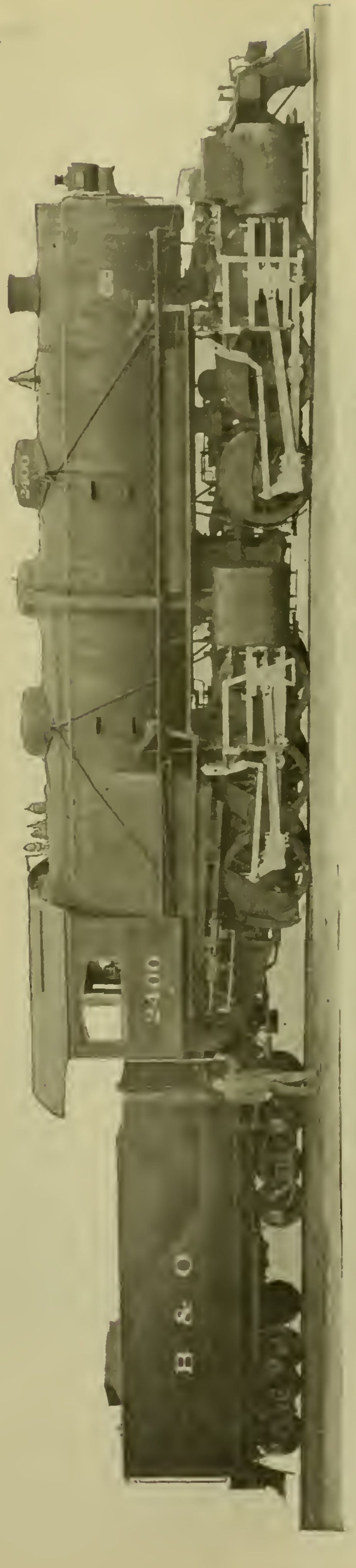
MALLET 0—6—6—0 TYPE.

RATIOS.

Heating surface to volume of high-pressure cylinders	471.6
Tractive weight to heating surface	59.89
Tractive weight to tractive effort	4.78
Heating surface to grate area	77.7
Tractive effort × diameter of drivers to heating surface	700
Tractive effort to heating surface	12.5
Heating surface to tube heating surface	1.4
Heating surface to firebox heating surface	25.4
Tube heating surface to grate area	74.5
Tube heating surface to firebox heating surface	24.4
Firebox heating surface to grate area	3.04

GENERAL DIMENSIONS.

Gauge	4 ft. 8½ ins.
Service	Heavy freight
Type	Mellin compound
Fuel	Run-of-mine bituminous
Cylinders, diameter	High-pressure, 20 ins.; low-pressure, 32 ins.
Cylinders, stroke	32 ins.
Driving wheels, number	12
Driving wheels, diameter over tires	56 ins.
Boiler pressure	235 lbs.
Weight on drivers	334,500
Weight, total	334,500
Weight, tender (with 13 tons coal and 7,000 gals. water)	143,000
Weight, total, of locomotive	477,500
Clearance, height	15 ft.
Clearance, width	10 ft. 6 ins.
Wheel base, rigid	10 ft.
Wheel base, total, of engine	30 ft. 8 ins.
Wheel base, total, of tender	20 ft. 2 ins.
Wheel base, total, of locomotive	64 ft. 7 ins.
Length of locomotive over all	80 ft.
Length from pilot to friction casting	51 ft. 5½ ins.
Height of center of boiler above rail	10 ft.
Main rods, length	9 ft. 7¼ ins.
Driving journals	9 x 13 ins.
Crankpins, main	6½ x 7 ins.
Crankpins, main side-rod	7¼ x 5 ins.
Crankpins, intermediate	5 x 4½ ins.
Crankpins, front	5 x 3¾ ins.
Pistons, thickness	High-pressure, 5⅞ ins.; low-pressure, 5¼ ins.
Piston-rods, diameter	3¾ ins.
Piston packing	Cast-iron rings
Piston-rod packing	U. S. metallic
Valve gear	Walschaert
Valves, kind, high-pressure	10-in. piston
Valves, kind, low-pressure	Double-ported slide
Valves, travel of	6 ins.
Valves, outside lap	High-pressure, 1⅛ ins.; low-pressure, 1 in.
Valves, inside clearance	High-pressure, ¼ in.; low-pressure, ¼ in.
Valves, lead of, in full gear	High-pressure, ⅛ in.; low-pressure, ⅛ in.
Steam ports	High-pressure, 1¾ x 23½ ins.; low-pressure, 2⅜ x 20 ins.
Exhaust ports	High-pressure, 1¾ x 23¼ ins.; low-pressure, 3 x 20 ins.
Bridges, width, low-pressure	1¼ ins.
Boiler, style	Straight top
Outside diameter first ring	84 ins.
Outside diameter largest ring	88 ins.
Outside diameter dome	31 ins.
Height over crown	22 ins.
Firebox, leng., 108 ins.; width, 96 ins.; depth, front, 80 ins.; back, 72 ins.	
Plates, sides, back, crown, tube sheets	⅜, ⅜, 7-16, ½ in.
Water space	Front, 6 ins.; sides and back, 5 ins.
Tubes..Thickness, No. 11; number, 436; diameter, 2¼ ins.; length, 21 ft.	
Heating surface:	
	Tubes, 5,366 sq. ft.; firebox, 219 sq. ft.; total, 5,585 sq. ft.
Grate area	72 sq. ft.
Tender—Weight loaded	143,000 lbs.
Capacity	Coal, 13 tons; water, 7,000 gals.
Construction	Steel frame
Trucks	B. & O. diamond



MALLET ARTICULATED COMPOUND LOCOMOTIVE.—BALTIMORE & OHIO RAILROAD.

J. E. MUHLFELD, *General Superintendent Motive Power.* AMERICAN LOCOMOTIVE COMPANY. SCHENECTADY WORKS, *Builders.*

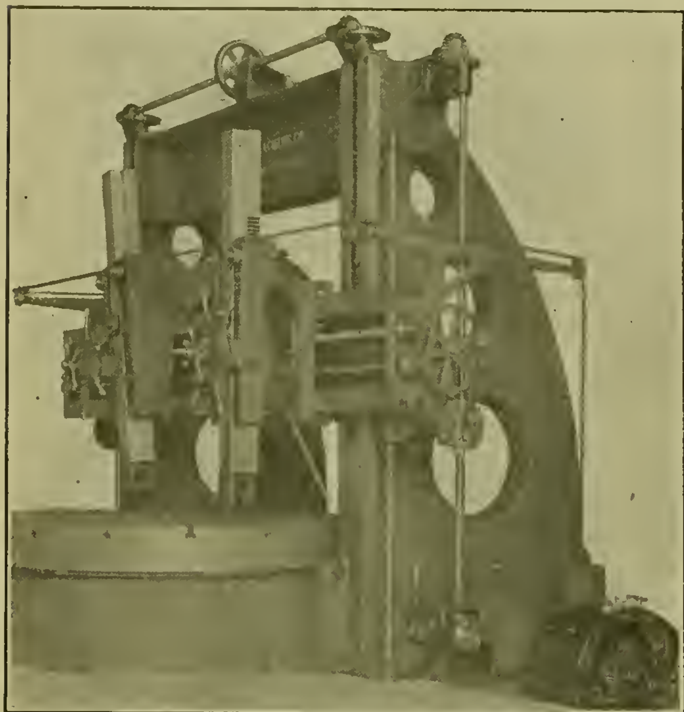
The Largest and Most Powerful Locomotive in the World.

(FOR ELEVATION AND SECTIONS OF THIS LOCOMOTIVE SEE PAGE 218.)

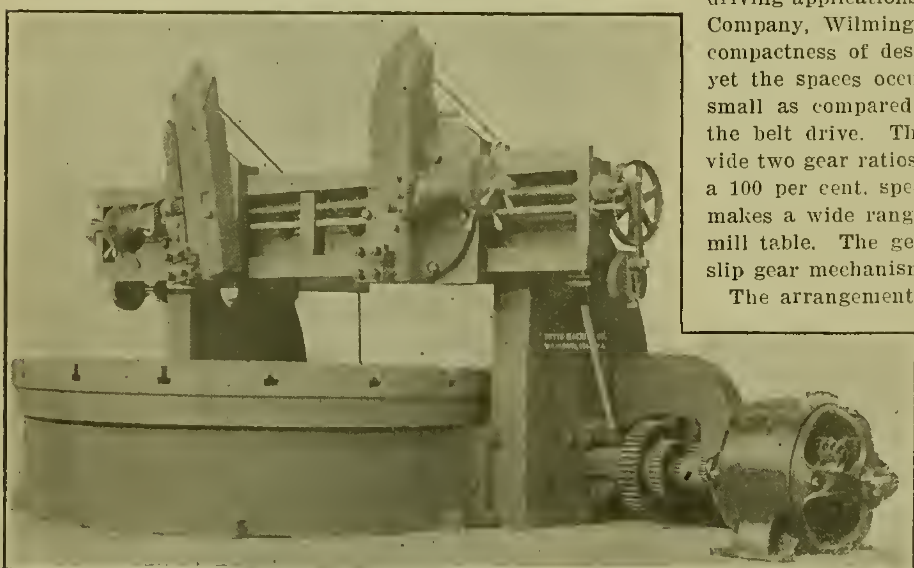
MOTOR-DRIVEN MACHINE TOOLS.

THE DEVELOPMENT OF METHODS OF INDIVIDUAL MOTOR-DRIVING FOR BORING MILLS.

There have been many important improvements and distinct advances made in the development of methods of electrically driving boring mills during the past year. The increasing importance of the boring mill as a machine tool for general shop work has caused as much thought to be devoted to methods of driving it as has been the case with the lathe. In fact, the boring mill is rivalled only by the lathe and milling machine in range and variety of work which may be brought upon it, so that refinements of speed variation offered by individual motor-driving are of as great advantage as upon the lathe. Especially in railroad repair shop work is the importance of advantageous driving arrangements for the boring mill coming to be recognized.

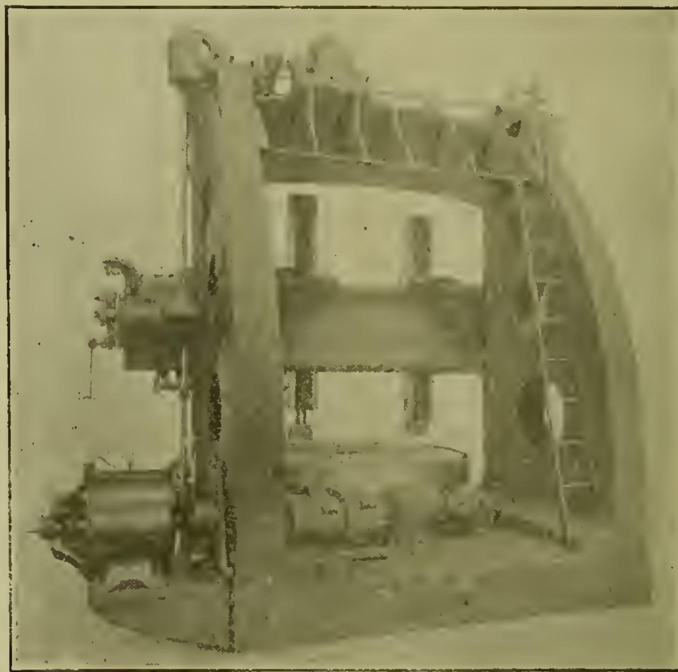


CHANGE GEAR MOTOR DRIVE UPON A LARGE BETTS BORING MILL.—VARIABLE-SPEED GENERAL ELECTRIC MOTOR.



COMPACT GEAR DRIVE UPON A LARGE SPECIAL BORING MILL.—BETTS MACHINE COMPANY.—VARIABLE-SPEED GENERAL ELECTRIC MOTOR.

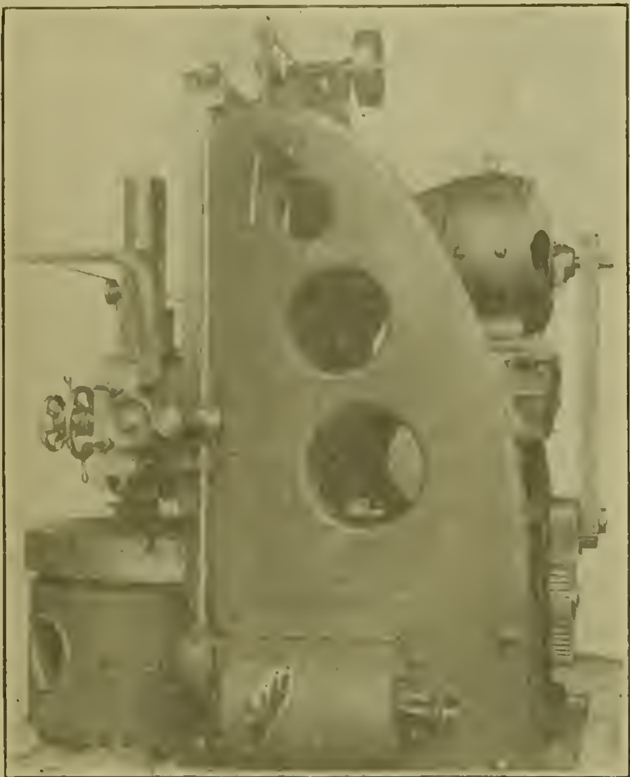
A year ago, in our June, 1903, issue, an article was presented illustrating some approved arrangements of motor-driving for use upon boring mills. In this article it is intended to indicate the lines along which progress has been made during the past year. It is of importance to note that there is a growing conviction among railroad repair shop men that variable speed driving for this class of tools is essential in obtaining the maximum efficiency and output from them. It is, of course, true that the constant speed drive is still much in evidence, with the entailed use of cone pulleys for variations of driving speed, but that this older method is being worked away from by the machine tool builders, may be seen by reference to the accompanying engravings.



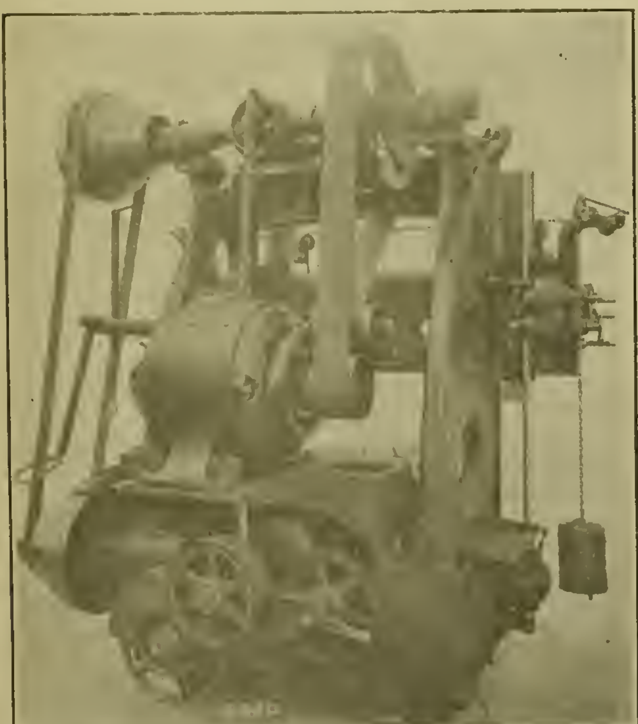
COMPACT ARRANGEMENT FOR A BULLOCK MULTIPLE-VOLTAGE SYSTEM VARIABLE-SPEED DRIVE UPON A 10-FT. BORING MILL.—BULLARD MACHINE TOOL COMPANY.

In the first two views are illustrated examples of motor-driving applications to boring mills built by the Betts Machine Company, Wilmington, Del., which are remarkable for their compactness of design. These are both very large tools, and yet the spaces occupied by the driving mechanisms are very small as compared with that which would be required with the belt drive. The driving mechanism is arranged to provide two gear ratios, in either of which cases, supplemented by a 100 per cent. speed variation at the motor by field control, makes a wide range of speed changes available at the boring mill table. The gear changes are, in this case, effected by a slip gear mechanism, which is easily handled by the operator. The arrangement of the motor is, in either case, here very easily taken care of, as it can be mounted upon the floor or above or below, in any way, so that its pinion will meet with the reducing gear. In one of these illustrations the motor may be seen arranged upon the floor level, while in the other it is below. The details of the drive of each of these two machines are identical. The motors are the well-known multi-polar direct current motors of the General Electric Company, Schenectady, N. Y., which operate at variable speeds by field control.

In the next illustration may be seen an important example of variable speed driving for the boring mill. This tool is the 10 ft. rapid-production boring mill, built by the Bullard Machine Tool Company, Bridgeport, Conn., equipped with their new variable speed gear drive box, which, in connection with the variable speeds made available at the motor, provides a wide range of gear changes for speed changes at the table. A wide range of speed changes is available at the motor by means of the multiple-voltage system, for which the motor is equipped. The motor used in this case is the type N four-voltage, variable-speed motor, built by the Bullock Electric Manufacturing Company, Cincinnati, Ohio.

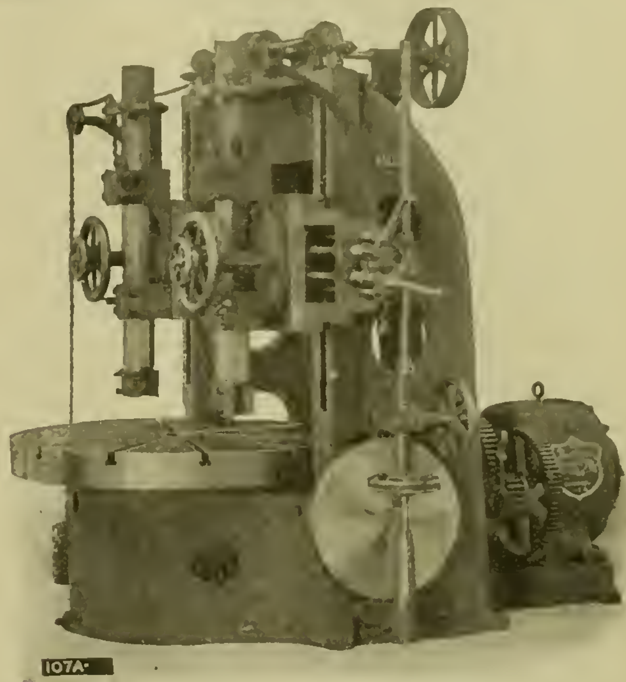


SPECIAL DESIGN OF MOTOR DRIVING EQUIPPED FOR THE M'KEES ROCKS SHOPS (P. & L. E. R. R.) BY THE BAUSH MACHINE TOOL COMPANY.—CROCKER-WHEELER MULTIPLE-VOLTAGE MOTOR EQUIPMENT.

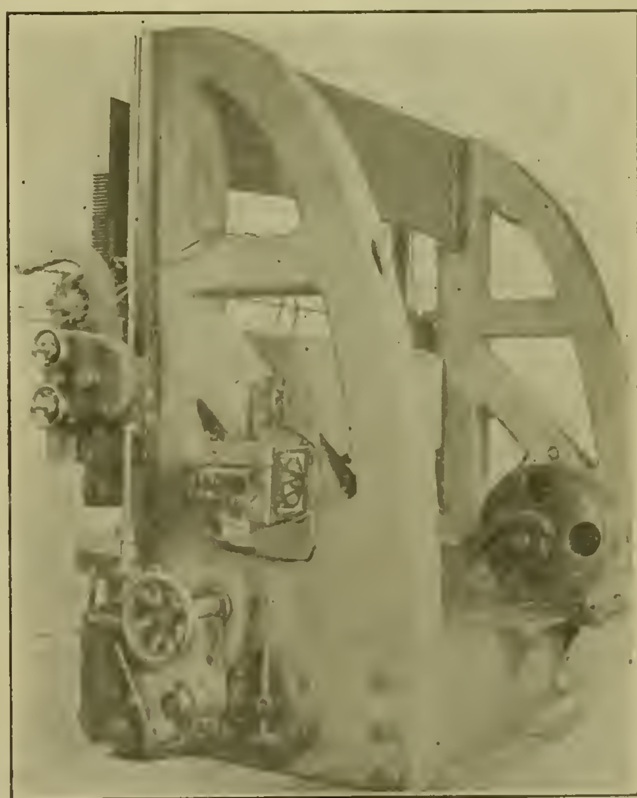


CONSTANT-SPEED DRIVE APPLIED TO A 51-INCH BULLARD BORING MILL.—GENERAL ELECTRIC MOTOR WITH BELT TIGHTENER.

The motor is, here, conveniently mounted for connection to the drive, upon a cast iron bracket at one side of the housing, from which location it drives direct through reduction gearing. Two changes of gear ratios are provided in the gear-box mechanism in the drive of the tool, which are easily controlled by levers near the motor. The effect of this combination is to make a driving arrangement of unusual convenience and compactness for the large size of this tool. It indeed requires less space than would be necessary for this purpose if belt-driving were used.



GEARED VARIABLE-SPEED DRIVE UPON A 51-INCH NILES BORING MILL.—BULLOCK MULTIPLE-VOLTAGE SYSTEM MOTOR.



CONSTANT-SPEED (CROCKER-WHEELER) MOTOR DRIVE UPON THE NEW DESIGN OF BORING MILL OF THE J. MORTON POOLE COMPANY.

In the following engraving is illustrated another interesting type of variable speed drive for the boring mill. This is the 51-in. boring mill, which was equipped especially for motor-driving by the Baush Machine Tool Company, Springfield, Mass., for the McKees Rocks Shops of the Pittsburg & Lake Erie Railroad. This drive embraces an interesting arrangement of the motor in its mounting upon a cross-bracket between the two housings at the rear of the tool; no more compact or advantageous arrangement could have been provided on account of both the directness of the drive and also the removal of the motor from the range of dirt and chips, which is usually found in floor mounting conditions.

The drive of this tool is through a special back gear, which provides two runs of speed, easily controlled from the side of the tool. Connection is made from the motor to the driving gear through a Morse silent chain. The driving-motor is a 15-h.p. Crocker-Wheeler multi-voltage variable speed motor.

In another illustration is shown the application of another multiple-voltage variable-speed drive to a Niles boring mill, in which a floor arrangement of motor is provided for. The motor is here direct connected to the drive by gearing, which has two runs for additional speed changes. The resulting arrangement thus effected is very compact and convenient. This motor is the type N multiple-voltage motor, built by the Bullock Electric Manufacturing Company, Cincinnati, Ohio.

The two remaining engravings illustrate representative types of constant speed drives, as applied to the boring mill. The first tool is the new mill of the J. Morton Poole Co., Wilmington, Del., which is equipped with a change gear mechanism in the drive for obtaining variable speeds, and makes it serviceable where variable speed motors are not to be had. Three changes of speed are available in this gearing by manipulation of a lever at the right side of the tool, thus offering a fair speed range, which can be met by the variable feeding speeds provided in the feed box.

The motor is mounted upon the bed of the tool at the rear between the housings, and drives through a silent chain. It is controlled by a starting box located conveniently upon the right housing for the operator. With this arrangement the motor is made most accessible for attention and care.

The other view illustrates one of the designs of constant speed drive that is used by the Bullard Machine Tool Company, Bridgeport, Conn., this arrangement being that applied to their 51-in. boring mill. The noticeable feature of this arrangement of driving is the convenient location of the motor upon the cross-bracket between housings at the rear. It is thereby raised up out of the dirt and dust that is inevitable near the floor. The drive is made by belt to a counter-shaft, conveniently located at the top of the housings, from which the drive to the lower shaft and back gearing of the table drive is made through cone pulleys and belt. The motor used in this case is the special type of direct-current motor of the General Electric Company arranged with belt tightener, which is used in the manner shown. This makes adjustments convenient and renders the arrangement very serviceable.

AIR BRAKE CONVENTION.

One of the most important reflections from the convention of the Air Brake Association, held at Buffalo last month, was the necessity for higher brake power for freight cars. It was proposed in a paper by R. H. Blackall that the brake power should be increased from 70 to 90 per cent. of the light weight of cars, and that a cylinder pressure of 60 lbs. for emergency application should be provided. The increased attention given to the handling of air brakes, together with the tendency toward the use of hard brake shoes, renders this change possible. An important paper by Mr. F. M. Nellis, secretary of the association, suggested that instead of arranging the braking power of passenger cars on a percentage basis that it should be based upon the dead weight carried per axle, because of the large variation of weight of passenger cars. When figured on a percentage basis the light cars in the train produce the greatest braking effect, in proportion to their weight, and are consequently likely to slide the wheels. Mr. Nellis supported his recommendation from the results of tests made on the New York, Ontario & Western Railroad, where, by arranging the braking as suggested, he reduced the sliding of the wheels and avoided the surging of the train by making each car do its share of the work of braking. The opinion that it is possible to increase train pressure of freight trains to 90 lbs. was generally supported at this convention.

COLE'S FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

This locomotive was illustrated on page 166 of our May issue. Additional engravings are now presented, together with the following description by the designer, Mr. F. J. Cole, mechanical engineer of the American Locomotive Company:

Owing to the satisfactory performance abroad of the four-cylinder balanced compound it seemed desirable to make a design embodying all the essential elements, but simplifying the construction to suit American requirements. With this in view the two cylinder single-expansion New York Central Atlantic was selected as the type which, without any radical changes in wheel base, boiler, etc., would be the most likely to give the best results. These engines possess many desirable features for heavy, high speed passenger service on roads of moderate grade. Their great steaming capacity, deep fire boxes, ample grate and fire box areas render them capable of sustaining high horse-power. Tests show that they have developed from 1,400 to 1,500 indicated horse-power for continuous effort.

The advantageous features of the four-cylinder balanced compound engines are:

(a) Balancing of reciprocating parts by similar horizontal moving parts. One outside piston and its attachments moving forward while the inside one is moving backward. These exactly balance one another without the use of unbalanced weights in the wheels.

(b) The increase of weight permissible on the driving wheels when considered dynamically. In the ordinary engine, at 60 miles per hour, with drivers 78 ins. in diameter, the increase or decrease at each revolution of the static weights on the rail is about 23 per cent. This is due to the centrifugal effect of the excess weights used to balance the reciprocating parts.

(c) Increase of from 25 per cent. to 33 per cent. in sustained horse-power at moderate and high speeds without any material change in size or style of boiler.

(d) Economy in the use of fuel, water and steam.

(e) The sub-division of power on two axles and four cylinders. Reduction of bending stresses on the crank axle due to the fact that only half the turning moment is transmitted through each axle. The advantages from light moving parts, such as cross-heads, main rods, piston rods, etc. The lightness of these parts permits them to be easily handled, and the probability is, as they have to transmit only half the usual amount of power, that the wear and repairs will be greatly decreased.

(f) Simplicity in design. One set of valve gear with comparatively few parts when compared with the foreign designs.

The boiler is identical with the present Atlantics, with the exception of 3 ins. increase in length of barrel, due to the extra amount of clearance required between the low-pressure cylinders and engine truck wheels. The high-pressure cylinders are placed ahead of the low-pressure cylinders with the guides and crossheads under the low-pressure cylinder saddle so as to obtain sufficient length of main rods. Otherwise the high-pressure rods would be abnormally short in comparison with the low pressure, which would result in too great angularity of the rods, excessive strains in the guides and crossheads and unsatisfactory distribution of steam.

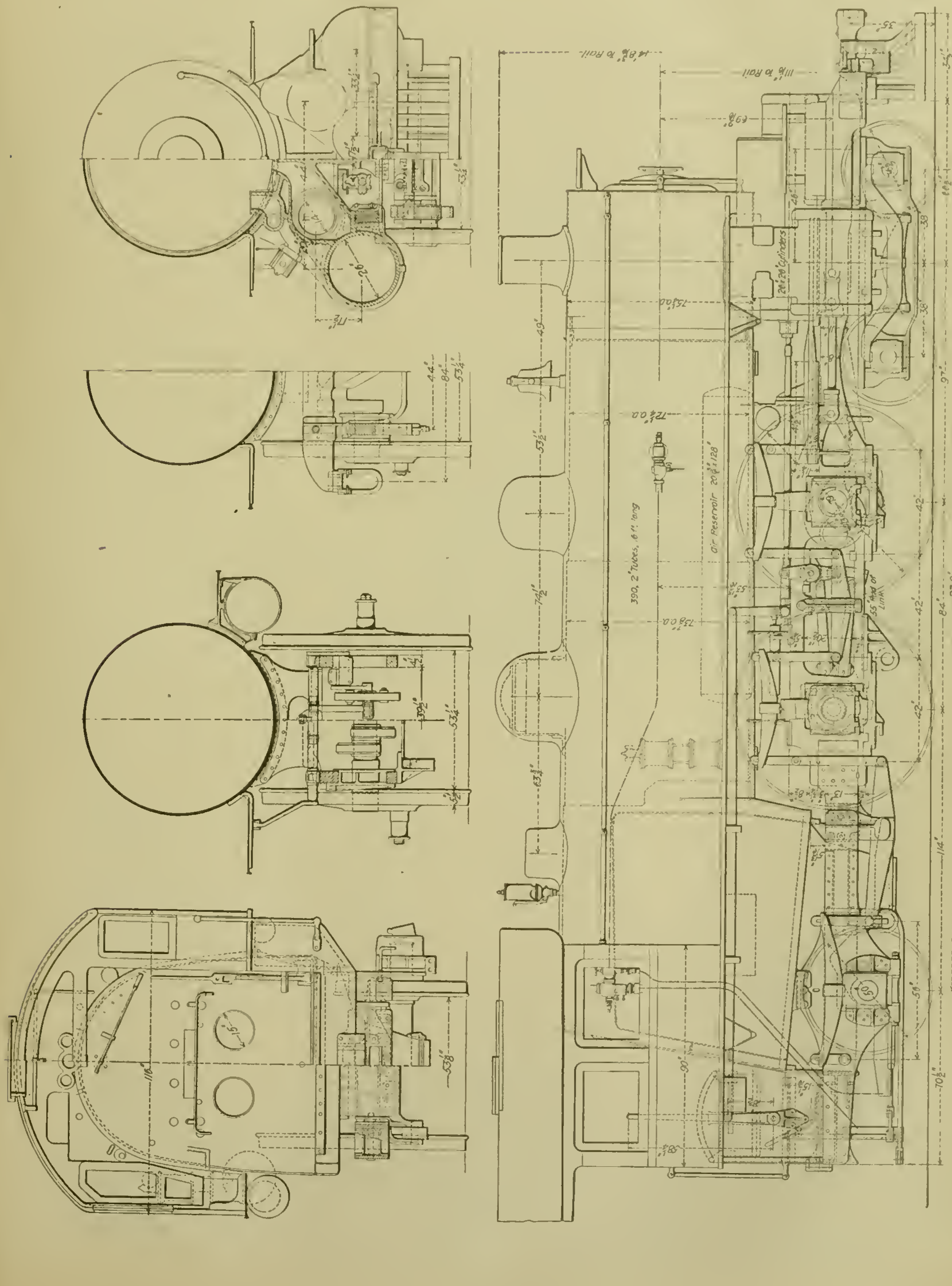
The valve gear is of the usual American type of Stevenson link motion, with reversing rocker and straight eccentric rods. The valves are 14-in. hollow piston type, four in number, identically the same and of extremely light construction. Two are used on each side on the same stem, the high-pressure ones being central admission and the low-pressure outside admission.

Preliminary tests show that this compound engine is capable of developing from 1,900 to 2,000 indicated horse-power, 1,980 having actually been obtained at 75 miles per hour, 1,688 at 67 miles per hour, and 1,680 at 84 miles per hour.

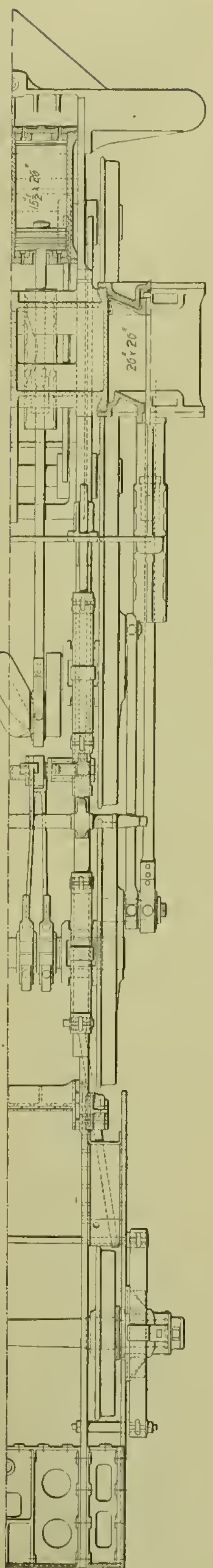
RATIOS, COLE'S FOUR-CYLINDER BALANCED COMPOUND.

Heating surface to cylinder volume (high pressure)	609
Tractive weight to heating surface	31.9
Tractive weight to tractive effort	4.58
Tractive effort to heating surface	6.96
Heating surface to grate area	68.5
Heating surface to tractive effort	14.3
Total weight to heating surface	58.03
Tractive effort × diameter of drivers to heating surface	1134

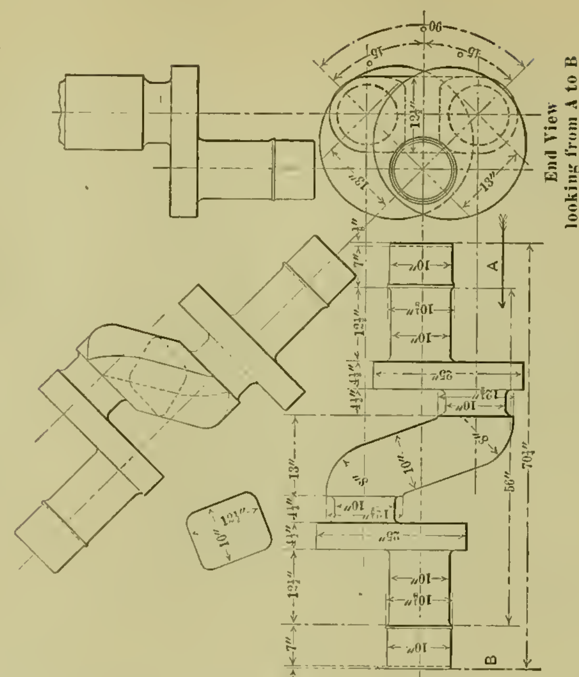
This locomotive will be tested on the locomotive-testing plant at St. Louis, and will form part of the exhibit of the New York Central at the World's Fair. It will afterward be put into regular passenger service on the New York Central. Several weeks of regular service indicate that the engine will be satisfactory from every standpoint.



COLE'S FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE.— NEW YORK CENTRAL RAILROAD.



PLAN OF RUNNING GEAR AND CYLINDERS.



CRANK AXLE.

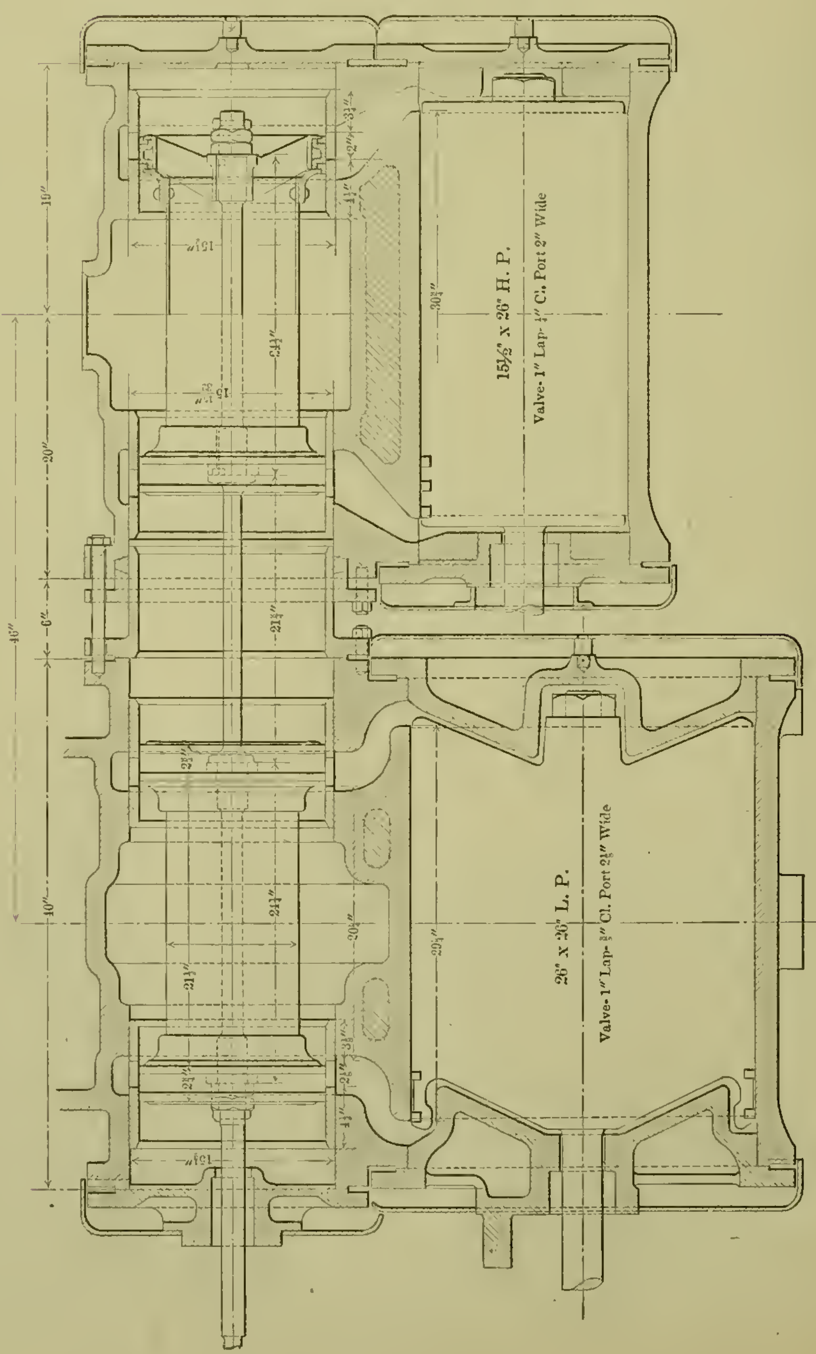


DIAGRAM OF VALVES AND CYLINDERS.

COLE'S FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE.—NEW YORK CENTRAL RAILROAD.

A NEW SEMI-RADIAL DRILL.

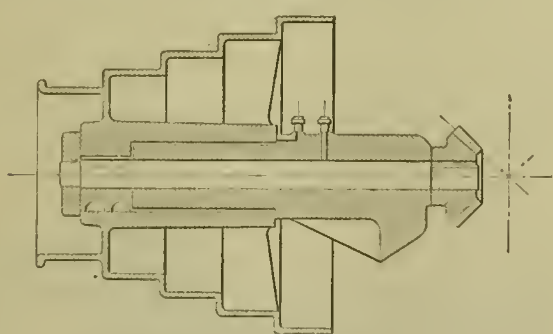
BICKFORD DRILL AND TOOL COMPANY.

A radical and interesting design of drilling machine has recently been developed and placed upon the market by the Bickford Drill and Tool Company, Cincinnati, Ohio, the well-known builders of heavy duty and rapid production machine tools. This tool is of an unusual design, which they term "semi-radial," the intention being to produce a tool of great rigidity and simplicity, which will be particularly serviceable for many classes of work. It will be received with interest by a large number of machine tool users who require very heavy and stiff tools in their rapid machining processes.

The criticism that would naturally be turned against the use of an overhanging cone, such as is here made use of at the top of the column, will be dispelled after a study of the extremely long and rigid bearing which is used for that cone. This bearing is shown in the accompanying sketch, from which may be seen the stiff and substantial character of this novel arrangement. The cone pulley has its bearing upon the outside of the overhanging arm, while the driving shaft extends through it to the other side, being connected to the hub by means of a special collar, as shown.

The chief characteristics of this machine are rigidity, simplicity and durability, which, combined with a high ratio of transmission gears, make it an admirable tool for many classes of work. The head, on which all bearings are of uncommon length, consists of a single casting and is adjustable on the arm by means of a spiral gear which gives it an easy, quick motion. The spindle is made of hammered steel and has an unusually great vertical adjustment for a machine of its size. It is provided with both hand and power feed, and a quick advance and return. The feeding mechanism furnishes three rates of feed, advancing by even increments from .008 in. to .016 in. per revolution of spindle, each of which is instantly available by means of a shifting key.

The driving mechanism contains but seven gears, the pitch and periphery speed of which are conducive to long life. The speeds are five in number and advance in geometrical progression from 50 to 170 revolutions per minute. The frame may be said to consist of but five parts, the base, column, cap, arm and arm shaft, each of which are commensurate with the continuous severe work which may be expected of a machine of this character.

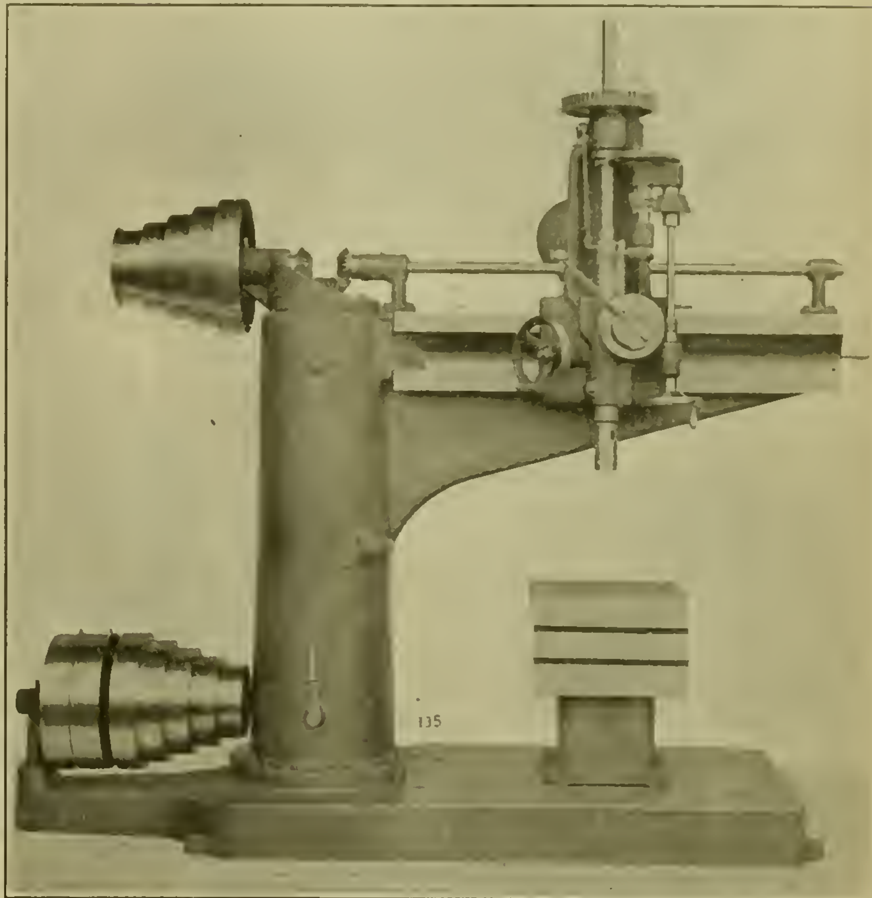


BEARING OVERHANGING CONE PULLEY.

GENERAL DIMENSIONS.

Diameter of spindle, least section	1 13-16 ins.
Traverse of spindle	18 ins.
Horizontal range of head	3 ft. 6¾ ins.
Receives under spindle over table	24 ins.
Receives under spindle over base	4 ft.
Receives under spindle over floor	4 ft. 7 ins.
Drills work in plane of base to center of	8 ft.
Size of table, working surface	20 x 20 ins.
Size of base, working surface	3 ft. x 4 ft. 1 in.
Distance from floor to extreme height of spindle	9 ft. 4¼ in.
Number revolutions of driving pulley to one revolution of spindle	6:9
Maximum diameter of driving cone	18 ins.
Width of cone belt	3 ins.
Speed of countershaft	350 revolutions
Floor space required	9 ft. 3 ins. x 11 ft. 9 ins.
Weight, net	6,500 lbs.

Mr. B. E. Stevens has been appointed general foreman of the locomotive department of the Illinois Central at the Burnside shops, to succeed Mr. George J. Hatz, recently resigned.



THE NEW DESIGN OF BICKFORD "SEMI-RADIAL" DRILL WHICH HAS BEEN DESIGNED FOR HEAVY AND EXACTING SERVICE.

Mr. K. Trowbergh has been appointed superintendent of shops of the Great Northern Railway, at Everett, Wash., to succeed Mr. John Dickson, who was recently transferred to Larimore, N. D., as master mechanic.

Mr. Nelson M. Maine has been appointed district master mechanic of the northern district of the Chicago, Milwaukee & St. Paul Railway, with office at Minneapolis, Minn., to succeed Mr. John Taylor, resigned.

Mr. James A. Hinson, president of the National Car Coupler Company, of Chicago, and widely known as an inventor of car coupling devices, died in Chicago, May 12. He was 52 years of age and had spent the whole of his business career in connection with railroad supplies. He brought out a large number of important inventions, and was one of the best authorities on all subjects connected with car coupling devices.

Mr. A. W. Whiteford, heretofore piece work inspector at the new Omaha shops of the Union Pacific Railroad, has been appointed superintendent of locomotive and car shops on the Nebraska division of this road, reporting directly to the superintendent of motive power. Mr. Whiteford served as a special apprentice on the Burlington, and afterward acted as piece work inspector of this road at St. Joseph, Mo. He went to the Union Pacific eighteen months ago, and has earned his promotion through the remarkable net saving resulting from the shop operations which have been under his charge.

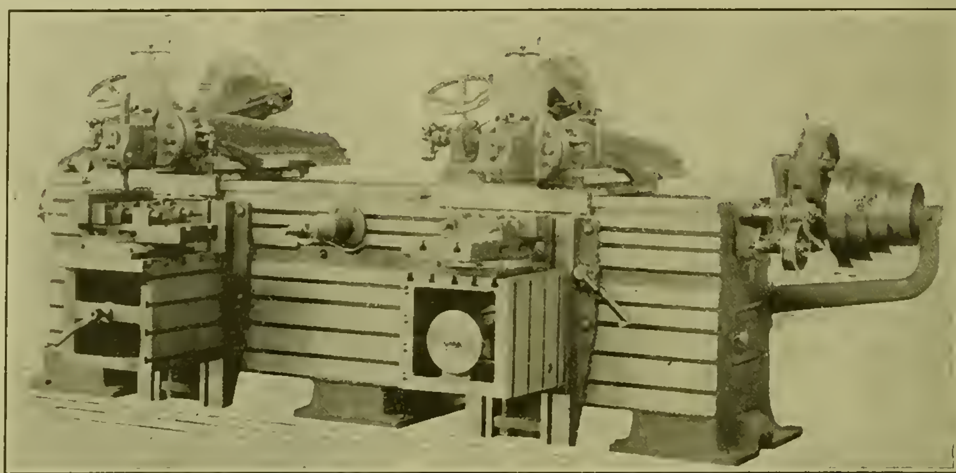
A NEW DESIGN OF SHAPER—THE "PULL CUT."

CINCINNATI SHAPER COMPANY.

One of the most important changes that has taken place in metal working machinery design of recent years is evidenced in the accompanying engraving—the development of the "pull cut" idea for shapers. The Cincinnati Shaper Company have taken this important step in design with a view of bringing their tools to a position in advance of the pace that has been set by the use of the new high-speed tool steels, and in no other way could this have been done more effectively. There has been a growing opinion among machine tool users for some time past that the "pull cut" offers many advantages over the older style of push cut, and this new design will do much toward filling this demand.

The tool here illustrated is the 24 in. x 12 ft. Cincinnati traverse shaper, with two heads, each of which is equipped for the "pull cut." The difference between this and the ordinary type of traverse shaper is that the cutting tools are reversed, the cutting taking place during the backward motion of the ram and quick return during the forward, the operation being thus directly opposite to that in the usual type of shaper.

The advantage of this type is that the pressure or thrust of the tool is taken directly back against the bed of the machine, and tends to draw the table and apron more closely to the bed, rather than force them apart, as is the case with all push-cut shapers. This is of a decided advantage, especially when heavy cutting is being done, as is the case since the introduction of high-speed tool steels. Then, in many cases, the work itself can be pressed directly against the bed of the machine, so that the resistance to the cutting is not all together dependent upon the hard clamping of the work and the table. Large pieces can also be advantageously bolted to the bed, the tables being removed; this is of considerable advantage in certain classes of work.



THE NEW "PULL-CUT" SHAPER RECENTLY INTRODUCED BY THE CINCINNATI SHAPER COMPANY.

The head is so constructed that the stress due to the cut comes directly upon solid metal contacts, and not upon threads, bolts or screw points, except in the case of the set screws for holding the tool. These screws are large in diameter, and have a long bearing. The whole construction of the head is one of great rigidity and strength, having the least possible tendency to yield or spring under the cutting strain. Except for the head, ram and such other modifications as have been found necessary, this traverse shaper is similar to the ordinary push-cut machine heretofore and still built by the Cincinnati Shaper Company, the introducers of this type of tool.

RELIABILITY OF GAS ENGINES.—A 400-H.P. gas engine has been run for 98 per cent. of the total number of hours in one year without stopping, and the idle 2 per cent. was made necessary by adjustment of the dynamo to which it was coupled. In another case four engines of 450 H.P. each have been run six months without stopping. These facts are cited in an article in *The Engineer*, of London, but without stating the location of the engines. An engine at Winington has been run from 20 to 130 days without shutting down, and Messrs. Mather and Platt have run a Korting engine of 750-H.P. at full load night and day for a week at a time, only stopping it to make examination. The Premier Gas Engine Company has frequently run engines of from 400 to 600 H.P. for three and four weeks at a time continuously. This record is sufficient to establish the reliability of gas engines upon a very satisfactory basis.

THE SPRING MEETING OF THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION.

An important meeting of the National Machine Tool Builders' Association was held at Cincinnati, Ohio, on Tuesday, April 26, this being the occasion of their semi-annual conventon. A large attendance was present, the membership now including 43 machine tool builders, three of whom were added at this meeting.

The association passed a resolution reaffirming the resolution, adopted at the last meeting, at New York City, which bound the members to maintain the present schedule of prices. Interesting papers were read by P. E. Montanus, of the Springfield Machine Tool Company; by F. L. Eberhardt, of Gould & Eberhardt, and by A. H. Tuechter, of the Cincinnati Machine Tool Company.

Mr. Montanus, in his paper entitled, "The Work of the Machine Tool Builders' Association," pointed out the good work that the association had done in maintaining prices during the present depression in the trade. He called attention to the fact of the decrease of net profits on the average line of machine tools, prior to the formation of the association, to a point where it was no longer profitable to the builders to make them. This was shown to be not only due to competition, but also to the increase in wages and in cost of raw material, in addition to which it became necessary to redesign many types of machines; weights had been increased, and many improvements had been added, such as gear guards, micrometer indexes, etc. The engine lathe had increased from 25 to 40 per cent. in weight, as had also planers, shapers, drills, milling machines, etc. Mr. Montanus stated that he did not believe it possible or advisable for the machine tool builders ever to form a trust, but thought that they should be united harmoniously in order to aid in advancing security and safety in business operations.

This association, which was formed in 1902, has succeeded in restoring normal prices in some lines, in eliminating certain defects in the prices of detailed parts, and in bringing about a better feeling of confidence. Mr. Montanus presented an elaborate and comprehensive argument, in which he gave detailed figures to show the value of the association; as, for example, in 1903, when prices were advanced from 5 to 10 per cent. and demoralization of the business was averted.

Mr. A. H. Tuechter, in an interesting paper upon "The Condition of the Upright Drill Trade," spoke about the general conditions of the market trade. He said that during the recent depression nearly every dealer and user asked for lower prices, but that such prices had been repeatedly refused. He cited a number of cases to show what could be done if the builders would stand firm. He thought that the drill makers were not making any money, and had only themselves to blame for this condition; it seemed to him that as a remedy they should organize and fix prices.

The officers of the Association are as follows: President, William Lodge, Cincinnati, Ohio; 1st vice-president, W. P. Davis, Rochester, N. Y.; 2d vice-president, F. E. Reed, Worcester, Mass.; secretary, P. E. Montanus, Springfield, Ohio; treasurer, Enoch Earle, Worcester, Mass.

An interesting feature of this convention was the banquet which was given to the visiting members by the local members at the Queen City Club in Cincinnati. This event was most pleasant and delightful, Mr. Philip Fosdick presiding as toastmaster in his own inimitable manner. A humorous diversion was presented at the banquet in the form of a "mechanical" (?) menu card, which is presented below, with a partial interpretation.

POSITIVE-FEED ARRANGEMENT.

DEMONSTRATION AT QUEEN CITY CLUB.
Tuesday, April 26, 1904.

MENU.

Drop Forgings.
Blue Prints.
Condensed Steam.
(No indicated horse-power.)
Plan(k)ed Shad, with Turned Potatoes.
Rhine Wine, 110 Volts, Alternating Current.
Spring Lamb; Mint Sauce with Ball Bearings.
Blowhole Cement.
Philadelphia Dovetails.
Salad; Apprentice Lard Oil Dressing.
Champagne, 500 Volts, Direct Current.
Cold Shot Castings.
Cheese, Double Back Geared.
Cutting Oil.
Valvoline.
Taper Pins.

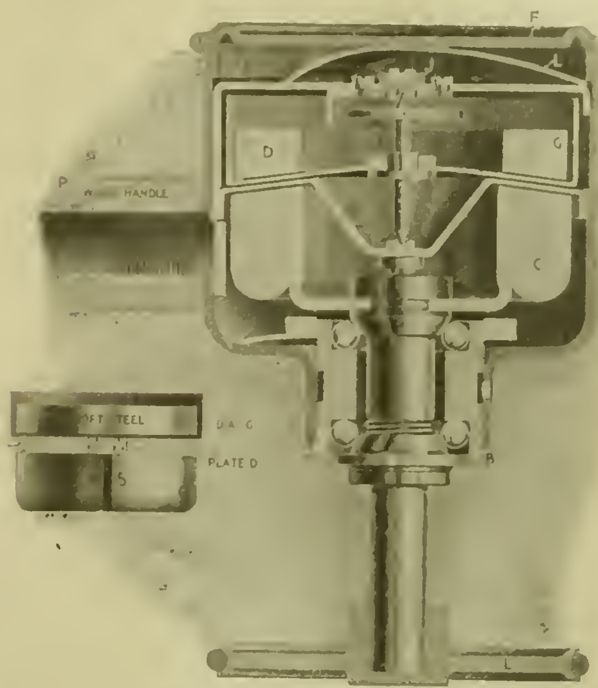
INTERPRETATION

Drop Forgings—Cocktail.
Blue Prints—Blue points.
Condensed Steam—Soup.
Ball Bearings—French peas.
Blowhole Cement—Sherbet.
Philadelphia Dovetails—Squabs.
Cold Shot Castings—Ice cream in forms.
Cheese—Brie.
Cutting Oil—Brandy.
Valvoline—Coffee.
Taper Pins—Cigars.

THE CUT-METER—A TACHOMETER FOR INDICATING CUTTING-SPEEDS UPON MACHINE TOOLS.

The keen competition of the last few years, supplemented by the rapid increase of use of the new high-speed tool steels, has had the effect of practically revolutionizing machine shop practice. The increased production which is now sought, where formerly easy-going methods were thought sufficient, has made such heavy demands upon the machine tools, their builders and even the tool operators, that important studies are now made of the possibilities of various cutting speeds, feeding rates, depths of cut, etc., with reference to maximum production. One of the greatest difficulties that has been met in the studies of this kind has been that of the lack of means of quickly and accurately determining the cutting speeds of working in the machine tool. This has usually been determined by the laborious and frequently inaccurate method of calculation from the known countershaft speed and pulley ratios.

The demand has been very great for some time past for some



CROSS SECTION VIEW OF THE CUT-METER, SHOWING DETAILS OF CONSTRUCTION AND INDICATING MODE OF OPERATION.

METHOD OF USING THE CUT-METER TO INDICATE THE TABLE SPEED OF A PLANER.—GIVES EXACT CUTTING SPEED INSTANTLY WITHOUT CALCULATIONS.

VIEW OF THE CUT-METER, AS USED FOR MEASURING CUTTING SPEEDS ON MACHINE TOOLS.

form of an instrument, in the nature of a tachometer, which could be arranged to indicate directly in cutting speed, but up till recently no device of this nature has been devised which is capable of ready application to any type of machine tool and of simple and compact construction warranting its continual use in machine shops. Such a device is illustrated herewith, and is appropriately called the "cut-meter." It is a portable tachometer, the dial of which is calibrated to read directly in feet per minute. An accompanying sectional view shows clearly the construction.

The principle of centrifugal force or hydraulic pressure is avoided in this instrument. It consists of a circular magnet, mounted on the shaft, carried by ball bearings, in front of which is a soft steel ring which deflects magnetic lines of force through an aluminum disk. This disk is mounted on a hardened steel shaft supported by jewel bearings, and on its outside edge are engraved figures which indicate the speed; this is resisted in turning by a hairspring attached to the shaft, which brings it back to the zero point when the magnet is at rest. Attached to the main shaft outside of the case, is the driving wheel, which has a rubber tread, or tire.

The magnetic lines of force flow from the negative pole through the aluminum disk to the steel plate and back again through the disk to the positive pole of the magnet; therefore, when the magnet is revolved, a dragging action is set up in the disk, the intensity of this action being in proportion to the speed of the magnet. The resistance of the hairspring to the rotation of the disk has a similar counter effect, so that the displacement of the dial is directly proportional to the rotative speed of the magnet; thus, the scale can be graduated in equal divisions representing feet per minute at the periphery of the driving wheel with rubber tire.

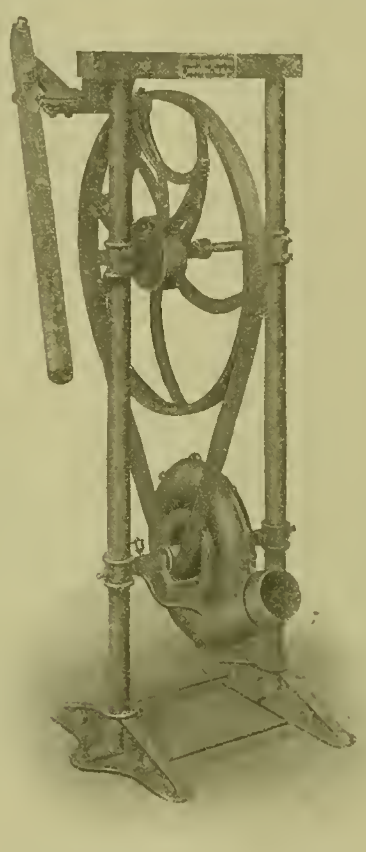
In the construction of the instrument the jewel bearings and steel ring are placed in an inner case, which may be removed at will, as shown in the detail view presented herewith. This inner case protects the dial from air currents set up by the revolving magnet, the opening through which readings are taken being covered by glass. In order to provide for permanence of the magnets they are aged after being hardened and magnetized; after this they are tested and again laid aside for a considerable interval, then retested. A change in strength too slight to be appreciable in actual work can be detected, and if the magnet has changed it is discarded. The air gap of this magnet is but 1-32 in., being so narrow as effectually to prevent influence upon the instrument by outside magnetic forces. The makers state that cut-meters have been used in constant and severe service for a year and then found to be as accurate as when first assembled. The machine is extremely durable, and the dial and shaft are very light, so that practically no stress comes upon their bearings.

The use of this instrument in the machine shop will be not only of great value but also of universal interest. The Warner Instrument Company, makers of the device, state that in testing it in one modern shop the cutting speed of a motor-driven tool running on soft steel was found to be 159 ft. per minute, but upon taking the average throughout the shop on the same stock, the average cutting speed was but 24 ft. per minute. In another shop two boring mills were indicated, the speed of one being 160 ft. and of the other 22 ft. per minute, the feed being practically the same in both cases. The difference in diameter of work makes it difficult to guess anywhere near the true speed, and in one instance a superintendent looking at a machine guessed the cutting speed at but one-quarter of the actual figure. A large number of tests have shown that, with modern equipment, working speeds run only from 25 to 50 per cent. of the speed that should be used to obtain the most profitable results. Little study of these figures is required to show the advantages to be obtained by use of this device for keeping track of machining conditions in a shop.

This cut-meter is manufactured by the Warner Instrument Company, Beloit, Wis., who have devoted unlimited care and expense in perfecting it. It is made for use at any desired speed. As adapted for use in the machine shop it is calibrated to indicate from 0 to 250 ft. per minute cutting speed, the smallest fraction of speed change indicated by it being a change of 1-5 of 1 per cent. An accompanying illustration shows the method of operating the instrument, in readig the cutting speed of a planer; the simplicity and practicability of its use in the shop are made evident in this instance. The makers will be pleased to furnish any additional information regarding this interesting new device upon application.

THE IMPROVED STURTEVANT HAND BLOWERS.

In these modern times devices are sought which will accomplish the greatest results with the least expenditure of time and exertion. To this fact, doubtless, more than any other was due the rapid introduction of the hand blower as a substitute for the old time bellows.


THE NEW STURTEVANT HAND BLOWER.

During the years which have elapsed since this change the B. F. Sturtevant Co., Boston, Mass., who have been pioneers in the manufacture of blowers, have been perfecting their design and construction until their hand blower, known as style A, has shaped itself into a new design, known as Style B, as herewith illustrated.

These hand blowers have been extensively introduced in connection with new forges of all kinds, and have likewise been applied to old style brick and iron forges as simple, efficient and economical substitutes for the bellows. Not only are they adapted to forge blowing but can readily be applied as portable ventilating apparatus.

The blower is adjustable on the shaft and its outlet may thus be set to discharge in any direction and readily connected to the forge tuyere by means of galvanized iron piping. The blower is of cast iron, strongly constructed in every particular, has a steel shaft running in babbitted boxes and a fan wheel of galvanized steel solidly riveted to a composition hub with extended arms.

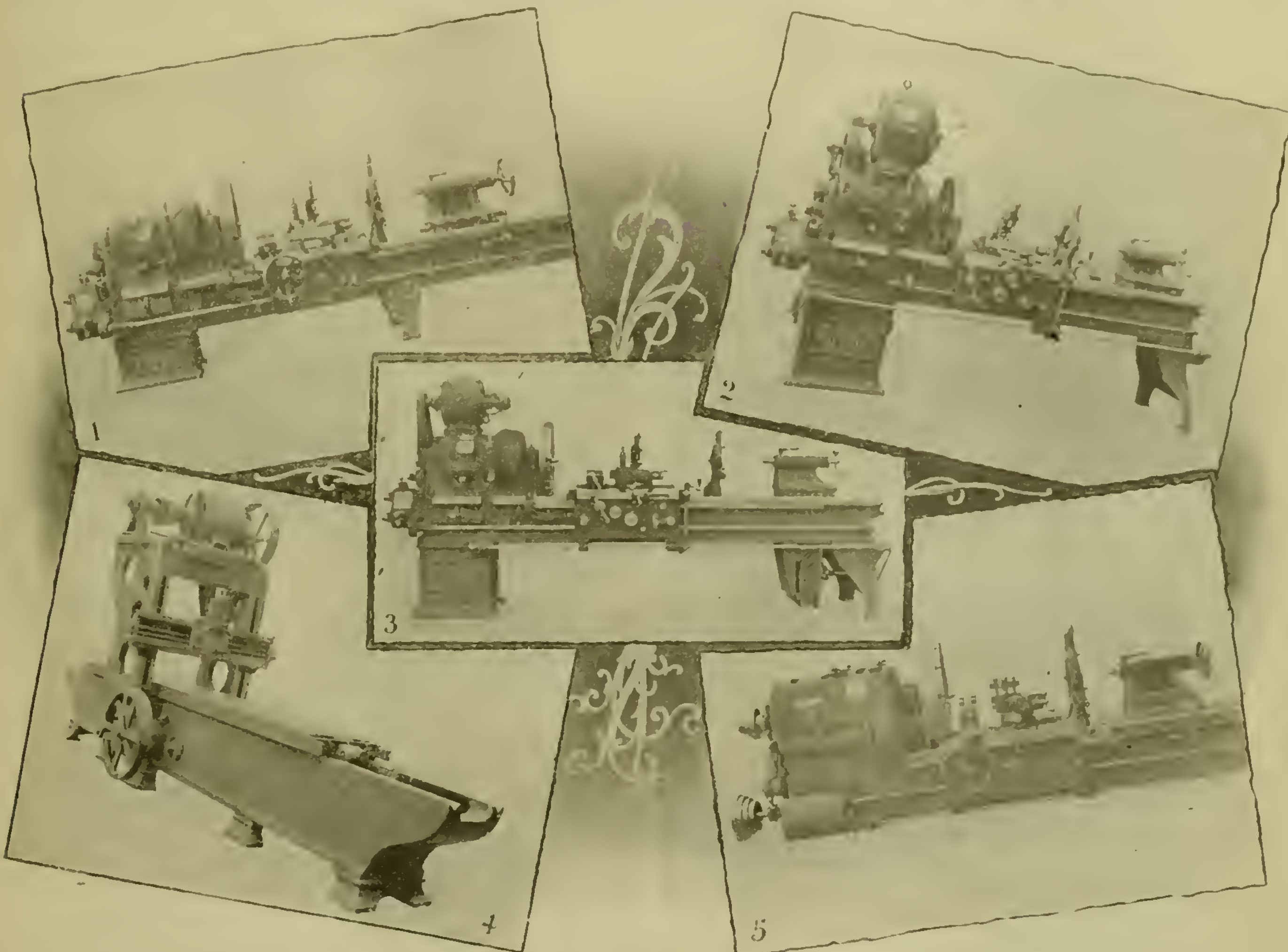
The frame is carefully designed, well braced, and is so arranged that the slackness of the belt driving the blower may be taken up by lowering the blower shaft, which is supported by collars sliding on the frame. The feet are provided with holes so that the hand blower may be readily screwed to the floor.

These hand blowers are made in two sizes. The total length on the floor of Style B-1 is 18 ins., while the total height of the frame is 48 ins. The driving wheel is 24 ins. in diameter, the blower outlet is 3½ ins. in diameter, and the complete outfit weighs but 135 lbs. Style B-2 is of slightly larger dimensions, and has proportionately greater capacity for delivering air. The driving wheel is 24 ins. in diameter, the blower outlet is 4¾ ins. in diameter, and the complete outfit weighs 155 lbs. Further information regarding these blowers may be had upon application to the manufacturers, the B. F. Sturtevant Company.

A MODERN LINE OF MACHINE TOOLS.

American Tool Works Company.

The recent developments in machine tool building have been both interesting and remarkable. The demands of the new methods of rapid production have been severe upon the machine tool builder, but the efforts made to meet them have been very commendable, and even greater than would have seemed possible. The American Tool Works Company, Cincinnati, Ohio, have made unusual preparations for their trade in this new machine tool era by the redesigning of their entire line, from lathes to shapers and planers. Each model of their new line of tools embodies the latest and best ideas of recent designs of metal working machinery, and are worthy of the careful attention of all interested in machine shop betterment.



AN INTERESTING LINE OF MODERN RAPID-PRODUCTION MACHINE TOOLS, DESIGNED TO ANTICIPATE THE REQUIREMENTS OF THE NEW HIGH-SPEED TOOL STEELS.—AMERICAN TOOL WORKS COMPANY.

We are enabled to present herewith some representative illustrations of this excellent line, from which an idea may be gained of their leading features. Four of the important new designs of the "American" lathe and the new "American" planer are illustrated in the accompanying half page view, and in a separate engraving is shown the new "American" shaper, with an excellent design of variable-speed drive.

Fig. 1 is an illustration of the new design of "American" lathe with an all-gear head, obviating the use of cone pulleys entirely for obtaining changes of speed. This tool may be arranged for either belt driving or the motor drive; in this case it is shown equipped for belt driving. The headstock is a complete unit, to which any type of motor, constant or variable speed, single or multiple voltage, may be readily connected, by setting the motor either on top or at the rear of the gear casing. The construction is very simple and powerful; only six gears are required for the mechanical speed changes, the gears being oppositely disposed on the spindle and driving shaft. The speed changes are obtained instantly while the lathe is in full operation, by an improved form of clutch and lever mechanism. The whole is encased in a neat and symmetrical box with provision for easy access to working parts, and ample means for lubrication. The great flexibility of this construction is a very important factor, as a machine installed as a belt-driven lathe may be readily converted into a motor-driven lathe at any future time—the motor being connected to the driving shaft by gear or silent chain—and also may be set at any angle to overhead works, or driven from the floor below.

Fig. 2 shows the new 18 in. American lathe, driven through this all-gear head by a 5-h.p. Crocker-Wheeler motor, substantially mounted on brackets cast integral with the gear cover and direct connected through gearing to the driving shaft on the all gear head. This all gear head gives a wide range of speeds to the spindle also. The controller is located at the back of the leg and is actuated by the crank handle at the right hand side of the carriage.

Fig. 3 shows one of the 20 in. American lathes, with the same construction of all gear head, but here driven by a 3-h.p. Northern motor, which, in this instance, is connected to the first driving shaft of the all gear head through a Morse silent chain. The controller is attached to the underside of the bed where it is, as in the other instance, entirely out of the way, and yet readily accessible. It is similarly actuated by a crank handle at the right hand of the carriage. The manipulation of this handle starts, stops or reverses the machine, and a slight movement of same will increase the speed of the spindle by a small increment over the preceding speed. Thus, the four fundamental speeds obtained through the all gear head, which on this lathe has a range of from 5 to 322 r.p.m., are supplemented by a great number of minute variations of speed obtained through the controller electrically. By actual tests on the 20 in. lathe, twenty-three distinct changes of speed are obained through the controller, and this, with the four changes through the all gear head, gives a range of 92 speeds at the spindle of the lathe.

Fig. 5 presents a view of the heavy 36 in. engine lathe equipped with all gear head of the same general construction, driven by a Northern motor, which is in this instance substantially mounted on a stand back of the head, and connected to the driving shaft through a Morse silent chain. In view of the heavy nature of the lathe and the extensive use of such tools in various railroad shops, we believe that this illustration will be of unusual interest to many of our mechanical readers who are interested in railroad shop work.

Fig. 4 presents an illustration of the interesting new design of the "American" planer. This tool is the 33 in. size, and is equipped for motor driving, the motor being located upon an extension housing and driven through a silent chain. It is

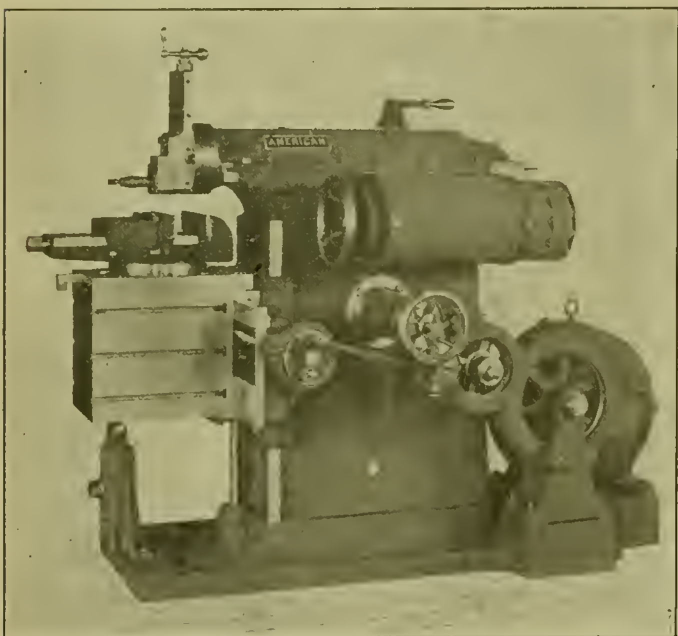


FIG. 6.—THE NEW "AMERICAN" SHAPER, SHOWING AN EXCELLENT APPLICATION OF MOTOR DRIVING.

of an extra heavy design; the bed is of deep pattern, extra wide between the Vs, thoroughly braced by box cross girts at short intervals, and rigidly supported by heavy legs. It is made unusually long in proportion to table length, leaving but little overhang to table when planing at full length. The central portion, where the gears are mounted and where the strain is heaviest, is strongly reinforced. The Vs are wide, giving good wearing surface, are scraped their entire length to a perfect fit.

The table has ample proportions. T-slots extend its entire length, and are planed from the solid, with very liberal allowance of metal around them, to obviate all spring from clamping. It is equipped with improved dirt-proof feature, which completely protects the Vs from dirt and chips. A safety locking device prevents the table from starting before the operator is ready and back dogs are so arranged that the table can be run from under the tool for examination of work.

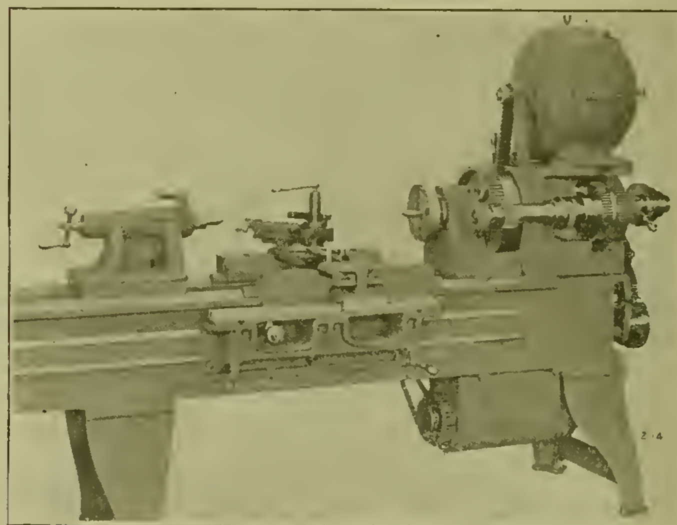
The photograph of the shaper, Fig. 6, shows one of the 18 in. American back geared crank shapers, driven by a 5-h.p. Crocker-Wheeler motor, which is mounted on a substantial base cast integral with the shaper base, and direct connected to gearing. The controller is located, as shown at the top of the column, readily at the hand of the operator.

This shaper has also many features of value. The column is unusually deep and wide, tapering slightly towards the top, giving the machine a neat and substantial appearance. It is strongly braced internally, the braces being so disposed as to meet the heaviest strains, and projects both front and rear.

The stroke of the ram is positive and has ten rates of speed, ranging from 8 to 98. Length of stroke may be changed at will without stopping the machine, through the handwheel on the side of the column.

MOTOR DRIVEN 18-INCH LATHE.

While a great deal has been published recently illustrating and describing motor drives applied to machine tools, constant progress is being made in the designing of new tools to accommodate motor drives and in the modification of old tools for the same purpose. One of these latter instances is illustrated in this photograph, showing an 18-inch Le Blond screw cutting lathe driven by a size 5 I shunt-wound Crocker-Wheeler motor. The motor is supported on a special housing and the drive is by means of a Morse silent chain from the motor shaft to the main lathe spindle. The speed control is accomplished by the Crocker-Wheeler multiple system, using in this case a size 40 M.F. 21 controller, giving a range with the controller of 21 speeds. Only a portion of this range is used as working speeds, the entire range of the tool being increased by a double back gear attachment which permits a total speed range of from 410 r.p.m. of the spindle to 5.75 r.p.m.



18-IN. LE BLOND LATHE DRIVEN BY CROCKER-WHEELER MOTOR.

With this entire range three runs of gearing are provided, one being direct and the other two through back gears. Each of these various runs is controlled by a friction clutch, the lever for operating which is located in front of the head stock. About 40 speeds are provided with 2.8 h.p., available at any speed between 20 and 410 r.p.m. of the spindle. For the heaviest working range of the tool, however, namely, 28 to 124 r.p.m., 3.4-h.p. is available.

The whole equipment is well laid out, the speed changes are accomplished quickly and easily, and the strength of motor and gearing is sufficient to accommodate cutting speeds in cast iron and soft steel of 70 ft. per minute. One prominent feature of the Crocker-Wheeler multiple-voltage system is that it affords speeds to properly use these high cutting speeds and gives ample power at all speeds without an excessively large motor.

Mr. Edwin T. James, master mechanic of the Lehigh Valley at Buffalo, has been appointed shop superintendent in charge of the extensive new shops of this road at Sayre, Pa., reporting direct to Mr. A. E. Mitchell, superintendent of motive power. Mr. James entered the service of this road in 1876 as a machinist at Easton, and has passed through the positions of round house foreman, general foreman and master mechanic. This is a particularly pleasing and significant appointment, pleasing because of the opportunity which comes to an efficient officer, who has been long in the service of this company, and it is significant of a change in organization, necessitated by the large modern shop plant.

PUBLICATIONS.

WIRE ROPE LUBRICATION.—A pamphlet is issued by the Joseph Dixon Crucible Company, Jersey City, N. J., describing the wearing of wire rope and indicating methods of properly lubricating it by means of their rope dressing, which lubricates but does not collect dust, and prevents rust.

PINTSCH LIGHT STEAM HEAT.—The Safety Car Heating & Lighting Company have issued memorandum booklets for distribution among visitors to their exhibits at the World's Fair in St. Louis. These serve to locate the exhibits of this company. They illustrate some of their specialties and also provide convenient memorandum pages for notices concerning the exposition.

SKYLIGHT GLAZING.—A pamphlet on the Halliwell system of skylight and glass roof construction has been received from Josephus Plenty, 215 Randolph avenue, Jersey City, N. J. It illustrates and describes the construction as applied to very large roofs of well-known manufacturing establishments, foundries, machine shops and railroad stations.

DISC VENTILATING FANS.—The American Blower Company, of Detroit, have issued a catalogue, No. 161, illustrating their "A B C" disc ventilating fans for mechanical draught apparatus, exhausting, for dry kilns, heat apparatus, and dust separators. The long experience of this company gives confidence to those who consult them in their specialty, and this pamphlet, which gives details and dimensions, will be found valuable in preparing designs for apparatus of this character. Copies of the pamphlet will be sent upon application.

A BIRD'S EYE VIEW OF LAKE WINNIPESAUKEE.—The numerous vacationists who annually journey to Lake Winnipesaukee, and those persons intending to take a vacation in this section, will be interested in the new publication issued by the Passenger Department, Boston & Maine Railroad, Boston. It is a bird's eye view of Lake Winnipesaukee, the different glens and coves on the lake and the hundreds of islands. Each mountain peak, island and cove is numbered and at the bottom is a table giving the name of each number. This map is interesting and useful in furnishing one with the geography of the lake, and prospective vacationists and New Hampshire enthusiasts should send six cents in stamps to the General Passenger Department, Boston & Maine Railroad, Boston, for it.

SOFT WATER.—Under this title a large water-softening installation, with a total treating capacity of 348,000 gallons per hour, is described in a handsome pamphlet by the Kennicott Water Softener Company, Railway Exchange, Chicago. It is a reprint of the series of articles from the AMERICAN ENGINEER AND RAILROAD JOURNAL describing the installation of their water softeners upon the Pittsburg & Lake Erie Railroad. The pamphlet is of great importance to railroad officials in that it describes the complete equipment of the entire railroad with water softeners to such an extent as to render it unnecessary for any of the locomotives on the road to use other than treated water. The articles were prepared for this journal with great care and by aid of the officials of the railroad who were directly responsible for the installation. We consider it the most definitely valuable work on the subject of water softening thus far available. The Kennicott Company has done a service to the railroads in distributing this valuable and handsome pamphlet.

Engineers' Arithmetic, by Fred H. Colvin and W. L. Cheney. Published by the Derrey-Cullard Company, 256 Broadway, New York. 1904; price 50 cents.

This little book is intended to give the foundation principle of such calculations as an engineer is likely to need. It is similar in its scope to Machine Shop Arithmetic and employs the same methods. It contains rules for horse power, proportions of boilers, explains indicator diagrams and includes a number of convenient tables. It is for men who operate steam engines and have charge of steam boilers.

New York Air Brake Catechism, by R. H. Blackall, author of the Westinghouse Air Brake Catechism. Norman W. Henley Publishing Company, 132 Nassau street, New York, 1904. Price, $1.25.

This is the only complete treatise on the New York air brake and air signalling practice, giving a detailed description of all the parts, their operation and troubles. It includes a full description, by aid of illustrations, of the plain and quick action triple valves, duplex valves, duplex pump, pump governor, brake and retaining valves, and of the detailed parts of this brake system, including the engineer's valve. The book also treats in special chapters the subject of piston travel, systems of leverage, water brake, piping and train handling. The author of this book is so well known through his previous work on the Westinghouse air brake as to render it unnecessary to say more of the present work except to indicate that it has received his usual careful and thorough treatment. A careful examination of the book fails to reveal any omissions. It is a guide to the New York air brake, which will be specially valuable to everyone having to do with the brake, particularly those in road service who are expected to pass examinations as to their knowledge of the brake and its operation.

Appleton's Encyclopaedia of Applied Mechanics. Edited by Park Benjamin.

Norman W. Henley Publishing Company, 132 Nassau street, New York, offer this encyclopaedia in a set of three fully illustrated volumes, handsomely bound in half morocco, for the special price of $12. Each volume contains over 900 pages and nearly 8,000 engravings. Heretofore the publisher's price has never been less than $22.50, and it has been sold only by subscription. The writers of the special articles are the best known experts in the various branches of applied mechanics, including names which are known all over the world.

Railroad Master Blacksmiths' Association. Proceedings of the Eleventh Annual Convention, Held at Buffalo, August, 1903. Edited by the Secretary, A. L. Woodworth, Lima, Ohio.

This volume contains a number of excellent papers and reports relating to blacksmith shop practice in railroad work. Making and repairing of locomotive frames, piecework vs. day work, oil furnaces, spring furnaces, dies for bulldozer work, tool steel, casehardening, flue welding and spring making are the most important of the subjects treated. This association is an important one, and its records are becoming more and more valuable as improved methods are being introduced into the smith shop. Every superintendent of motive power should inform himself with reference to the work of this organization.

Twentieth Century Locomotives. By Angus Sinclair Company. Published by Railway and Locomotive Engineering, 1 Maiden Lane, N. Y., 1904. Price $3.00.

We have just received from the press a copy of an interesting book entitled "Twentieth Century Locomotives." It is a work of 670 pages and conforms to railway standard publication sizes, being similar to the annual reports of the M. M. and M. C. B. Associations.

The subject matter of the book is largely drawn from articles which have appeared in *Railway and Locomotive Engineering*. It deals with the designing, construction, repairing and operating of railway machinery, and is intended for use by all railway men anxious to learn about railway machinery, but the book is more particularly for superintendents of motive power, master mechanics, master car builders, mechanical engineers, shop foremen, engineers, firemen and trainmen.

Among the subjects dealt with are first principles, steam and motive power, workshop operations, locomotive boiler construction, compound locomotives, operating locomotives, valve motion, forces involved in train movements, injectors, sight feed lubricators, electric headlights, steam engine indicators, machine tools and shop appliances, educational topics, miscellaneous data, workshop receipts, definitions of technical terms, illustrated descriptions and dimensions of the various types of modern locomotives and observation on the Schmidt superheater.

Various tables and engineering data are to be found scattered through the work together with simple formulas for calculating power and train resistance. The book has been carefully indexed and ready reference is easy and satisfactory.

Mr. Meyers A. Garrett has been appointed vice-president and Western representative of the Farlow Draft Gear Company, with headquarters in Chicago. Mr. Walter D. Thomas has been appointed Southern representative, with headquarters in Savannah.

Mr. H. V. Croll, who has been in charge of the Salt Lake City, Utah, office of the Allis-Chalmers Company for several years, and who was before that the representative of the E. P. Allis Company at Spokane, Wash., has been appointed to the charge of the Allis-Chalmers office in San Francisco as the successor of Mr. George Ames, who has resigned. Mr. Croll's San Francisco office is 623 Hayward Building.

NOTES.

Locomotive & Machine Company, Montreal.—The principal offices of this company have been removed from the Street Railway Chambers to the Imperial Bank Building, Victoria Square, Montreal.

Walter A. Zelnicker Supply Company.—The Chicago office of this company has been removed from the Old Colony building to the Railway Exchange building, where sufficient room has been obtained for its rapidly increasing business. The office is in charge of Mr. H. L. Schamberg.

The Canadian business of the Allis-Chalmers Company, which recently acquired the Bullock Electric Manufacturing Company, of Cincinnati, will hereafter be conducted by a new organiation bearing the name Allis-Chalmers-Bullock, Ltd. The works and principal offices of this important new Canadian company are in Montreal.

The Pneumatic Engineering Company, of New York, has just secured an order for a large air compressor, to be used in connection with the water works at Sherman, Tex. The machine is a special Rand-Corliss compressor, with Tangye frame, having air cylinders 20 and 12 x 20, and steam cylinders 9 and 17 x 20, designed for 200 pounds per square inch air pressure.

The Kennicott Water Softener Company announces the receipt of an order for one of their water softeners of a capacity of 10,000 imperial gallons from the Great Western Railway of England for the water station at Aldermaston, Berkshire, and another order for a 3,000 gal. machine, from the United Railroads of Yucatan. This company has an office at 29 Gt. St. Helens, London, and has also recently opened an office at 7 Rue Meyerbeer, Paris.

Mr. J. C. McQuiston, formerly secretary of the Westinghouse Companies' publishing department, has been appointed superintendent, and is the responsible head of that department, having in charge all matters connected with advertising, press notices and similar matters of mutual interest to the technical press and the Westinghouse Companies. In view of the responsible position which Mr. McQuiston has long held in this department and his thorough knowledge of the technical press, this appointment is appropriate and fitting.

Flannery Bolt Company.—The Flannery Bolt Company, 339 Fifth avenue, Pittsburg, Pa., announce that the services of Mr. T. F. De Garmo have been secured to represent them in the West, with headquarters in Chicago, Ill. Mr. De Garmo will give his attention to the Tate Flexible Stay Bolt, which was illustrated in this journal last month.

Falls Hollow Stay Bolts.—The Falls Hollow Staybolt Company has just received the third large order for hollow stay bolts from the Norwegian State Railway during the past year. This is a gratifying testimonial, coming from Norway with its reputation for producing good iron. These stay bolts are made by blending iron from Norway and Sweden with a high grade of native charcoal iron, producing the necessary tensile strength and other qualifications needed in stay bolt material.

Vest Pocket Map of the World's Fair.—The Broderick & Bascom Rope Company, of St. Louis, Mo., have issued a very complete and authentic vest pocket map of the World's Fair which will be a valuable aid to visitors, as it shows methods of reaching the fair from any point in the city, giving the location of all buildings and other points of interest on the grounds. Copy of the map will be mailed upon receipt of a 2-cent stamp sent to Mr. C. E. Bascom of this company. To visitors at their exhibit handsome souvenir blotters will be given at the fair. These are well gotten up and very convenient for the desk.

The widespread interest that is being taken by railroad master mechanics generally throughout the country, in the all-important question of proper machine tool equipment in the railroad shops, is well indicated by the great number and variety of railroads which have just closed orders with the leading builders of railway machine tools. The American Tool Works Company of Cincinnati, one of the foremost and most progressive firms manufacturing machine tools for railroad work, have lately been furnishing tools of their construction to such roads as the New York Central, Pennsylvania, Central Railroad of New Jersey, Big Four, Southern, Balmore & Ohio, Canadian Pacific, Missouri Pacific, L. & N., St. Louis & San Francisco, M., K. & T., the Hocking Valley, etc. They report that the railroad master mechanics are evidencing much interest in their new all-gear head for motor-driven lathes, a remarkable construction which we take pleasure in presenting in other columns. It warrants the close attention and study of all who are interested in such questions.

Babcock & Wilcox Water Tube Boilers.—In a recent comparative test of Babcock & Wilcox and Stirling boilers at the power house of the Pacific Power & Light Company, at Los Angeles, Cal., the Babcock & Wilcox boiler showed decided advantages over the Stirling boiler in a number of different counts. These tests were made by a representative of the Pacific Power & Light Company, and each of the boiler companies were represented by an engineer, the report being signed by all three. In the matter of efficiency the Babcock & Wilcox boiler showed a gain of 4.93, 5.10, 7.18 and 2.97 per cent. in four tests; the temperature of escaping gases from the Babcock & Wilcox boiler was lower than that of the Stirling boiler in all four tests, and the evaporation per pound of oil (which was used for fuel), from and at 212 deg., was in favor of the Babcock & Wilcox. In the matter of efficiency in normal as well as in forced working, the Babcock & Wilcox showed superiority. Comparative records obtained under such circumstances, which are signed by one independent and two interested engineers, are very rare. The Babcock & Wilcox Company are to be congratulated upon the results of this interesting test. Those interested should procure complete records of the tests.

Riehle Brothers Testing Machine Company, Philadelphia, Pa., report that they have received an order to design and construct for the University of Illinois a vertical-screw power testing machine of 600,000 lbs. capacity. This is the largest testing machine of this type ever built. Some specially novel features will be introduced which will make it a machine of advanced type. It is designed for the widest range of testing by tensile, transverse, and compression strains; and will take in tensile specimens 22 ft. long, allowing for 20 per cent. elongation; transverse specimens 10 ft. long, and compression specimens 25 ft. long. The machine will stand 30 ft. high above floor line, will be 17 ft. long, and nearly 11 ft. wide; it will weigh about 50 tons. Nearly 15 tons of steel castings will be used in the construction of this machine. The weighing beam is one of the special features and is the most improved type of the Riehle dial screw beam. Two poises are used; the forward poise can be run out till it registers 300,000 lbs., when it will automatically release itself; then the other poise can be thrown in and out, or if preferred, both poises can be run out together. All the weight is registered on the weighing beam and no loose weights are required. This company also recently delivered to the University of Illinois a 100,000-lb. testing machine; in addition to which they have furnished the Simplex Railway Appliance Company, Hammond, Ind., a 300,000-lb. car bolster testing machine, a 100,000-lb. spring tester, and a 75,000-lb. closing press; Lafayette College, Easton, Pa. with a 200,000-lb. testing machine and torsional machine and the Philadelphia Veneer & Lumber Company, with two Smith veneer cutting machines.

Chicago Pneumatic Tool Company.—The litigation of this company against the Keller Company and the Philadelphia Pneumatic Tool Company, covering infringement of the Boyer pneumatic hammer, has been terminated in favor of the Chicago Pneumatic Tool Company by the granting of a final decree for perpetual injunction and accounting; this decision declares the validity of the Boyer patent and the infringement of claims which were under litigation. The defendants are enjoined from the manufacture, use, or sale, of pneumatic tools covered by these patents. The date of this decision and injunction is April 9, 1904. In addition to this decision, Judge Hazel, of the United States Court, on April 30 handed down a decision sustaining the Moffet drill patent, and held the Philadelphia-Keller drills to be infringements thereof, granted the decree for accounting for profits and damages, and injunction prohibiting the further manufacture, sale or use of such drills. A similar decision was granted previous to this, but it covered the feed screw only, whereas the latter decision covers the drill itself. This decision is the result of a final hearing upon pleadings and full proofs, and it places the Philadelphia Pneumatic Tool Company under complete legal restraint whereby they are now enjoined from manufacturing, selling, or using, or permitting, or authorizing others to sell or use such drills irrespective of whether they are, or are not, provided with feed screws, for the sustained claims cover the drill proper, irrespective of the feed screw. This decision secures to the Chicago Pneumatic Tool Company the exclusive right to manufacture and sell, and authorize others to sell and use the modern pneumatic drill, as this company is advised that all other pneumatic drills on the market infringe the sustained claims of the Moffet patent, and are completely within and covered by this decision.

(Established 1832.)
AMERICAN ENGINEER AND RAILROAD JOURNAL

JULY, 1904.

RAILWAY SHOPS.

BY R. H. SOULE.

XV.

CONCLUSIONS.

The Passenger Car Repair Shop. (Including the Paint Shop and Transfer Table).—The latest installation is that of the Pennsylvania at Wilmington, Del. The arrangement is the conventional one of two buildings on opposite sides of an intermediate transfer table pit, which is 70 ft. wide; on either side of the pit is a space of 90 ft. wide between edge of pit and adjacent building, making the distance between buildings 250 ft.—rather far, considering the amount of business which must be interchanged between them; each building is 180 ft. wide, and intended to hold two cars to the track. The repair shop stalls can be reached from either side of the building, on one side by ladder tracks and on the opposite side by the transfer table, but the paint shop stall tracks can be reached from the transfer table side only. The capacity of the plant is stated as being 75 coaches repaired per month.

The new Portsmouth, Va., passenger car repair and paint shop of the Seaboard Air Line is a good example of simple, straight-forward design and construction, where local climatic conditions were taken advantage of, and the cost of the building kept down to 68 cents per square ft. The building is 80 ft. wide, with doors at both ends of each stall track, so that trucks can be moved outside the building and repaired, and as above implied, the stalls can be used interchangeably for both repair work and paint work.

The Freight Car Repair Shop and Yard.—There have been some recent examples of improved practice; at Portsmouth, Ohio, the N. & W. have laid out a new double-ended yard with planing mill immediately alongside, and a system of cross tracks for trucking lumber.

The Scranton, Pa., freight car repair plant of the D., L. & W. is, as far as known, the only plant which has been put up for the exclusive work of freight car repairs; a group of eight buildings provides very complete facilities; there are two large buildings, each 150x400, and each building holding 48 cars, for heavy repairs or for construction, while light repairs only have to be done in the open. With such complete and well arranged facilities, and with the entire resources of the plant concentrated on one class of work, very large output results ought to be expected.

The Danville, Ill., plant of the C. & E. I. includes a single-ended freight car repair yard with a standing capacity of about 460 cars when properly separated; there is no provision (other than the coach repair shop) for doing freight repair work under cover; the planing mill is alongside the yard, and the machine and smith shops are not far away.

The Planing Mill. (Including the Cabinet Shop and Lumber Yard.)—In rearranging the West Milwaukee plant of the C., M. & St. P., a stream was diverted and the lumber yard rearranged, the result being an extremely ample and convenient yard which is laid out on the general basis which practice has pointed out as the best, although in this particular case the tracks are spaced farther apart than usual.

The Power Plant.—At Moline, Ill., the C., R. I. & P. have put up a power plant in connection with their new shops which has several noteworthy features. The installation includes economizers and induced draft apparatus which naturally go together, but does not include condensers, which arrangement provides for utilizing the waste heat from the boilers, but not that from the engines, but no doubt all the exhaust steam will be used for heating purposes, and possibly water for condensing purposes would have been expensive, as the pumping station supplying the plant is evidently very far away, as there is a rotary converter and a step-up static transformer for furnishing power to it. The induced draft apparatus is housed in a small wing, and there is a second one covering the coal-receiving hopper, a rather unusual arrangement, as the majority of our railway shop power plants are simple rectangles in ground plan outline; the breeching or smoke flue is of brick, a much better permanent arrangement than the usual sheet iron construction, which is liable to corrosion and is apt to cause interruptions of boiler service when renewals are required.

At Wilmington, Del., the power plant of the new P. R. R. shops also has interesting features; a track runs into the boiler room, but at trestle height above the floor; the coal is dumped on the floor and the boilers are hand fired; this arrangement of internal trestle is simple and direct, but is seldom used in the ordinary form of power plant, where the engine room and boiler room are side by side, as it would require the width of the building to be increased; but at Wilmington the two are end to end, and the width of the building was fixed by the engine room requirements, so that the internal boiler room trestle could be used to advantage and without extra cost of building. In this plant the primary generators are alternating, although there is a secondary direct current generator, in addition to an exciter set; there being also a motor generator, a very flexible arrangement results, as, even with the complete disablement of either class of generating machinery, it will still be possible to produce either or both currents in limited quantity. Three separate switchboards are installed, one for local alternating current, one for local direct current, and one for direct current used in the signaling system of the main tracks. The air compressing plant is usually complete, as it supplies air not only for local use at the shops but for the electro-pneumatic switch and signal system as well; there are special after coolers, both air and water, designed by the railroad company and intended to condense and precipitate the greatest possible proportion of the suspended moisture, which is sure to cause trouble if allowed to pass into the service pipes, particularly those of the signal system.

Danville, Ill., on the C. & E. I., affords another example of recent power plant practice; here, on account of coal being cheap and water comparatively dear, compound cylinders and condensers were eliminated, and only simple engines are found; moreover, so much confidence is felt in the generating apparatus that no spare units are provided, although the power actually installed is in two units; direct current is used throughout, power being distributed on the two-wire system and lighting current on the three-wire. Here is also found the only known extensive application (in railway shop power plant practice) of the double commutator system of motor speed control; those motors which are to be worked at variable speeds have two distinct armature windings, each connected to its own commutator, and obviously these windings can be so proportioned as to give any desired speed ratios (within limits) when used either one singly, the other singly, or the two together. In practice these combinations are effected through a controller which may be placed conveniently to the tool operator, and which is arranged to switch in and out such varying amounts of field resistance as may be required to secure the necessary intermediate steps of motor speed. In this particular application each controller is also equipped with automatic cut-outs for overloads and no load, so that the motor mechanism is well protected; it is quite possible that this and perhaps other installations of the double commutator system of motor speed control may make it necessary to revise the opinion previously expressed that the system was too complicated.

The Storehouse.—It is stated that the new storehouse of the Seaboard Air Line, at Portsmouth, Va., is one of the largest in the South; it is 70 ft. by 225 ft. and two stories; it has ample platforms, which are supported by earth filling, now planked over, but later, when renewal is necessary, to be cemented; the walls up to the level of the first floor window sills are of brick, but above that are corrugated galvanized iron on wooden framing; the roof is gravel; the whole making a very satisfactory, and also a very cheap, building.

At Wilmington the storehouse and office are combined, but at Danville they are separate.

The Foundry.—A recognized authority on foundry practice has recently stated that the best arrangement for taking cupola supplies up to the charging platform was a single hydraulic lift for plants turning out not over 50 tons of castings per day, and a double, balanced, steam or electric elevator for plants of greater output. A recent improvement in foundry equipment is the centrifugal sand mixer, electric driven, which yields an output as high as 5 tons per hour; ordinarily, however, this would be used only where a better grade of castings was required.

The Roundhouse.—An examination of the new roundhouse of the Pennsylvania at Wilmington, Del., will disclose several noteworthy features; the span, out to out of walls, is close to 90 ft., which is equal to the maximum of those previously listed; this dimension is so liberal, and the chances of any considerable increase in the over-all length of locomotives is so remote, that it is likely to remain a maximum for some time to come, although the justification for it is so complete that it is probable that it will become almost standard for the future. The turntable diameter is 75 ft. as against the maximum of 80 ft. at three B. & O. points previously listed; this is one of the lightest roundhouses yet built; others have had as high outer walls, but none have had as large a percentage of window openings; the provision of a traveling crane runway in the outer circle is the first case in railroad practice, but was probably based on the precedent established by the Baldwin Locomotive Works in their new Twenty-seventh street (Philadelphia) roundhouse. In this case smoke jacks are dispensed with and a continuous slatted ventilator in the peak is substituted, but patented systems have been devised by which traveling cranes and smoke jacks may be used in combination; the smoke jack, being both telescopic and jointed, may be drawn up and swung out of the way to allow the crane to pass. The feature of greatest novelty, however, is the provision of two inspection pits on the tracks approaching the ash pits, each of these pits being 80 ft. long; they are about 4 ft. deep, properly drained and lighted (electrically) and are entered from either side, at the center, by transverse steps formed in concrete; the idea is that proper and thorough inspection can be made while the engineman is present, and necessary repair work anticipated and arranged for while the engine is on the ash pit: in some cases it will happen that no work is required, and in such cases the engine, if business is pressing and power is in demand, may be supplied with coal and water, turned, and started out again, without entering the roundhouse at all.

At Danville the new C. & E. I. roundhouse has an out to out span of over 85 ft.; but in this case a low flat roof, supported by circular cast iron columns is used; the house is heated by the fan system and well lighted electrically; the turntable is 75 ft. diameter.

The Layout.—The original article having been published in the May issue, there is little to add, but a comparison of the layouts at Wilmington and Danville is instructive. At Wilmington the shop buildings are grouped as a unit or complete plant, while the roundhouse is isolated, being perhaps 1,200 ft. (on the average) from the departments with which it has intimate relations, as, for instance, the storehouse, erecting, machine, boiler, and smith shops; the roundhouse has a few machine tools as an offset to this. At Danville, on the other hand, the roundhouse is the centre of the group, the other departments (above listed) being ranged approximately in a circle about, and equidistant from it; the car shop buildings, the power plant, and the planing mill, being given locations farther away.

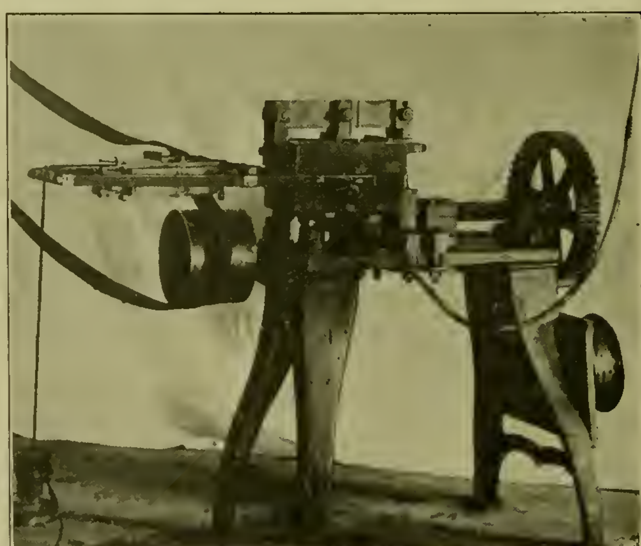
General.—It is noticed that shop buildings are sometimes figured to even feet in their outside dimensions, and sometimes to even feet in their inside dimensions, in which latter case the outside dimensions will almost always involve inches, and in many cases fractions of inches. As a problem of shop design always begins with the layout, and as the ground areas covered by the several buildings are essential factors in the problem all through, there is every reason why even feet outside dimensions should be used; when the cross sections are taken up it is just as convenient to start with an even outside as with an even inside span; in some cases neither the outside nor the inside dimensions can be expressed without resort to inches and fractions, and it is probable that in such cases the structural engineer has taken even feet for his roof span, making all other principal dimensions come out uneven. But this is a final plea for the uniform use of even feet outside dimensions.

TEST OF THE EFFECT OF INCREASING BOILER PRESSURE ON THE LIFE OF A STAY-BOLT.*

BY MILTON J. PHILLIPS.

As the stay-bolt is one of the weak parts of the modern locomotive boiler, and as much fear has been entertained by designers on the effect of increasing boiler pressures on the life of the stay-bolts, a test was made to show the effect of increasing boiler pressure.

With varying boiler pressures we have only one variable, as it is common practice to give stay-bolts a constant load per square inch at root of the threads, irrespective of boiler pressure, thus the only variable is the temperature, which varies with the boiler pressure. It is a well-known fact that stay-bolts do not fail in tension, but that they fail due to bending caused by the travel of the fire-sheet of the locomotive boiler



PHOTOGRAPH OF TESTING MACHINE SHOWING OIL BOX AND MECHANISM.

relative to the outer sheet or shell. That these sheets have a relative movement was shown by a series of experiments conducted on the Western Railway of France in 1894, and reported in the American Engineer and Railroad Journal, 1894, page 114; also in the same journal in 1897, page 319, is a report upon the same subject, which says that most of the broken bolts are found on the curved portions of side sheets and at the corners where the movement is greatest.

Though stay-bolts have been given only a load of from 5,000 to 6,000 lbs. per square inch, giving them a factor of safety of from 8 to 10, it has come to be recognized for some time past that the tensile test is but a poor test, and that some form of bending test is better. Several tests of this kind are in use, as, for example, the doubling test of the Baldwin Locomotive Works and the vibrating test of the Pennsylvania Railroad, where one end of the bolt is held rigid and the other

* Thesis text, Sibley College, Cornell University, Ithaca, N. Y.

moved back and forth ⅛ in. off center until fracture occurs. Thus the only thing to be done to ascertain the effect of increasing boiler pressures on the life of stay-bolts was to build a machine to duplicate as far as possible actual conditions and vary the temperature.

LOG OF STAYBOLT TEST.

Test. No.	Boiler Pressure, Lbs. Per Sq. In.	Temperature, Degrees F.	Vibrations.
1	150	365.5	2,760
1a	150	365.5	3,389
2	175	377.1	2,860
2b	175	377.1	2,205
3	200	387.5	2,900
4	225	397.0	2,949
5	300	421.7	3,778
6	350	436.3	3,933

1a was about 1-16 in. long.
2b was about ⅛ in. short.

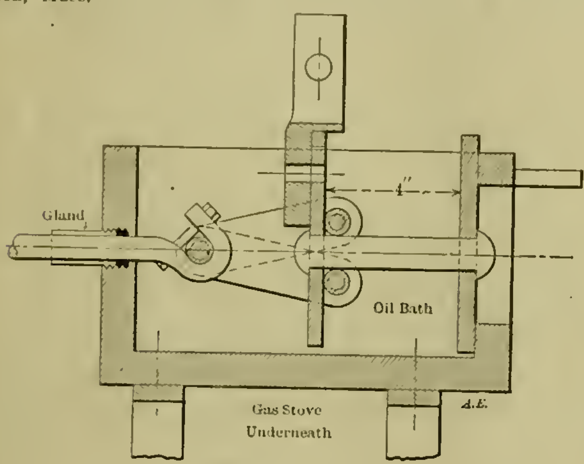
TENSILE TEST OF BOLTS.

Specimen.	Diam. in Inches.	Sectional Area	Ultimate Strength — Total Lbs.	Ultimate Strength — Lbs. Per Sq. In.	Elongation in 2 — Inches.	Elongation in 2 — Per Cent.
1	.5764	.2604	15,300	58.800	.71	35.5
2	.6	.2827	15,690	55,500	.72	36.1

TENSILE TESTS OF TAYLOR IRON ROUND BARS, 30 INS. LONG.

Diameter in Inches.	Section at Area Sq. In.	Elastic Limit — Total Lbs.	Elastic Limit — Lbs. per Sq. In.	Ultimate Strength — Total Lbs.	Ultimate Strength — Lbs. per Sq. In.	Elongation in 10 In. per cent.	Appearance of Fracture
1.00	.785	25,070	31,940	42,710	54,410	31.7	Fibrous
1.01	.801	28,580	35,680	42,250	52,750	29.7	Fibrous
.93	.679	23,700	34,900	36,160	53,250	31.3	Fibrous

Report of tests made at Watertown Arsenal for B. M. Jones & Co., Boston, Mass.

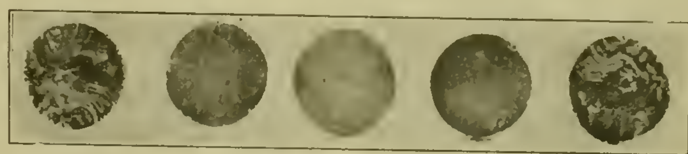


THE OIL BATH.

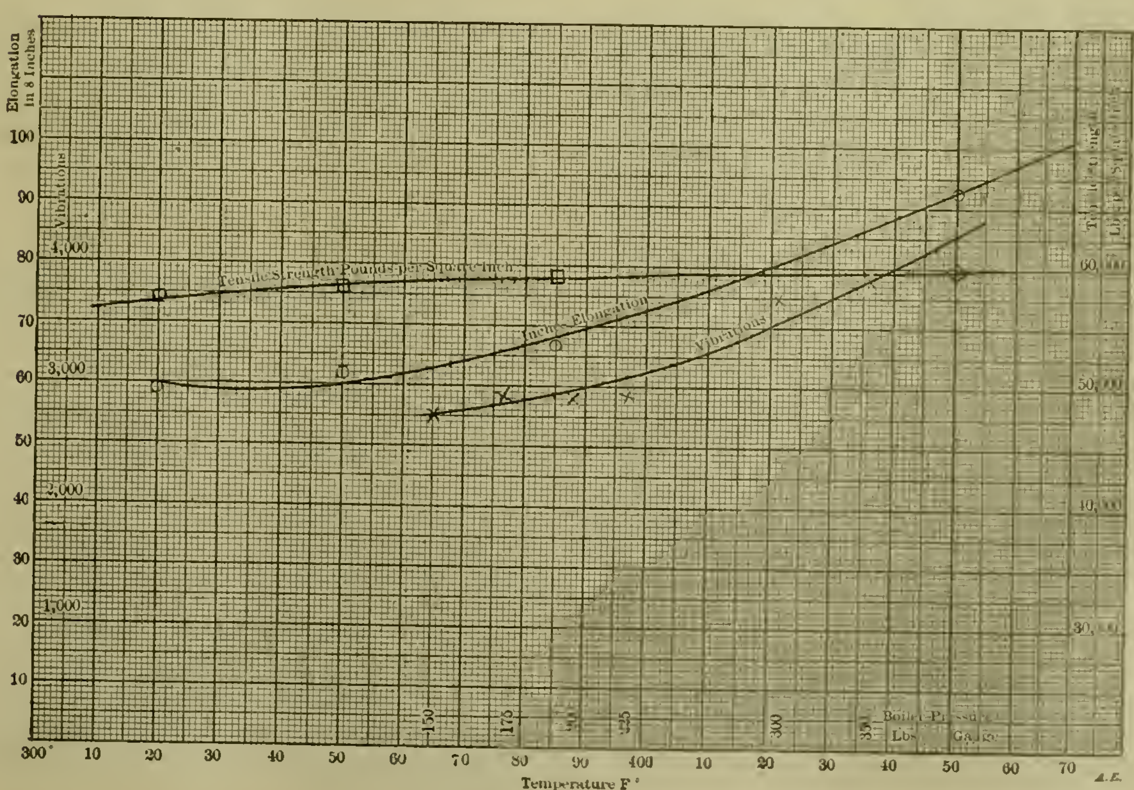
The conditions to duplicate were to hold the stay-bolt in boiler plate, outer plate thicker than inner, stay-bolt to be subjected to constant tensile load, inner plate to move relative to outer plate; outer plate to be fairly rigid; inner plate to be as free to bend as it is when hot, and to provide two further conditions of the machine, namely, the bolt to be held in the same manner each time, with the same rigidity, and the bolt to bend in the same way relative to the piling of the iron. Of course, these last two conditions are not met in actual practice, but had to be maintained to make but one variable for the test.

The above conditions were maintained in the machine used. The outer plate was bolted over a 4 x 4-in. hole in the end of the box. The outer plate was ½-in. plate, while the inner was ⅜-in. boiler plate, having been furnished by Burnham, Williams & Co. A constant tensile load was applied by means of a spring dynamometer, which acted on a rod coming through the stuffing box in the end of the box and attached to rods with roller bearings on the water side of the inner plate. The rolls gave the inner plate freedom of motion up and down. The dynamometer load was adjusted by means of two ½-in. bolts in the end of the dynamometer frame. The inner plate was moved relative to the outer plate by means of an eccentric on a shaft which lifted and lowered a lever, the movement of the plate being ⅛-in. off center each way. This was more than is found in actual service except in extreme cases, but had to be large to reduce the time of test within commercial limits. The inner plate was free to bend under the strains given, yet was rigid in directions in which rigidity is required.

The bolts were 1 in. in diameter, of the best "Taylor" iron, furnished by B. M. Jones & Co., of Boston, Mass. The ends of the bolts were etched and they were found to be of slab piled iron, as is shown by the prints taken from some of the etchings. According to Paul Krenzpointner, of Altoona, a bolt tested with the pile will stand several hundred more vibrations



ETCHED SECTIONS OF STAY-BOLTS.



CURVES SHOWING COMPARATIVE RESULTS.

than one against the pile. Thus, to make the test constant in that respect, all bolts were etched and then tested with the pile. Great care was taken also to have 7-16 in. of the bolt to rivet over and to make good, even heads. The number of vibrations was obtained by means of a revolution counter, attached to the main gear. In conjunction with this there was an automatic belt shifter that operated when the bolt broke. When the bolt broke the dynamometer drew the connection bar out until it disconnected a dog which allowed a gravity belt shifter to throw off the belt. The temperatures were obtained by means of a bath of cylinder oil and a gas stove. The inside of the outer sheet, the bolt, and both sides of the inner sheet, were exposed to boiler temperature, as in the locomotive boiler, while the outer sheet was exposed to the atmosphere on the outside. To keep the temperature constant, and to collect the fumes from the oil, a hood of tin was placed over the whole machine.

The constant tensile load was 3,200, or 200 lbs. per square inch on 16 sq. ins., an average of a large number of existing designs examined. The curve of vibrations shows an increase of from 2,760 vibrations at 150 lbs. pressure to 3,933 at 350 lbs. This curve is compared with one made on ductility at different temperatures by O. R. Wilson and R. L. Gordon for a thesis and reported on to the American Society of Mechanical Engineers in December, 1895, by Prof. R. C. Carpenter. Both curves show the temperatures corresponding to various boiler pressures to be beyond the point of minimum ductility or the blue heat danger point, as it is commonly called.

While the length of the stay-bolt was supposed to be kept constant, in two cases it was allowed to vary, and it showed that the length played a very important part in the life of the stay-bolt. That this is so may be seen from a record of two similar boilers in the AMERICAN ENGINEER AND RAILROAD JOURNAL, December, 1899, where one had a 3½-in. water leg and a record of 236 broken stay-bolts in six months, while the other, with a 4½-in. water leg, had only 32 broken. This is probably due to the fact that the movement of a 4-in. bolt even 1-32 in. off center would strain the metal in the outer fiber beyond the elastic limit, yet even beyond the ultimate fiber stress. This is shown by an application of the cantilever formula, as found in Unwin. The application of this formula shows how a small deflection may strain the outer fiber of a bolt beyond the elastic limit or beyond the ultimate strength. This may account for the results given by Mr. Spencer Otis in the discussion of a stay-bolt test of Francis J. Cole before the American Society of Mechanical Engineers in June, 1888. Mr. Otis said: "Ordinary tests give very little indication as to how a given iron will stand vibration; for instance, the average of some twenty tests of two irons is as follows:

	Tensile.	Elongation, Inches.	Elastic Limit.	Vibrations with 1,000 lbs. Tension.
No. 1	52,000	25%	26 600	89,170
No. 2	51,400	28%	26,210	37,470

While the No. 1 had much less ductility, its tensile strength was greater, thus the outer fiber was not strained so much beyond the ultimate limit."

While the above test has shown the groundlessness of the fear of higher boiler pressures, and temperatures corresponding as to blue heat effects, it has accidentally shown us that great care should be taken in getting as great a length of stay-bolt as possible. The computations also show the need of some form of ball and socket head in the places of greatest movement. In fact, the test has shown us the reason for hope of better stay-bolt life with higher boiler pressures.

CORRESPONDENCE.

SIMPLE METHOD OF ADJUSTED TONNAGE RATING.

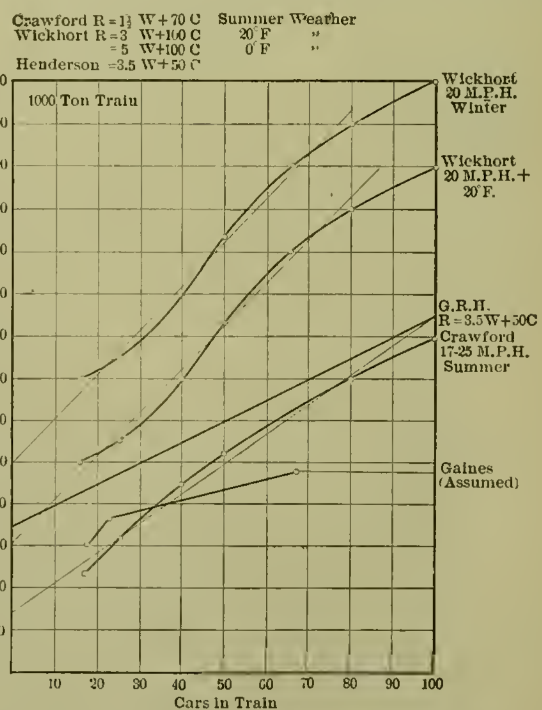
To the Editor:

I have been very much interested lately in matters relating to adjusted tonnage rating, and have read once more Mr. Wickhorst's admirable paper before the Western Railway Club on this subject, and the discussion it gave rise to. In that discussion Messrs. Gaines and Henderson both referred to their experience as to the tractive power required for light and loaded cars, and Mr. Henderson gave as his experience an especially simple formula, R = 3.5 W + 50 C, and also referred to a chart he had designed to enable the results of this formula to be practically applied. In looking into the matter more carefully it will be noticed that Mr. Henderson's formula does not agree with the results obtained by Mr. Wickhorst and Mr. Crawford on the Pennsylvania lines.

To illustrate this I have plotted the resistance on the level of a 1,000-ton train of from 10 to 100 cars, to show the relation between the resistance and the number of cars on the train. It will be remembered that Mr. Wickhorst gave a curve (Mr. Crawford's), which he called the P. R. R. curve for summer weather, a curve obtained from his dynamometer car records, which represented the resistance at a temperature of 20 deg. F., and an arbitrary curve obtained by adding 2 pounds per ton to the latter, which was assumed to be the resistance at 0 deg. F. These curves, plotted as mentioned above, are each shown on the diagram, and I have also shown a line derived from Mr. Gaines' statements, but this line is probably not correct, owing to Mr. Gaines not having stated the grade resistance in his experiments. Now, while none of the results are exactly straight lines, they are practically so within the limits of 20 and 70 cars per train, which are those which would obtain in service. The straight lines corresponding to the various curves between these limits are shown by dotted lines in the diagram, and these lines can be expressed as follows, if R = resistance in pounds; W = weight of train in tons; C = number of cars in train:

Crawford, summer weather, R = 1½ W + 70 C.
Wickhorst, 20 deg. F., R = 3 W + 100 C.
Wickhorst, 0 deg. F., R = 5 W + 100 C.
Henderson, R = 3.5 W + 50 C.

It would appear as if Mr. Henderson's allowance per car was rather too low, but the important result remains that the resistance can be expressed in this manner, and if it be assumed that Mr. Wickhorst's results can be accepted, or for that matter



COMPARISON OF METHODS.

any of these results, then I cannot see why a chart is necessary at all. It must be remembered that on any grade of g per cent. the formula would become:

$R = (3 + 2g) W + 100 C.$

Now let $W_1 (3 + 2g) = R$;

Then $W_1 (3 + 2g) = W (3 + 2g) + 100 C$;

$$\text{Or, } W = W_1 - \frac{100}{3 + 2g} C.$$

In other words, if W be an arbitrary rating, then all that it is necessary to do to obtain the equivalent tonnage is to subtract 2, 3, or 4 tons per car from this rating. This figure could easily be established for any division. For instance, suppose g to be 1 per cent. Then $2g + 3 = 23$ and $\frac{100}{23} = 4$ 1-3 tons, say 4 tons.

Now if for any engine the arbitrary rating were established at 950 tons, then for a 20-car train the rating would be 950 — 80 = 870 tons; for a 40-car train it would be 950 — 160 = 790 tons, and so on. It appears to me that this method is far simpler than the use of any chart, and that once the principle of equivalent tonnage is established on any road there is no objection to the use of an arbitrary rating. I should be very much obliged to some of your readers who are interested in this subject if they would correct me if I am wrong in these statements, as, unless I am, it appears to me that the formula proposed by Mr. Henderson will allow of a very simple method of obtaining the equivalent tonnage being used, if utilized as I have outlined.

H. H. VAUGHAN,
Superintendent of Motive Power,
Canadian Pacific Railway.

SUGGESTIONS CONCERNING "SUCCESS."

To the Editor:

Many of those who have relied for advancement upon suggestions similar to those of "Retired" in your April issue have been disappointed, and I would like to add the following as bearing on questions on which young men are doubtful at some time in their careers:

Keep constantly in mind your intention to take advantage of every opportunity to learn by observation and by thinking. If your employer wishes to advance you, he will be glad to have the quantity of your work suffer to a reasonable extent in your efforts to learn.

Be ready to work overtime cheerfully in emergencies: do not jump for your hat as soon as the clock indicates the hour of closing, and do your best while at work, whatever your salary may be. But your employer is the customer for your services, and habitual overtime work is as uncalled for as the delivery of two pounds of sugar when but one is ordered. What further effort you are capable of making would best be spent in study and reading to prepare yourself to handle in an efficient, up-to-date manner the problems that you hope soon to have presented to you.

If employed in office work, do not neglect out-of-door exercise. Few who have not tried it realize the severity of continued mental work combined with confinement in an office. When possible, office work should have outdoor work alternated with it. Indulge in judicious relaxation. If at all troubled with sleeplessness, ascertain the cause at once; and if the cause is severe mental exertion just before retiring, reduce or regulate your work so that the hour for retiring finds the emotions calm, though the brain may be tired. Health is an important factor of prosperity as well as of enjoyment, and should be cultivated at any cost.

Do not assume that, because you are strenuously complying with all your duties to your employer, you can leave all your interests to his care. In your dealings with him govern yourself by that independent, cautious, self-reliant judgment which he would want you to employ if you were to represent him in dealings with a third party. Consult freely, but decide for yourself. Some employers would think you "easy" if you acted otherwise, and none can find fault with such a course.

Have a distinct understanding as to what are your duties and responsibilities. Perform your duties conscientiously, and leave others to perform theirs. As your position becomes more important, it is well to have your duties specified in writing.

Transact all business with the proper authority. Work heartily in the interests of your immediate foreman, and do not solicit the favor of, or have direct business intercourse with, his superior without his knowledge and approval. Do not allow the superior to slight your foreman in any way in his dealings with you. In other shops and offices where you may have business always transact it with the foreman, unless you are sure he wants you, in any particular instance, to deal directly with his men. You may occasionally have to decide between the conduct which will advance you most and that which is most creditable.

Be extremely cautious about criticising other men employed by the same company as yourself. Govern yourself by a sincere and far-seeing desire to help your fellow-employees, to do no injustice, and to avoid needless entanglements. Assume that your words will have a "large circulation" and will reach the person criticised.

Study your superior officers. No two are alike, and the most careful watchfulness may fail to reveal to you their ideals of a good employee. Some officers may think that a few of these suggestions, as well as some of those of "Retired," should be ignored. One foreman may think that your attitude toward work should exhibit certain characteristics, and you may by watchfulness modify your inclinations so as to satisfy him. Presently a change places you under a foreman who prefers the opposite characteristics, but you may never know of his displeasure unless you hear of it indirectly after a conference in which your promotion was discussed.

Take a kindly interest in the men about you and greet them cordially on meeting them, but avoid anything resembling intimacy with any for whom you are responsible or with those who have authority over you.

What is "executive ability"? How does it manifest itself? How can it be acquired? Must it be "born in one"? Your employer's views on this subject are important to you.

Though ambition for positions of prominence is laudable, and though by far the greatest factor in the attainment of such positions is individual effort, in your relations with other men bear in mind the fact that position is not a measure of worth, and that many successful lives have been lived in comparative obscurity.

OBSERVER.

APPRENTICESHIP ON AMERICAN RAILROADS.

To the Editor:

I have been greatly interested in your consistent and systematic efforts to place this subject before your readers. I firmly believe that nothing more important than this confronts the officials of American railroads to-day. In this connection, the London editorial in your issue for May, relating to the apprentice schools which have developed in English railway practice, is an exceedingly interesting matter and presented interestingly. It may be made more so if the editor, from this basis, outlines a system of apprentice education for railroads, especially adapted to the mechanical departments here at home. It appears from the statements made of the situation abroad that the average establishments there have provided as favorable conditions for apprentices as are consistent with the practical working of shops.

The writer holds that the best experience and development are possible only in connection with education hand in hand with shop practice in regular apprentice systems, and that in America the railway apprentice might be, and should be, given equally favorable opportunities for education as those you describe abroad. If at the close of the apprentice term any have developed marked ability, their graduation certificate should show this to be the case; and these may be given opportunity to follow up their education by a course in technical schools or colleges.

Professor Goss has given us an insight into some of the difficulties experienced by college graduates in their progress through shops and beyond the shops. In the other system of "Shop and Education" first this difficulty is removed and the man enters college with far greater freedom and chances for success for the man and usefulness for the railroad.

What perhaps is most useful is the educational influence on the workman generally, and as a mass. With a fair education the average American workman will take good care of himself and influence his fellows for good as he advances in the scale of official life which is open to him.

GEORGE W. CUSHING.

WHY A YOUNG TECHNICAL MAN LEAVES RAILROAD SERVICE.

EDITOR'S NOTE.—The following is quoted from a letter received from a young technical graduate who has spent a number of years in railroad work, where he rose to the position of foreman. It is printed without comment because no comment seems necessary:

To the Editor:

I did not leave railroad service without considerable study and thought on the subject, and finally came to the conclusion that there was not enough in railroad work to make it pay. In the first place, mechanical department officials are notoriously underpaid. First-class mechanics and engineers get more per month than roundhouse and general foreman, and even master mechanics. Then, too, when one has climbed the ladder he is apt to be relieved from duty at a moment's notice because of the pull of some man who wants his position, and it is certainly ridiculous for the higher officials to expect men to accept twenty years of hard knocks at low wages, only to be asked to resign when they have secured something which in a measure rewards the efforts they have put forth.

I have noticed with pleasure the vigorous protests you have made in the *American Engineer* from time to time regarding the low salaries of motive power officials.

I had not the slightest trouble in securing a position at a salary which is better by 25 per cent than the best railroad position I have held, and that is only a start. Everything considered, I cannot see how railroads can expect to keep good men in their employ when they will be more appreciated elsewhere, both financially and in regard to stability of position. I see that the last sentence sounds egotistical, but there is no personal reference meant.

The fact is, that the young technical graduate today does not receive much encouragement from the railroads and the mechanical officials themselves are no better off. It will be different some day, but I cannot wait. I am one of many who regret to leave this field of work, but what else can we do? * * *

ALLFREE-HUBBELL VALVE GEAR.

To the Editor:

I have noted with a great deal of interest the comments on page 200 of your May number, and in connection with your reference to decreased compression, I want to call your attention to the fact that I think the correct expression of this thought is "the decreased volume of compression," in that we do not decrease the terminal pressure of compression.

is much heavier than in diagrams 1 and 2, proving conclusively that the scheme of undertaking to blow compression past the main valve is not a success.

Comparing diagrams 3 and 4, which represent the back pressure and compression from Allfree-Hubbell locomotive No. 3 at 110 r. p. m., as against 90 revolutions, and diagram 4, taken at 231 r. p. m., as against 180 revolutions in 2 and 6, you will note that by our ability to delay the exhaust closure we decrease the negative work of compression through the decreased volume in compression, and by our ability to do this we are therefore able to reduce cylinder clearance and still maintain relatively the same terminal pressure of compression, as in diagrams 1, 2, 5 and 6. It seems to me that a blind man ought to be able to see the great advantages that must necessarily follow to do what we do do in every-day practice and as shown by the diagrams sent you herewith. Cards 1, 2, 5 and 6 are from a very well-known Western railroad.

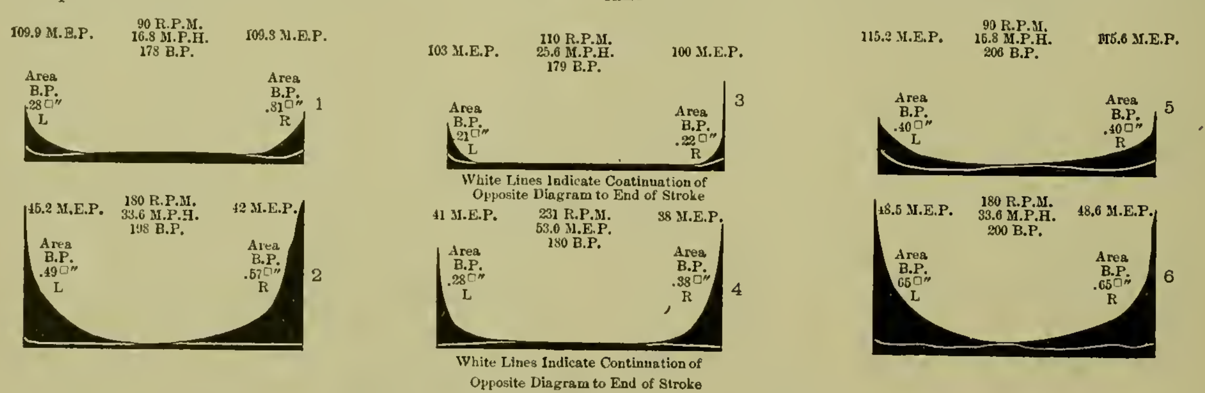
IRA C. HUBBELL.

INFORMATION ABOUT MOTOR-DRIVING.

To the Editor:

In the May (1904) issue of your journal you were kind enough to publish my letter containing some notes upon the use of our old machine tools. In writing this letter I wish to call attention to two things: First, there are a great many men holding responsible positions to-day who are awake and keenly upon the alert, looking for information whereby they may be better fitted to fill whatever position they hold; second, many of those who give information by writing or otherwise assume that those for whom the instruction is intended are as well, or nearly as well, informed as themselves. Of such information given, much that would otherwise be valuable data is useless to many of us, owing to incompleteness.

In your issue for May an article entitled "The Power Required for Planer Driving" was published, which is very interesting; but, while appreciating in this case the data given, we, like Oliver Twist, "ask for more." The writer neglects to say whether the power required is the net power required to do the cutting or the gross power used for the motor and machine, including the cut. An analysis of the article mentioned shows, first, that three cuts were taken the total area of which was .086 sq. in. This area, at 20 ft.



COMPARISON OF BACK PRESSURE AND COMPRESSION.

There is a very neat distinction in decreasing volume in compression and decreasing compression, in that decreased compression necessarily means a decreased terminal pressure in compression, whereas a decreased volume in compression necessarily relates to a decrease in the negative work inseparable from compression, and I know of nothing that illustrates the point more distinctly or clearly than the six diagrams which I send you on the enclosed blue print.

Diagrams 1 and 2 represent the back pressure and compression from a 20 x 26 locomotive with piston valve having the usual link motion. Diagrams 5 and 6 represent the back pressure and compression on the same locomotive after it was equipped with a valve for the purpose of allowing compression and back pressure to blow past the main valve through the nozzles and stack to the atmosphere; the scheme being to add exhaust lap to the main valve, so as to delay exhaust opening, and which would necessarily advance exhaust closure, but the intention is, through this auxiliary valve, to let the increased volume in compression blow past the main valve to the atmosphere, and you will note that, as a result, the negative work in diagrams 5 and 6 is considerably greater than the negative work in diagrams 1 and 2, as a direct result of this early closure of the exhaust port.

You will note that diagrams 1 and 5 are taken at 90 r. p. m. Diagrams 2 and 6 are taken at 180 r. p. m., and you will see at a glance that the negative work of compression in diagrams 5 and 6

per min. cutting speed, equals a cutting rate of 20.64 cu. ins. of metal removed per minute. This amounts to a rate of 312.6 lbs. of metal removed per hour. The reason for giving these figures will be apparent later.

Referring to the table of figures given, it will be seen that, for a cutting speed of 20 ft. per min., 23.5 amperes were required, and for 26 ft. per min. 28.75 amperes were needed. From these figures it will be seen that, while the cutting speed increased about 30 per cent., the amperes increased only about 22 per cent. It would seem that the net power required for cutting would increase in the same ratio as the cutting speed. This being the case, it would further seem that the amount of amperes given represented gross power required. If this is true, then the natural inference is that the power needed to drive the machine increased at a less ratio than that of the speed of the machine.

To illuminate the matter, reference can be had to our notebooks, and here we have the following rules: First, for each cubic inch of metal removed per minute allow for a net power of ½ h. p.; second, the net horse-power required = W × .032 where W = the weight of metal removed per hour; third, the net horse-power required = W.0165 where, as before, W = the weight of metal removed per hour. Between the authorities for the second and third rules there is an ocean's width, both figuratively and literally. Note that these rules are for ordinary cast iron—a somewhat elastic set of formulæ. According to the first and second rules, about 10 h.p. would be required for the net work of cutting, while by the third rule only about 5.34 h.p. will be needed. Hence the application of rules 1 and 2 would indicate that the amperes given in that article were for cutting only, while rule 3 would seem to show power used.

If this little "digging" for light should prove of as much interest to some of your readers as it has been to me, I will not regret it. Some of us are compelled to learn from the experience of others; hence the "digging." Let us apply rule 3 and assume that only 5.3 h.p. are needed for the net work of the cut; this, taking 23.5 amperes, or 7.24 h.p. (at 230 volts), as the gross power required, leaves 1.91 h.p. for running the motor and machine. We have noted that the increase of cutting speed was 30 per cent. and the ampere increase was 22 per cent. Applying these, we have 5.3 h.p. + 30 per cent. = total of 6.93 h.p., and 1.91 + 22 per cent. = 2.3 h.p., or a total of 9.2 h.p., which brings it somewhere near the horse-power of 28.75 amperes, which = 8.86 h.p.

The conclusions that can be drawn from these figures are: First, if the data given represent gross power, then rule 3 comes quite close in this particular case, and the performance is good. Such a result, to my mind, would indicate very soft metal and very sharp and well-shaped tools; also that 1.91 h.p. for driving this size machine, including the motor, seems very light indeed. But if the data given represent net horse-power, some rule between 2 and 3 might be deduced which would be of use in similar cases and under the same conditions.

To have made such data more beneficial there should have been given, in connection with the cutting speeds, the power required for running the motor and belts alone, the power required for moving the platen in each direction, and the net power for taking the cut, as well as the total gross power required at the various speeds.

Have I made myself clear in this request, that your contributors should give more attention to these little matters, and by so doing make their communications of more benefit to those who need them?

M. E.

EXPERIMENT WITH "PONY" AND FOUR-WHEEL TRUCKS.

To the Editor:

The increasing use of the 4-6-2 type of locomotive keeps before us the question of the relative safety of pony and four-wheel leading trucks. Considerations of cost and efficiency of the engine, necessary length of boiler tubes, sizes of turn-tables; and lengths of engine-house stalls, add to the interest. A rational view of the problem seems to be about as follows:

Having given a pair of wheels of given weight and tire section, running on a given rail, at a given speed, and carrying a given load with its center of gravity at a given height above the rail, its sensitiveness to derailment depends upon (1) the horizontal forces acting on it, due to the centrifugal tendency of the truck itself, and to the horizontal components of the forces transmitted by the cradle suspension links; and (2) the direction of the axle with relation to a radius of the curve of the track. The effect of (1) is, in both trucks, to throw the outer wheel over its rail, and quantitatively the effect per wheel is not much different in the two kinds of truck. The direction of the forward axle of the four-wheel truck necessarily acts in conjunction with the horizontal forces, but the direction of the pony-truck axle can be made to oppose the tendency of the horizontal forces, producing a truck which it is very difficult to derail.

With the object of investigating the action of the trucks experimentally, a model of the running-gear of a locomotive was prepared, as shown by the sketch. The wheels are of cast iron, the axles of steel, the hangers of wire, and the rest of wood. It was so arranged that the front part could be altered to represent either a ten-wheel or a mogul-wheel arrangement. In all the experiments the same pair of wheels was the leading pair, and each wheel was always on the same side of the engine. The equalizing arrangement was used so as to be sure each wheel had its proper load. The model was loaded with shot to bring its weight as follows:

	Ten-Wheel.	Mogul.
Weight on drivers	6 lbs. 10 oz.	7 lbs. 11 oz.
Weight on truck	2 lbs. 10 oz.	1 lb. 5 oz.
Total weight	9 lbs. 4 oz.	9 lbs

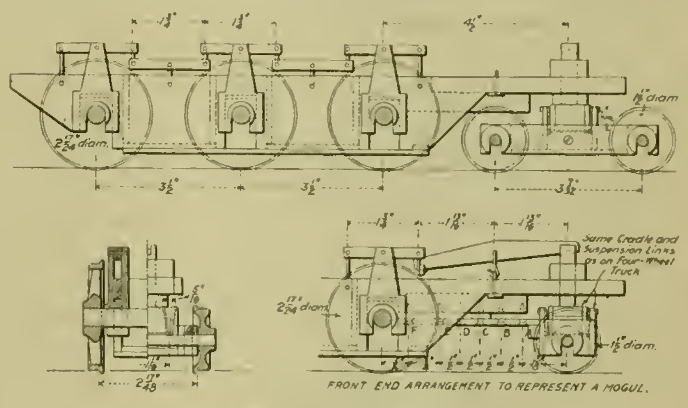
In order to investigate the effects of different lengths of radius bars, the model was so arranged that the radius bar pin, which was a wood screw, could be placed at A, B, C, D, E, or F. An inclined plane, 16 ft. long, and having its higher end 38 ins. above the lower one, was erected, on which to run the model. At the bottom of the incline there was a level curve of 14 ft. radius.

It is evident that, this being a reproduction of the running-gear of a locomotive to a scale of ½ in. to the foot, and all weights concerned being proportional to the size, the forces obtained will have the same directions as, and be proportionate to, those produced by the full-size locomotive on its track; therefore, this is a legitimate method of studying the subject.

The method adopted consisted in placing blocks inside both rails on the curve so that the flange would run onto the blocks. As they were of the same height as the rail, there was nothing to guide the wheels while on the blocks. The experiments consisted in determining the lengths of blocking that the trucks could pass over, afterward falling into their proper places on the rails. Preliminary experiments showed that the speed had little, if any, influence on these results, but the speeds were, notwithstanding, kept uniform by starting the model from the same point on the inclined plane for each trial. The inner rail was blocked as well as the outer one so as to have both wheels running on their flanges, with the same effective diameter. The results are given below:

Experiment Number.	Truck Used.	Location of Radius Bar Fulcrum.	Length of Blocking Required for Derailment (Inches).
1	Four-wheel		½
2	Pony	F	1¼
3	Pony	D	1½
4	Pony	C	6
5	Pony	B	12
6	Pony	A	12

The figures show that, although blocks but ½ in. long threw the four-wheel truck off, the pony truck with a short radius bar would follow the track for over 11 ins., with nothing to guide it, dropping into its place after passing the blocks. It is needless to say that the model would not back over anything like this obstruction. After derailment the cradle suspension links of the pony truck kept the truck frame in a fairly good position and the model rolled along smoothly. But the four-wheel truck turned more quickly, and the



EXPERIMENTAL TRUCKS.

wheels began to slide sidewise in a way that would have been disastrous if they had struck an obstacle. (The rails were attached directly to a board.) The experiments show also the advantages of short radius bars.

The rocking usually observed on a locomotive having a pony truck could not be reproduced here, but this rocking is not a necessary feature of the truck. It can be overcome by slight changes in the equalizing arrangement.

It appears, then, that the 2-6-0 and 2-6-2 types need not be rejected on the score of safety.

G. F. STARBUCK.

Waltham, Mass.

SCHOOL FOR TELEGRAPH OPERATORS WANTED.—"While the railroads are spending millions for various equipment to reduce expenses and improve operation, not one cent, nor one moment's time, is devoted to procuring and carefully training the operators they place in charge of their most valuable property. When an operator is to be employed it is a fish-net proposition and whatever is caught is pressed into the service, his habits and qualifications not fully known for some time afterward. One appropriate remedy for this condition would be the establishment of a telegraph school by as many as five or six large railroads, the only obligation required of each road being to furnish transportation for the student to school and employ such students as become operators, the school to be made thorough, teaching every branch of the work."—*J. C. Browne, before the St. Louis Railway Club.*

LOCOMOTIVE STEAMING CAPACITY.

BY L. L. BENTLEY, MECHANICAL ENGINEER, LEHIGH VALLEY RAILROAD.

An expression for the steaming capacity of a locomotive, to be satisfactory, must be simple in form and applicable to all cases and conditions. It is possible to get, by a combination and development of several of the methods already advanced, an expression for the required heating surface of a locomotive at maximum power which contains only two variables for simple engines and three for compounds. If, then, we have the required heating surface to supply steam to the cylinders at maximum power, and divide this into the actual heating surface of the locomotive, the quotient is a direct measure of the steaming capacity.

Mr. F. J. Cole, in his article in the AMERICAN ENGINEER for June, 1900 (page 176), has shown that the maximum power of a locomotive is a function of the piston speed, and that maximum power is developed at a piston speed of about 1,400 ft. per minute. Then the total heating surface is equal to the product of the maximum horse-power multiplied by a constant. (See AMERICAN ENGINEER, July, 1902, page 238.) These two facts are utilized as follows:

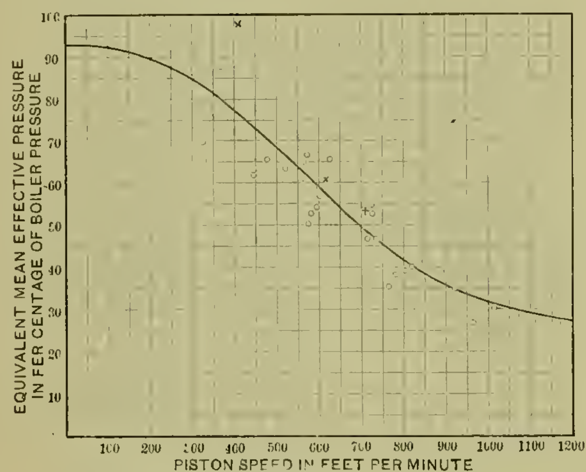


FIG. 1.

Let H = Horse-power.
p = Mean effective pressure.
L = Stroke in inches.
d = Diameter of cylinder in inches.
r = Revolutions per minute.
V = Speed in miles per hour.
P = Piston speed in feet per minute.
B = Boiler pressure in pounds per square inch.
D = Diameter of driving wheels in inches.
S = Heating surface of boiler in square feet.

Then for a simple locomotive of two cylinders,

$$H = \frac{p \times \frac{L}{12} \times \frac{3.1416d^2}{4} \times 4r}{33000} \qquad (1)$$

$$r = \frac{V \times 5280 \times 12}{60 \times 3.1416\ D} = \frac{1056V}{3.1416\ D} \qquad (2)$$

$$H = \frac{p \times \frac{L}{12} \times \frac{3.1416d^2}{4} \times \frac{4 \times 1056\ V}{3.1416\ D}}{33000} = \frac{p\ d^2\ L\ V}{375\ D} \qquad (3)$$

$$P = \frac{2\ L\ r}{12} = \frac{2\ L \times 1056\ V}{12 \times 3.1416\ D} = \frac{56\ L\ V}{D} \qquad (4)$$

For maximum power, P = 1400; therefore, we have $1400 = \frac{56LV}{D}$

$$\text{Whence, } V = 25\frac{D}{L} \qquad (5)$$

$$H\ (\text{maximum}) = \frac{p\ d^2\ L}{375\ D} \times 25\frac{D}{L} = \frac{p\ d^2}{15} \qquad (6)$$

At a piston speed of 1,400 ft. per minute, p = .28 B (see F. J. Cole, in AMERICAN ENGINEER, June, 1900, page 176);

$$\text{Then } H\ (\text{maximum}) = \frac{.28\ Bd^2}{15} = .01866\ Bd^2 \qquad (7)$$

If we make the assumptions that the cylinders of a simple locomotive require 28 lbs. of steam per horse-power per hour at the cut-off corresponding to maximum power, and that the boiler can evaporate as a maximum 15 lbs. of water from each square foot of heating surface in the same time, then for just sufficient boiler power we have:

$$28\ H\ (\text{maximum}) = 15\ S \qquad (8)$$

$$28 \times .01866\ Bd^2 = 15\ S;$$

$$\text{Whence, } S = .0348\ Bd^2 \qquad (9)$$

Fig. 1 shows the results of a study of the data which were at hand concerning compound engines. The points on the diagram were plotted from indicator cards as follows: The mean effective pressure in the high-pressure cylinder was reduced to the equivalent pressure in the low-pressure cylinder by dividing by the ratio of the cylinder volumes. This equivalent pressure was averaged with the actual mean effective pressure in the low-pressure cylinder. Then for equality of work in both cylinders it is evident that the initial pressure (and therefore the mean effective pressure) in the low-pressure cylinder will vary inversely as the ratio plus 1 of the low-pressure cylinder volume to the high-pressure cylinder volume. The average pressure just mentioned was multiplied by this factor and divided by the boiler pressure, to give a proper basis of comparison.

This process is expressed symbolically as follows: Letting ph = M. E. P. in the high-pressure cylinders, pl = M. E. P. in the low-pressure cylinders, and q = ratio of cylinder volumes;

$$\frac{ph}{q} = \text{equivalent M. E. P. for the high-pressure cylinder in low-pressure cylinder.}$$

$$\frac{\frac{ph}{q} + pl}{2} \times (q + 1) = \text{equivalent mean effective pressure for the high-pressure cylinder exhausting to atmosphere.}$$

This value in percentage of the boiler pressure was plotted on the diagram, each point representing an indicator card. The curve drawn through the average of these points is very similar to that given by Mr. F. J. Cole for simple engines. If the horse-power be computed for various speeds with pressures as given by this curve it will be found that the maximum horse-power is attained at a piston speed of about 750 ft. per minute.

For two cylinder compounds, assuming the work done to be equally divided between the cylinders, we can now write the following by analogy with equation (3):

$$H = \frac{pl\ (dl)^2\ L\ V}{375\ D} \qquad (10)$$

For compounds at maximum power, $P = \frac{56\ L\ V}{D} = 750;$

Whence, $V = 13.39 \frac{D}{L}$ (11)

Hence $H\ (\text{maximum}) = \frac{p\,l\,(d\,l)^2\,L}{375\ D} \times 13.39\ \frac{D}{L} = \frac{p\,l\,(d\,l)^2}{28}$ (12)

At 750 ft. per minute piston speed, $p\,l = \frac{.46\ B}{q+1}$ (see diagram); so that $H\ (\text{maximum}) = \frac{46\ B\ (d\,l)^2}{28\ (q+1)}$ (13)

If we assume that at the cut-off corresponding to maximum power the cylinders of a compound locomotive require 25 lbs. of steam per horse-power hour, and that, as before, the boiler is capable of evaporating 15 lbs. of water per square foot of heating surface, then for just sufficient boiler power, we have:

$25\ H\ (\text{maximum}) = 15\ S$ (14)

Substituting,

$25 \left[\frac{.46\ B\ (d\,l)^2}{28\ (q+1)} \right] = 15\ S, \text{ and } S = .0274 \frac{B\ (d\,l)^2}{q+1}$ (15)

And, similarly, for four-cylinder compounds,

$S = \frac{.0548\ B\ (dl)^2}{q+1}$ (16)

Of course, the assumptions made above are not true for all locomotives, but they represent average good conditions.

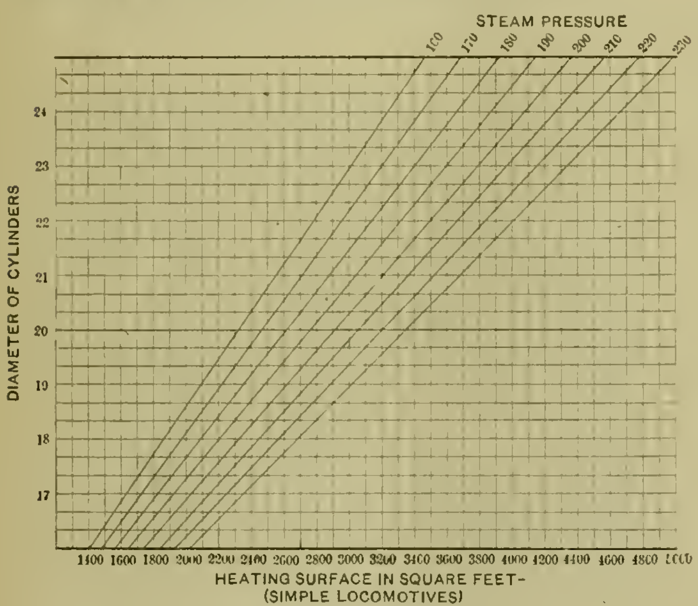


FIG. 2.

from this position the heating surface is read on the scale at the bottom.

Fig. 3, which shows the heating surface required for a four-cylinder compound locomotive to furnish sufficient steam at maximum power, has been constructed from equation (16). The value of $\frac{(d\,l)^2}{q+1}$ is taken from Table I. Fig. 3 can also be used for two-cylinder compounds by taking half the result.

TABLE II.

PASSENGER ENGINES.—FROM SUPPLEMENT TO "AMERICAN ENGINEER," JUNE, 1903.

Road.	Type.	Cylinders.	Actual S.	Calc. S	Steaming Capacity at Max. Power.
Plant System ..	119	4-c. bal. com.	2793	1812	1.54
C. & N. W.....	D	Simple	3015	2784	1.08
C., R. I. & P....	1301	Simple	2806	3000	.94
C. R. R. of N. J.	....	4-cyl. com.	2657	1597	1.66
L. S. & M. S....	I-1	Simple	2917	2930	.995
B., R. & P......	162	Simple	3007	3140	.96
Mo. Pac.	1118	Simple	2953	2784	1.06
L. S. & M. S....	J	Simple	3362	2920	1.15
N. Y. C. & H. R.	1-2980	Simple	3505	3070	1.14
Pa. Lines	E 2 A	Simple	2639	3000	.88
P. R. R........	E-2	Simple	2640	3000	.88
I. C.	1001	Simple	3191	2784	1.14
C., M. & St. P...	A-2	4-cyl. com.	3215	1812	1.77
Col. Mid.	201	4-cyl. com.	2625	2315	1.17
C., B. & Q......	1586	4-cyl. com.	2990	1903	1.57
A., T. & S. F....	....	4-cyl. com.	3029	1994	1.52
C. R. R. of N. J.	....	Simple	1834	2250	.815
C. & O.........	147	Simple	3533	3360	1.05
C. R. R. of N. J.	590	Simple	2967	3065	.97
L. V.	10-D-17-W	4-cyl. com.	2708	2315	1.17
Nor. Pac.	284	Simple	3463	3360	1.03
I. C.	1000	Simple	3534	2784	1.23
A., T. & S. F....	P-14 A	4-cyl. com.	3738	2315	1.62
N. Y. C........	1410	Simple	2437	2784	.875
C. & A.........	601	Simple	4078	3690	1.11

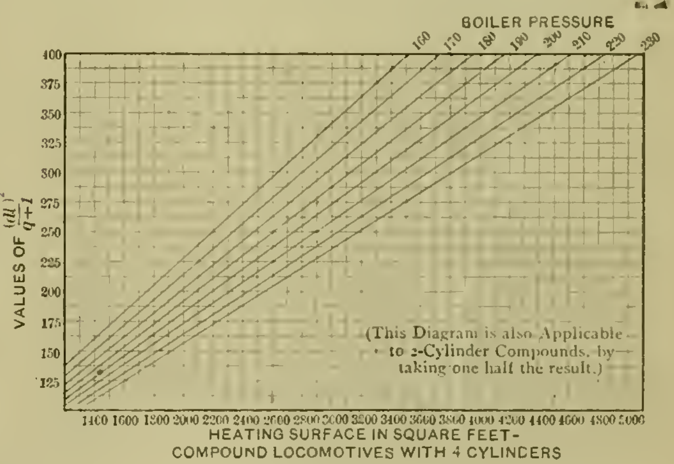


FIG. 3.

TABLE I.

VALUES OF THE EXPRESSION $\frac{(d\,l)^2}{q+1}$ FOR VARIOUS SIZES OF CYLINDERS.

Diameter of High-Pressure Cylinder.

Diameter of Low-Pressure Cylinder.	13	13½	14	14½	15	15½	16	16½	17	17½	18	18½	19	19½	20	20½	21	21½	22	22½	23	23½	24
22	125	132																					
23	128	135	143	150																			
24	131	138	146	154	162	169																	
25		142	149	157	165	173	182																
26			152	160	169	177	186	194	202														
27				163	172	181	190	198	207	216													
28					175	184	193	202	211	220	229	238											
29						187	196	206	215	224	234	244	253	262									
30							198	209	219	229	238	248	258	267	277	287							
31								212	222	232	243	252	263	273	283	293	303	312					
32									225	236	246	257	268	279	289	299	309	319	329				
33										240	250	261	272	282	293	303	314	324	335	346	356		
34											253	264	275	286	297	308	320	332	342	352	362	374	
35												267	279	291	302	313	324	336	347	358	369	380	392

Fig. 2 has been constructed from equation (9) and shows the heating surface required for a simple locomotive to furnish sufficient steam at maximum power. To use this diagram find the cylinder diameter at the left and proceed toward the right to the inclined line corresponding to the steam pressure;

Tables II. and III. show these methods applied to the comparison of locomotives, tabulated in the supplement of the AMERICAN ENGINEER for June, 1903. The compounds nearly all show a large excess of boiler power, and were more data available, the curve shown in Fig. 1, or some of the assumptions made, might be changed somewhat, but the general accuracy is confirmed by the fact that if the heating surface is figured for the equivalent simple engine, the excess boiler capacity is still shown.

The general experience with compounds has been that they are more sucessful at low speeds, such as are attained in freight service, than in high-speed passenger service, and it would appear that designers have supplied the compounds with heating surfaces unnecessarily large with the idea of helping them out at high speeds. An examination of the curve shown in Fig. 1 shows this to be useless, as at a piston speed of about 750 ft. per minute the equivalent pressure decreases faster than the piston speed increases, and hence at that point the cylinders use steam at their maximum rate. That this point of maximum power for compounds occurs at piston speed so much lower than for simple locomotives is probably due to the fact that for the compounds the steam must be handled through ports and valves twice as often as in the case of simple engines.

TABLE III.

FREIGHT LOCOMOTIVES.—FROM SUPPLEMENT TO "AMERICAN ENGINEER," JUNE, 1903

Road.	Type.	Cylinders.	Actual S.	Calc. S	Steaming Capacity at Max. Power.
L. S. & M. S....	B-1	Simple	2874	3070	.94
Sou. Pac.	2026	2-cyl. com.	3025	2025	1.49
N. Y. C........	G. 2.	2-cyl. com.	3480	2125	1.64
P. R. R........	H. 6-A	Simple	2842	3440	.83
Nor. Pac.	Y-2	4-cyl. com.	3414	2020	1.69
N. Y. C........	2399	4-cyl. com.	3480	2020	1.72
C., R. I. & P....	1603	Simple	3264	3350	.98
A., T. & S. F...	836	4-cyl. com.	2965	2642	1.12
I. C.	639	Simple	3203	3870	.83
D., L. & W.....	808	Simple	3168	3070	1.03
Burlington	580	Simple	3827	3520	1.09
Erie	1565	4-cyl. com.	3011	2178	1.38
Nor. Pac.	Y-3	4-cyl. com.	3646	2018	1.80
Soo	600	4-cyl. com.	3000	2482	1.21
Great Northern..	100	Simple	2965	3220	.92
A., T. & S. F....	824	4-cyl. com.	4266	2425	1.75
I. C.	640	Simple	3500	3870	.90
L. V.	....	4-cyl. com.	4105	2610	1.58
N. Y. C........	G-4	4-cyl. com.	4142	2282	1.81
Union	95	Simple	3321	3690	.90
A., T. & S. F....	989	4-cyl. com.	4681	2824	1.65
A., T. & S. F....	900	4-cyl. com.	5366	2940	1.82
A., T. & S. F....	940	4-cyl. com.	5390	3320	1.62

REDUCED COST OF OPERATION THROUGH GRADE AND CURVATURE REDUCTION.

An admirable paper on this subject read before the American Railway Engineering and Maintenance of Way Association by Mr. J. B. Berry, chief engineer of the Union Pacific Railway, contains the following conclusions:

Gradients.—A reduction of gradient on an engine district 100 miles long so as to require one less daily train in each direction will result in a saving of $37,230 per year. For other lengths of district or a greater reduction in the required number of trains, the saving in operating expenses per year will be in direct proportion to this. Any reduction in length of helper grades or other change that will eliminate one helper engine of the same size as the standard road engine will result in a saving of $14,673 per year, providing that the helper engines average 100 miles per day. For other average daily mileage of helper engine the saving is in direct proportion to this.

Distance.—A saving in distance will result in the following savings per year per daily train one way:

Class A.—Distances so short as not to affect wages of engine or trainmen, 2.6 cents per foot, or $137 per mile.

Class B.—Distances affecting train wages, but not affecting the number of side tracks required, 3.7 cents per foot, or $196 per mile.

Class C.—Distances so great as to affect the number of side tracks required, 4.8 cents per foot, or $252 per mile.

Curvature.—The elimination of degrees of total curvature will result in a saving per year per daily train one way of 23 cents per degree for uncompensated curvature and 19 1-3 cents per degree for compensated curvature.

Rise and Fall.—The elimination of one foot of rise and fall will result in a saving per year per daily train one way as follows: Class B, where grades are such as to require shutting off steam in descending but not to require application of brakes on minor grades, 55 cents per foot and on ruling grades, 96 cents per foot. Class C, where grades are such as to require the application of brakes on minor grades, $1.15 per foot and on ruling grades $1.57 per foot.

The proportions of the boilers being installed at the Fifty-ninth Street power plant of the underground rapid transit railway in New York City are interesting for their great size. Each of the 60 boilers is of 600 h.p. rated capacity and delivers superheated steam at 200 lbs. pressure. The boilers are of the water-tube type, built by The Babcock & Wilcox Company, each having 294-4-in. tubes, 18 ft. long; the tubes are arranged in 21 vertical sections, each 14 tubes high. Each boiler is provided with 3 steam drums, 23 ft. 3 ins. long by 42 ins. diameter; these drums are of open hearth steel, 9-16 in. thick, of 56,000 lbs. tensile strength.

Main Line Electric Train on an English Railway.—The North Eastern Railway instituted electric service on its main line, between the Central Station and Benton, about a month ago. The current is brought from the Newcastle-on-Tyne Electric Supply Company, the transmission voltage being 6,000, which is reduced to 600 volts for the third rail at sub-stations. Thirty-seven miles of road are operated electrically, with two and four tracks, the schedules being reduced from 35 minutes by steam to 23 minutes by electricity for local trains, and to 15 minutes for express trains.

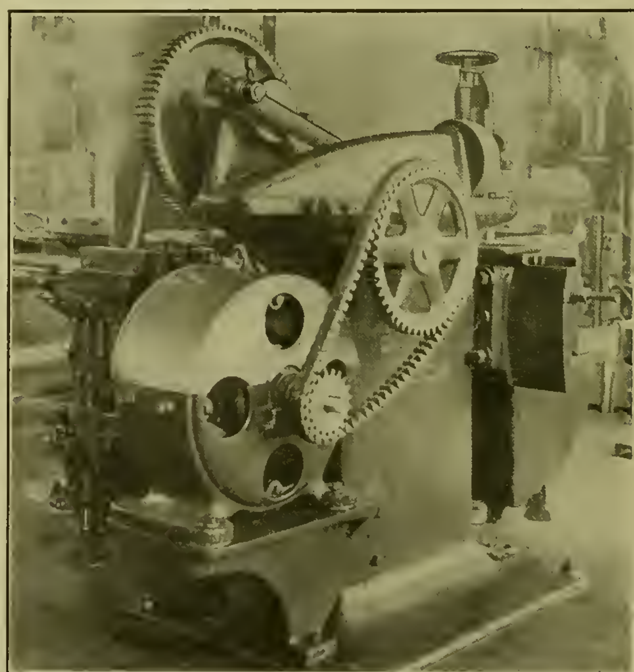


FIG. 57.—A COMPACT ARRANGEMENT OF VARIABLE-SPEED MOTOR DRIVING UPON A 12-IN. HEWES & PHILLIPS CRANK SHAPER.—5 H.P. CROCKER-WHEELER MOTOR.

Remarkable Acceleration by Automobiles.—The recent automobile speed trials at Nice developed facts which should set people thinking as to the possibilities of internal combustion motors for transportation purposes. One, a 100 horse-power automobile, made a remarkable record of a mile from a standing start in 53 3-5 sec., or at the rate of 68 miles per hour. This machine is entitled to the utmost respect. In these trials one of the machines made a record of 82.24 miles an hour, and another one 94.74 miles an hour. These speeds have a significance much greater than that connected with the construction of mere racing machines, and they point to the possibility of a much more important and practical use of internal combustion motors than that of driving pleasure or racing automobiles.

THE APPLICATION OF INDIVIDUAL MOTOR-DRIVES TO OLD MACHINE TOOLS.

McKEES ROCKS SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

BY R. V. WRIGHT, MECHANICAL ENGINEER.

XII.

SHAPERS.

In continuation of the description of the applications of motor-driving to reciprocating tools which was taken up in the preceding article of this series, here are described such applications to shapers. Figs. 57, 58 and 59 illustrate the application of individual variable-speed motor-driving to two old shapers at the McKees Rocks Shops. Both of these installations are quite simple, the object, of course, being to make the combination as compact as possible.

A Hewes & Phillips 12-in. crank-shaper is shown in Fig. 57. In order to apply the motor it was only necessary to replace the belt speed-cone by the large Morse silent-chain sprocket and to furnish the cast iron bracket to support the motor, the details of which bracket are shown in Fig. 58.

The motor used here is a Crocker-Wheeler 5-H.-P. compound-wound motor, operated by a type 40-M.F.-18 controller of the same make; this combination gives the total maximum speed of 65 strokes per minute. The panel board, which is shown to the left in Fig. 57, carries on its rear side the main switch, fuses and the circuit breaker, and on its front side the controller.

This shaper has a maximum speed of 71 strokes per minute and is driven by a Crocker-Wheeler 7¼-H.-P. compound-wound motor, in connection with a 40-M.F.-18 controller. This shaper has two runs of gearing, and these, in connection with the motor, furnish a wide range of speed. The panel board and the controller are placed in the same relative position as for the shaper described above.

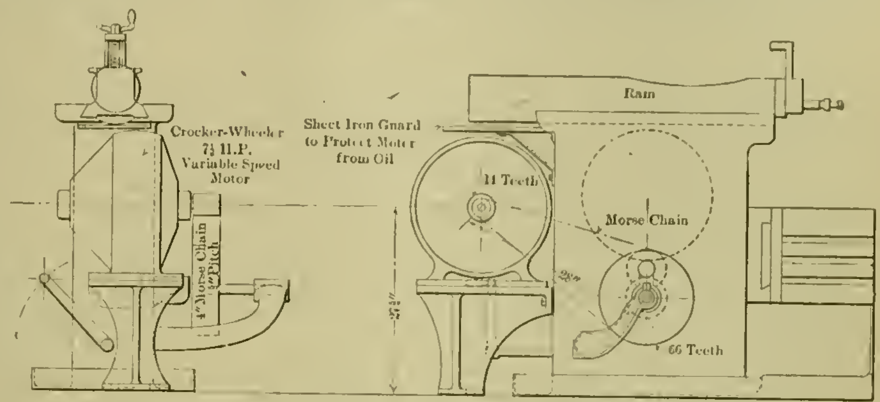


FIG. 59.—THE ARRANGEMENT OF MOTOR DRIVING USED UPON THE 24-IN. GOULD & EBERHARDT CRANK SHAPER.—7½ H.P. CROCKER-WHEELER MOTOR.

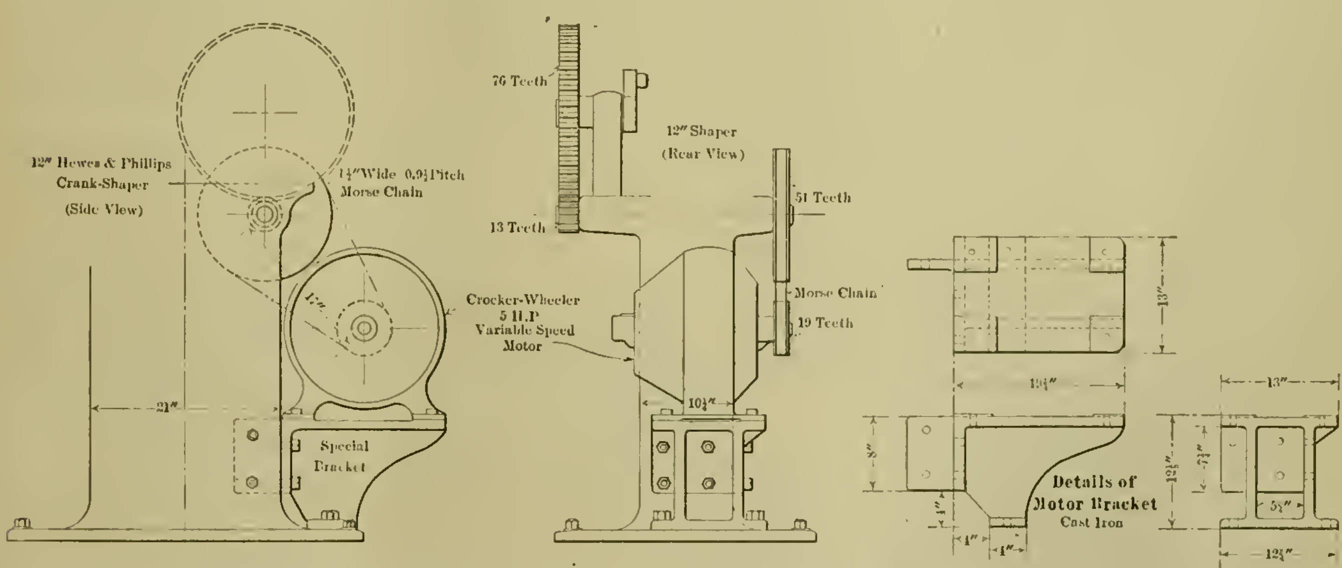


FIG. 58.—DETAILS OF THE MOTOR DRIVE APPLIED TO THE HEWES & PHILLIPS SHAPER, SHOWING STYLE OF MOTOR SUPPORT BRACKET.

An application to an old Gould & Eberhardt 24-in. crank-shaper is shown in Fig. 59. The method of applying the motor is practically the same as for the shaper described above. The belt cone was replaced by a silent chain sprocket and a bracket made to support the motor at the rear of the tool, as shown in the drawing.

This drive is of particular interest in this connection, as it illustrates the flexibility of the silent chain in this class of work. The size of the largest sprocket which could be used was so limited that it was impossible to use a chain with very large pitch. The pitch was made as large as possible, and then the chain was merely made wide enough so that it would have sufficient strength.

REMARKABLE SERVICE OF PISTON VALVES.—A set of "American" semi-plug piston valves with their valve cages have just been removed from a locomotive on the Buffalo & Susquehanna Railroad in order to be sent to the exposition at St. Louis. These valves were applied June 11, 1901 and have been in continual service up to March 31, 1904, a little over two years and nine months. In this time no repairs of any nature have been made to the valves and they have not been removed from the valve cylinders except for the application of metal packing and once for examination. Mr. C. R. Williams, general master mechanic of the road, stated that during this service no blow whatever has been detected in the valves and they were perfectly tight when removed." He says: "From the present condition of the valves I see no reason why they should not continue to give this same service for five years yet." During the period of service mentioned, the engine has made 91,340 miles. A profile of part of the road on which this engine has been running shows that it has done a large amount of drifting. Mr. Williams states that the reverse levers of this engine are dropped while drifting, in the same manner as slide valve engines are handled, and that the engine drifts freely, although there are no by-passes or relief valves in the steam chests.

MALLET ARTICULATED COMPOUND LOCOMOTIVE.

0-6-6-0 TYPE.

BALTIMORE & OHIO RAILROAD.

(See AMERICAN ENGINEER for May, page 167, and June, pages 218 and 237.)

In such road trials as could be made before this locomotive was sent to the World's Fair at St. Louis the performance was entirely satisfactory. Those who witnessed the trials were impressed with the fact that in hauling a very heavy train on slippery rails, without sand, both engines did not slip simultaneously and the tension on the drawbar was never relieved as it is in the case of an ordinary engine. Further trials will be deferred until the locomotive is put into regular service.

This engine was designed to haul 2,222 tons, in 50-ton cars, up a grade of 1 per cent. on straight track, at a speed of 10 miles per hour, under fair conditions of weather and rail, the engine working compound and the resistance being figured at 31.5 lbs. per ton. It is to work between Cumberland, Md., and Sandpatch. The design was prepared for 30 deg. curves and 20 deg. reverse curves, without tangents between.

The engine being very large to be handled in the shops, advantage was taken at every possible opportunity to use bushings in the running gear, so that running repairs might be made without taking the engine over the road except when absolutely necessary.

The boiler has been already described. The locomotive stands so high as to render it necessary to use an unusually low dome, which is made of cast steel, with an annular cavity partially surrounding it, leading from the throttle valve connection to the high pressure dry pipes on the right and left sides of the dome. The throttle itself is outside of the dome and upon one side of it. This illustrates the difficulty in the matter of clearance for such a large boiler. The high pressure cylinders are upon the rear engine, the frames of which are secured to the boiler and fire box. The boiler is supported and attached to the rear engine frame by means of a ½-in. plate at the rear end of the fire box, extending the full width of the mud ring, and also by an intermediate sliding support midway between the rear and intermediate drivers and a sliding support at the front end of the fire box, all attached to the mud ring. The high pressure saddle does not separate in the center of the space between the frames, the parting being at one side in order to provide space for the joint of the receiver pipe, which extends forward from the center of the saddle. This saddle is secured to the belly of the boiler, which is reinforced by 1-in. plates inside and outside of the shell-plates at this point.

The boiler is supported upon the front engine by a sliding support with lateral and longitudinal motion to provide for expansion and contraction of the shell and for side movements in curving, this being located between the rear and the intermediate drivers of the front engine. The boiler is further supported on the forward engine by a sliding support with lateral and longitudinal motion, which is located between the front and intermediate drivers, and is adjusted to take the load of the boiler only at such times as inequalities of the road bed make it necessary. This support is provided with a spring-centering device having an initial pressure of about 13,000 lbs. All the wearing surfaces of the boiler supports are fitted with wrought, case-hardened bearings working on the same material, or brass.

The articulated joint between the front and rear engines is of cast steel, and very substantial. The front engine frames also have hinge supports of cast steel, so constructed as to break in case of excessive strain on the articulated joint, which will save the more expensive castings. The frames of both front and rear engines are 4¼ ins. wide, and have a minimum depth of 5 ins. for the top rails. The driving wheels are 50 ins. in diameter, with all tires flanged; the driving journals are 9 x 13 ins., and the total lateral motion of the driving wheels is 1-16 in. between hub faces and boxes, or a total of ⅛ in. for each pair of wheels.

Steam is brought from the dome through 5-in. dry pipes to the high-pressure steam chests, where it passes through 10-in. piston valves to the high-pressure cylinders, and exhausts through a 9-in. receiver-pipe with a ball-joint at the back end and a sliding-joint and also a ball-joint at the front end, reaching the double-ported slide valves for the low-pressure cylinders of the leading engine. This exhaust pipe provides for 30 deg. curves. There is but one intercepting valve, and that is of the Mellin type, which has been so successfully used in the Richmond two-cylinder compounds. The high-pressure pistons are of cast iron and hollow, with snap rings, while those of the low-pressure cylinders are of cast steel with cast iron bull rings. The cross-heads are of the alligator type. The valve motion is arranged to cut off equally at 17 ins. of the stroke. The high-pressure valves have ⅛-in. outside lap. The low-pressure valves have 1-in. outside lap and ¼-in. exhaust clearance. The valve gear is of the Walshaert type, which was absolutely necessary because no room was available inside the frames. The reversing is done by air, with a very ingenious construction of reverse lever. The flexible wheel base rendered necessary a flexible connection of the valve motion to the low-pressure cylinders, which was accomplished by long lifting rods, with a compound hinge joint at the top, at the side of the boiler, and a ball joint at the bottom. The hinge joint at the top avoids the twisting of the rod, and the rod is made long enough so that the side motion of the forward engine does not introduce a serious error in the position of the link block.

The boiler has two sliding fire doors. The grates have 40 per cent. air opening, and are arranged to rock in six sections. The ash pan has 10 sq. ft. of air opening, 80 per cent. of which is under the control of dampers.

The cab is of 3-16 in. steel plate. Westinghouse brakes are fitted to the engine and tender. Two 4-in. Coale enclosed pop-valves are set at 240 lbs., and one 4-in. Coale muffled valve is set at 235 lbs. pressure, located in the roof sheet in front of the cab.

The tender frame has 10-in. steel channel center sills and 8-in. channel side sills. It carries 7,000 gallons of water and 13 tons of coal.

Additional detail engravings will be presented in another issue.

ENORMOUS PASSENGER-CARRYING CAPACITY OF NEW YORK STREET RAILWAYS.—Statistics collected by the State Railroad Commission of New York show that for the year ending February 29 the car lines in Manhattan alone carried 670,000,000 passengers, exclusive of transfers; this is more than one million more passengers than all the steam railroads of the United States carried in the same period, their record being 568,000,000 passengers. In Greater New York more than one billion passengers were transported. It is interesting to know of the enormous gain of 37,000,000 passengers on the elevated lines during the year, whereas the surface lines had only a trivial increase of 144,300. This would indicate that the surface lines are working very nearly up to their total capacity.

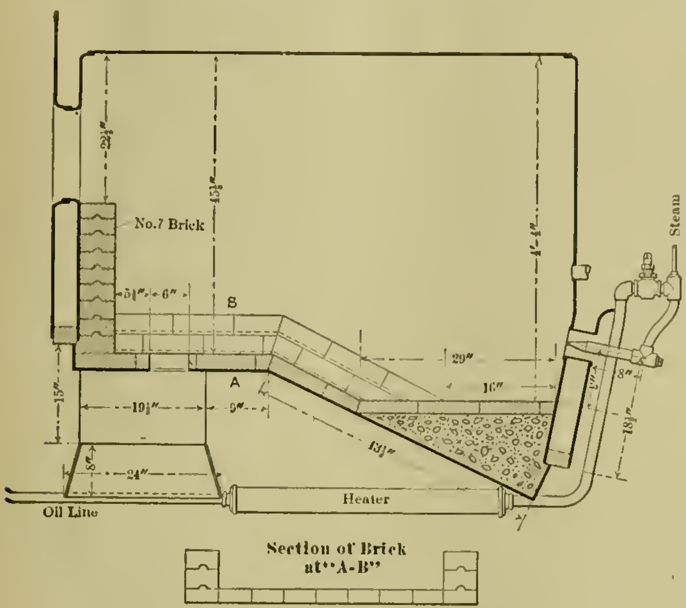
A remarkable long-distance run of a passenger train is recorded for "The Ocean Mail" special of the Great Western Railway of England, on May 9, 1904, 246¾ miles, from Mill Bay dock, Plymouth, to Paddington Station, London, made in 3 hours 46½ minutes, this being at the rate of 65.07 miles per hour. The train weighed 140 tons behind the tender.

Internal Friction of Locomotives.—In recent tests on the Berlin-Zossen Military Railroad a steam locomotive developed a maximum of 1,800 h.p. The resistance being about 25 lbs. per ton, the net power was approximately 1,200, leaving about 600 h.p., or over 30 per cent. of the power of the engine as the amount required to move itself against all resistance.

A NEW ARRANGEMENT OF FUEL OIL BURNERS FOR LOCOMOTIVES.

SOUTHERN PACIFIC RAILWAY.

Heretofore all arrangements for burning liquid fuel in locomotives have introduced the flame at the back end of the fire box, projecting the flame towards the front and generally under a fire brick arch extending backward from the front tube sheet. The Southern Pacific Railway has employed oil burning very extensively in locomotives, and from the experience of a



APPLICATION TO A NARROW FIREBOX.

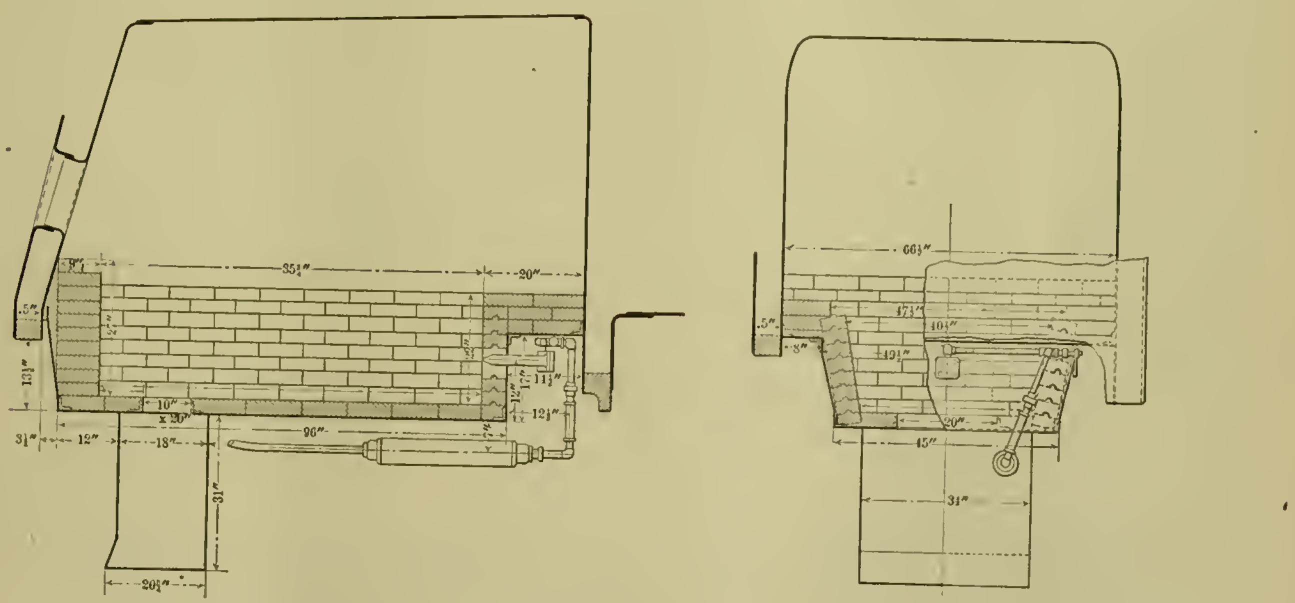
number of years Mr. T. W. Heintzelman, superintendent of motive power, at Sacramento, California, and Mr. J. G. Camp, general foreman, have brought out a new method which seems likely to revolutionize this practice.

at the rear of the fire box and below the fire door. The usual

The accompanying engravings illustrating methods of applying the new arrangement, show that the burner is placed at the front end of the fire box; in one case the atomizer passes through a hollow stay-bolt, in the front water leg, projecting the fuel backward, against a vertical fire brick wall which is built fire brick arch is dispensed with altogether. At the back end of the fire box an opening through the plate floor, which takes the place of the ash pan, admits air vertically upward against the flame immediately in front of the fire brick wall. This plan projects the flame toward the rear of the fire box and in a direction opposite to that of the natural course of the draft. There is no obstruction in the fire box and the air coming direct upon the flame, from beneath, deflects it in an upward direction, where it turns to travel forward towards the tubes. This gives a long flame-way for the fuel and subjects a larger portion of the surface of the fire box to a direct heat and prevents the concentration of the heat in certain portions of the box, which necessarily takes place in connection with the usual method. In the saving of the cost of the fire-brick arches alone, the saving due to this method is enormous, and to this must be added a very material improvement in the matter of the injury to the fire box sheets, which has been a serious difficulty in large locomotives where the fire, with oil fuel, is greatly forced.

The second engraving illustrates the application to a new 2-8-0 type, wide fire box locomotive. In this case the burner is placed inside of the fire box, protected by brick-work.

This road now has 65 locomotives equipped in this manner and the application is being made to all engines as fast as possible. Methods of using oil in locomotive fire boxes have been studied with special care on this road and until the development of this arrangement, Mr. Heintzelman considers that all have been working on an entirely wrong principle. This was probably for the reason that no one could see how oil could be burned in a locomotive in any way except that of usual practice. There is good reason to believe that this system will continue to be as successful as at present and that it will revolutionize methods of burning fuel oil in this service. This seems to be the most important recent contribution to progress in fuel oil burning, and it seems likely to result in great advantage to the life of firebox sheets and tube ends.



APPLICATION TO A RECENT LOCOMOTIVE WITH WIDE FIREBOX.

A NEW ARRANGEMENT OF FUEL OIL BURNERS FOR LOCOMOTIVES—SOUTHERN PACIFIC RAILWAY.

GASOLINE ENGINES FOR TURNING A DRAWBRIDGE.—The new drawbridge of the Central Railroad of New Jersey crossing Newark Bay is operated by two 75-h.p. gasoline engines supplied by Fairbanks, Morse & Co. They are of the three-cylinder vertical type, and by their use the engine-room equipment is greatly simplified. Either engine may be coupled to a common jack-shaft by means of friction couplings, so that in case of accident to one, the other engine will be immediately available. Circulating water is supplied by small pumps driven by the engines. Storage tanks for gas are provided on a special platform outside of the house and below the floor-level. For hoisting supplies and fuel a small crane is provided, which derives its power from one of the engines.

HIGH SPEED PLANING.

The G. A. Gray Company, of Cincinnati, Ohio, have prepared a leaflet on the subject of high-speed planing, directing attention to practice which they recommend, from which the following statements are taken:

The ordinary way to speed up a planer is to increase the speed of the countershaft. This is practicable only within certain limits, because it results in increasing the return speed in proportion to the cutting speed, and thus the former is usually increased beyond its practical limit long before the latter reaches the cutting limit, especially where modern tool steels are used.

Some variable-speed countershafts are in use, which permit a wide range of cutting speed, with a constant return speed; but where these are not available it is a good plan to put in a pulley of larger diameter on the countershaft for the cutting stroke instead of too greatly increasing the speed of the shaft itself.

It will be readily understood that in practice a certain amount of time is necessary in order to shift the belts and start the table in an opposite direction at each end of the stroke. The greater the speed the greater will be the momentum of the revolving parts and consequently the greater the delay necessary to overcome them. On a very short stroke the time so lost may offset the gain due to increased speed. In view of this, this company recommends for return speeds such limits as long experience has proved to be most practicable for general purposes, viz.: From 60 to 80 ft. per min., depending upon the size and length of the planer.

When an extreme cutting speed is wanted they substitute a special shifter lever and front dog for those ordinarily used; the object being to effect the contact of the dog and lever higher up, in proportion to the speed, and thus preserve the smooth reverse motion which characterizes the operation of Gray planers. This company is frequently asked the question: "What is the quick return ratio of your planers?"

The person asking such a question seems to assume that this ratio determines the efficiency of a planer, and that a comparison of such ratios for various planers indicates their relative efficiencies. Both of these assumptions are radically wrong. The mere ratio of return and cutting speeds is no indication whatever of the efficiency of a planer, and a comparison of such ratios for various planers is of no value unless the actual cutting speeds are known. The man who asks, "What is the quick-return of your planer?" assumes that a return of 4:1 must be more efficient than 3:1. If the cutting speeds are alike on both planers, then the comparison is valid; but if the cutting speeds are not alike, then both speeds must be known before a basis of comparison can be established. Thus, a planer with a quick-return of 2:1 may be really more efficient than another with a quick return of 4:1. It depends entirely on the actual cutting speeds, as may be understood from the following elementary calculation:

Assuming the cutting speed to be 24 ft. per min., then a stroke 12 ft. long is made in ½ min.; and if the quick return is 2:1, then the return stroke is made in ½ of ½ = ¼ min. Thus, one "round trip" is made in ½+¼ = ¾ min., *i. e.*, at the rate of 80 round trips per hour.

Assuming the cutting speed to be 18 ft. per min., then a stroke 12 ft. long is made in 12-18 = 2-3 min.; and if the quick return is 4:1, then the return stroke is made in ¼ of 2-3 = 1-6 min. Thus, one "round trip" is made in 2-3+1-6 = 5-6 min., *i. e.*, at the rate of 72 round trips per hour.

Similar calculations with various other cutting speeds and return ratios give the results embodied in the following table:

Cutting sp'd of 18 ft. and a return of	4 :1 gives	72 round trips per hr.
Cutting sp'd of 20 ft. and a return of	3 :1 gives	75 round trips per hr.
Cutting sp'd of 24 ft. and a return of	2 :1 gives	80 round trips per hr.
Cutting sp'd of 40 ft. and a return of	2 :1 gives	133 round trips per hr.
Cutting sp'd of 60 ft. and a return of	1¼ :1 gives	166 round trips per hr.

From the above it is plainly evident that the cutting speed is the principal factor in determining and increasing the efficiency of a planer, and of infinitely more importance than the mere magnitude of quick-return ratio. Recognizing this fact, the Gray planers are designed and constructed so that they may be run at the fastest speeds which the work and tool steels will stand.

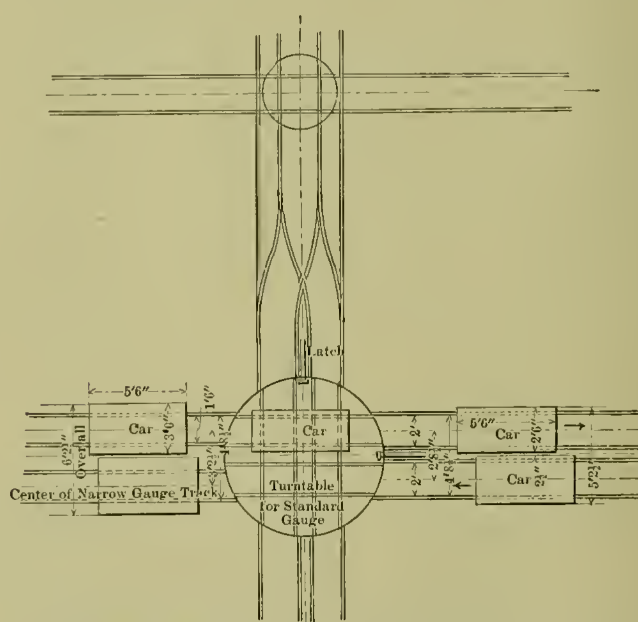
The G. A. Gray Company from their experience in planer construction have a great deal of additional information with respect to planer practice and those requiring further information should apply to them.

MATERIAL TRACKS IN SHOPS.

BY J. H. MORTON.

In these days employers cannot afford to have men standing around waiting for the transfer of material, and nowhere is it more important to provide efficient track systems than in the railroad machine shop. The arrangement of a single track, either narrow or standard gauge, for the handling of material does not entirely meet present day conditions, even when well provided with branches. Space does not admit of providing a double gauge track on account of the loss of valuable floor space, and no railroad can accommodate itself entirely to the inconvenient narrow gauge system through which standard gauge cars can never pass.

A narrow gauge track down the center of a standard gauge or one formed with a single extra rail to provide a narrow



A CONVENIENT ARRANGEMENT OF MATERIAL TRACKS IN SHOPS.

standard gauge track with three rails are familiar systems in many shops, but the necessity for turning one truck off on a side track, to pass another in an opposite direction, is a serious disadvantage of this arrangement. As far as the writer is aware, a double narrow gauge system between standard gauge tracks, as devised by him for large new shops now in construction, has not as yet been adopted elsewhere. The accompanying sketch clearly shows the advantages of such a system. By using each narrow gauge track, for one direction only, a continuous stream of trucks can be kept moving in opposite directions without causing blocking, which is so familiar on a single track. When necessary standard gauge trucks, or cars, may be brought into the shops on the outside rails—and in this case, of course, it need not occur often—the narrow gauge tracks must be cleared. An 18-in. gauge and trucks 3 ft. wide may pass each other on the tracks shown, with a clearance of 2½ ins. between the trucks. If necessary a 2-ft. gauge may be used, but this allows only a width of 2 ft. 6 in. for the truck, with the same clearance. The narrow and long truck, however, may be a blessing in disguise in the crowded shop.

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

EDITORIAL CORRESPONDENCE.

(*Continued from page* 175.)

LONDON:

A man to become a locomotive runner in Europe must have had shop experience. On some roads he starts in the shop, then serves as fireman, and takes his place as "driver" in his turn. On others he fires first, then goes into the shop and qualifies as "driver." There seems to be no regular rule, but shop knowledge is nearly always necessary before a man is given charge of an engine. In France it is not unusual for young technical men entering railroad work to serve as firemen for an entire year in order to give them thorough knowledge of how locomotives are handled. They are told that they cannot learn anything on the road in a few weeks or months, and it is true. A young technical man who is now work manager on one of the leading English roads served six years in the shop and on the road before he was given any responsibility. Now he occupies a leading position in England and is well qualified to fill it.

English roads have "engine drivers." French roads have "mechanicians." We have "locomotive engineers." They are all supposed to be one and the same, but they are not.

Over here the "driver" or "mechanician" touches his cap and gives some attention when he is asked a question. This of itself might speak for a number of undesirable things; for example, it might be an evidence of servility or groveling or a sign of class distinction, but these men did not give me such an impression. I talked with a number of English "drivers" and also studied French "mechanicians" by aid of several friends. These men are brought up to treat an official with distinguished courtesy, and this fact is mentioned because it reflects light upon a difference between foreign and American practice. Organizations of labor are strong over here, but it is not necessary for the officials to devote a large proportion of their time to grievance committees. Those who employ labor in England have their troubles, and the labor organizations bring great pressure to bear in the way of "leveling influence," but with it all there yet remains an element in the situation which is very desirable. I refer to the fact that "engine drivers" must be good men in order to attain and hold their positions. Of course everyone will say that this is so the world over, but over here to be given charge of a locomotive means something, and the first anxiety of the man is to hold the job. To do this they must give a very high grade of service. They are held to strict account of the fuel given them, and they must be good men and remain good men or others take their places. The point is that the men are not the only ones who are making demands, and they are not the only ones to make grievances known. The company also has a grievance committee, which tends to make the standard of service high. This keeps the men busy to hold up their end of the burden. They are held to strict accountability. If the men who handle and fire locomotives first make sure that they are doing their work well, they are not likely to keep their grievance committees so busy. I believe that we ought to adopt coal premiums, paid in cash, and also cash premiums for perfection of service, all of which would tend to reward excellent service and also tend to make the difference between good and poor service perfectly apparent to the men through their pay envelopes. There is no difficulty in the way of our adopting premiums for engineers and firemen except properly organizing and carefully administering the system under competent direction. Foreigners have employed this system for years because their coal is expensive.

This high cost of fuel has an important bearing on locomotive practice abroad. In England it has led to keeping locomotives in more perfect condition than in any other country in the world. In Germany it has led to experiments in superheating, and in France it has resulted in locomotive design and construction without any regard to any question but that of producing the best locomotive which those who understand the conditions know how to build. The high cost of fuel has led to both scientific design and scientific operation of locomotives in Europe. We have the same reason for doing these things. Our fuel cost may average less per ton, but the amounts of the bills because of our heavy trains would stagger Europeans.

Some, but not all, locomotive superintendents over here take special pride in continuing locomotives in service which are 30 and 35 years old. They are poor weaklings, and new ones could be built for the cost of keeping them in repair. Englishmen, as a rule, insist upon the severest simplicity of construction in their locomotives. They have gone as far as they can now, and must face the question of complication very soon. They insist upon extra fine finish, both in the drawing room and in the shop. Take for example an English main rod. It is beautiful in proportion and is graceful in curves and in details. In the shop it is finished with equal care, and is a perfect mechanical job. It is always ready for the severest critics of international expositions. These things are overdone in England. They are a little underdone at home, and a position about one-third of the way between the two, beginning to measure from our end, would be about right.

English locomotives are works of art as to finish and painting. This is carried to a point far beyond justification on business principles, and it is only justified as far as it affects the quality of care in keeping the engines in condition. For example, a corner of the running board with a large fillet is much easier cleaned than are those with a sharp angle. An engine which is well painted is more easily kept clean than one that is rough. There is a great deal of expensive sentiment about the English locomotive. The traveller derives no comfort in a cold car from the fact that the engine is well finished, but it must be admitted that he is nevertheless very apt to go forward at a long stop, in order to have a look at the beautiful machine at the head of the train. Good fitting and good workmanship are always in order, but draw-filing, polishing and the refinements of the painter's art serve no essential purpose. The money would be better spent in other ways. The marine engineers of Great Britain are more practical in this respect. English boiler work is something to be unreservedly admired. Here is where perfection of fitting is absolutely necessary.

Our engines certainly have higher mean effective pressures in their cylinders than these. If it were otherwise these engines would be sadly overcylindered because their cylinders are so large. On the other hand, English engines of the inside connected type are very free in the exhaust. In many of them the valves may be seen through the exhaust pipe and stack. English engines have necessarily narrow ranges of power, and are built for the light work they do. We have shorter laps, greater lead and wider ranges of cut off.

I did not see a single English passenger engine which gave evidence that the front end had ever been hot, but not so with freight engines. Some results of tests were shown me indicating temperatures of 1,500 deg. F. in the smoke box. This was a 38-ton freight engine in coal service. It had 1,134 sq. ft. of heating surface, 18 by 26 in. cylinders, 20.5 sq. ft. of grate, 56 in. drivers, and carried 150 lbs. steam pressure. The maximum draft was 4 in. of water, and the mean 1.75 in. I was told that this little engine used 20.3 lbs. of coal per horsepower hour, and produced a maximum of 820 indicated horsepower with 40 per cent. cut off on a grade of 83 ft. per mile, at 23 miles per hour. On another trip with a load, including engine and tender, of 284 tons in 45 coal "wagons," the same engine indicated 441 horse-power at 36.5 miles per hour. In the best of these tests the rate of coal consumption ranged from 44.5 to 60 lbs. per sq. ft. of grate per hour. The water evaporated per sq. ft. of heating surface per hour varied from 7.78 to 9.09 lbs., and the water per indicated horse-power hour ran from 17.1 to 18.6 lbs.; the water per pound of coal from 7.7 to 10.8, and the maximum loads from 507 to 605 tons. The engine must have been efficiently handled to do such work.

G. M. B.

(*To be continued.*)

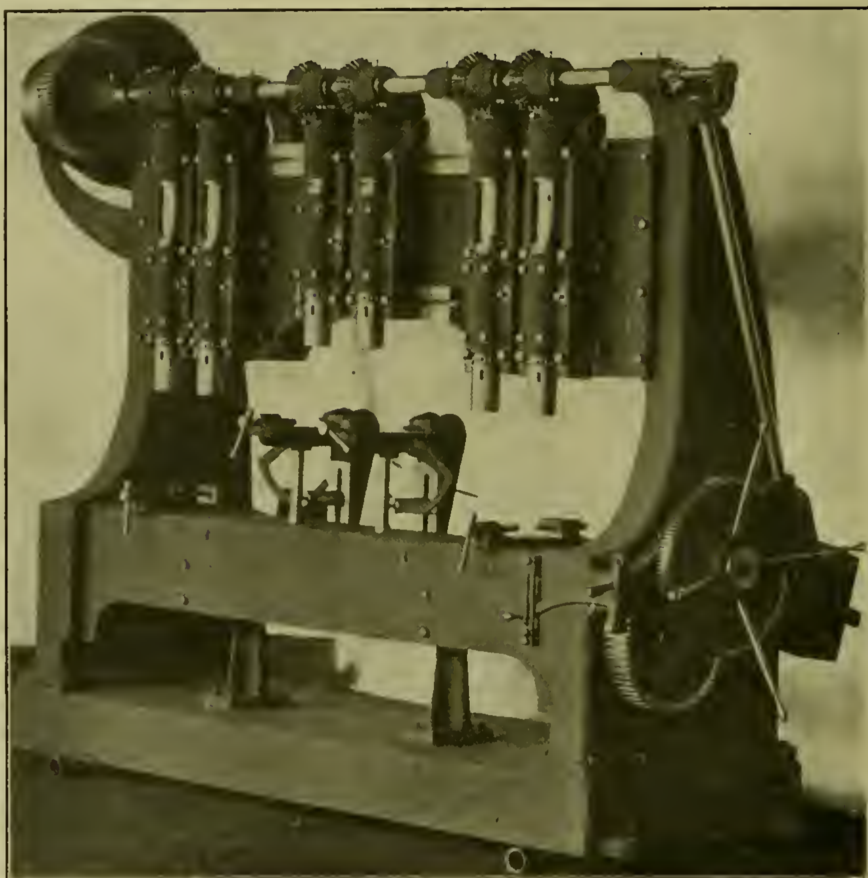
STANDARD ARCH BAR DRILL.

This machine, manufactured by Messrs. Foote, Burt & Co., Cleveland, Ohio, is specially designed for railroad shops for building arch bar trucks. It combines rigidity and convenience in operation.

The uprights are of box form and very heavy, with the metal distributed to give the greatest stiffness at the point of greatest stress. The cross-rail is of solid web construction, cross girted to withstand the upward thrust from the drills and resist all tendency to twist. Absolute absence of deflection under the heaviest cuts was the aim in the construction of the entire machine. The spindles are driven by forged steel miter gears with planed teeth, 8 ins. diameter, 4 pitch. Stiffness of the driving shaft is not depended upon for holding the driving in mesh with the driven miter, as the driving miter is securely housed in a bearing which is a part of the spindle head, securing this gear not only in its mesh with the spindle gear, but it is self-contained with the head and moves along the shaft when the head is adjusted for different centers of drills.

The table is fed up by means of rack and pinions, the feed shaft being 2¾ ins. in diameter, the feed racks having 3-in. face, 4 pitch, both the rack and pinions being of forged steel. Positive and very powerful feeds are provided, rendering the work smooth and steady in cutting. This adds to the capacity for work which can be done without regrinding the drills. An automatic knock-off is provided, which knocks off the feed at any point. A quick return is provided for its table, operated by means of the pilot hand-wheel at the right hand end of the machine. All the spindles are adjustable vertically for a distance of 5 ins. in order to permit the use of drills of unequal length, and this also permits the height of the drill points to conform to different offsets in the top and bottom arch bars. This adjustment is made by means of a rack and pinion in each head, moving the spindle up or down easily and quickly to the desired point, where it is quickly clamped.

In the engraving the convenient clamps for the arch bars are clearly shown.



STANDARD ARCH BAR DRILL, FOOTE, BURT & CO.

LIBERAL ATTITUDE OF A LABOR UNION.—Grand Chief Stone of the Brotherhood of Locomotive Engineers recently gave utterance to one of the most liberal and far-seeing policies which has yet emanated from any labor union leader. In speaking at a meeting of labor representatives in Fort Worth, Tex., he stood squarely for the "open shop." He stated that he was a "firm believer in union labor and the right of laboring men to organize," but held that it was unwise and unjust to form an organization and to compel a man to join it against his will, this being an interference with the personal liberty guaranteed by the Constitution of the United States. He attributed the fact that the railway labor organizations stand head and shoulders above others to the fact that they do not oppose the "open shop," and said: "On almost every road in the country we work side by side with men who do not belong to our orders. No man is forced to join us. We try to show him how he would be benefited by belonging to us, and where his interests are, but we never say to him to join us or you cannot earn an honest living by working here. I do not believe any man ever made a good member in any organization who was forced to join it against his will, for the chances are that when opportunity offers he will prove a traitor and betray you."

Logarithms for Beginners, by C. M. Pickworth. D. Van Nostrand Company, 23 Murray street, New York, 1904. Price, 50 cents.

The purpose of this little book is to present a more detailed and practical explanation of logarithms and their various applications than is to be found in text books on algebra and trigonometry. The author intended to assist the beginner by giving him a safe grasp of the underlying principles of this method of calculating, which he usually does not get in the usual methods of attacking the subject. The author intends the book to meet a need which has arisen in the latter developments of thermodynamics as applied to the electrical, physical and mechanical sciences. The book is intended as a simple introduction to the subject. Those who are accustomed to using logarithms will be very glad to have this book upon their shelves, and those who are making a study of the subject will find it a very valuable treatise.

Train Rules and Train Dispatching. A practical guide for train dispatchers, engine-men, trainmen and all who have to do with the movement of trains. By H. A. Dalby. First edition. Published by the Derry-Collard Company, 256 Broadway, New York, 1904. Price, $1.50.

The author of this book has been engaged in train dispatching for years and is still in active service. The book is heartily endorsed by Mr. John F. Mackey, of the Train Dispatchers' Association, who is the author of the introduction. The book is practically a textbook upon the work of a train dispatcher, and is a valuable treatise on the handling of trains. It follows and explains the work of the American Railway Association in systematizing the operation of trains through the standard time and standard code of train rules. It discusses time tables, divisions, districts and terminals, classes and rights of trains, train orders, types of train-order signals, the relation between the dispatcher, engine and trainman, gives suggestions to young dispatchers, and presents the standard code of the American Railway Association. It will be particularly valuable to operators who desire to become dispatchers, to engine-men, trainmen and others who have to do with the operation of trains. The book is well printed and well bound, which is something unusual in works of this character.

JOINT MEETING OF INSTITUTION OF MECHANICAL ENGINEERS AND AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

This meeting, which opened in Chicago May 31, was unique in the assembling of over 900 registered attendants, and it was successful in every way. About 100 members of the English society were present. In the opening exercises Mr. J. Hartley Wicksteed, president of the Institution of Mechanical Engineers, represented that organization.

The papers covered a wide field, those of greatest interest to our readers being one by Prof. Goss on locomotive testing plants, and one by Mr. G. J. Churchward, of the Great Western Railway, of England, describing the interesting locomotive testing plant recently installed by him at Swindon, and one by E. A. Hitchcock, describing tests on a 2—6—0 locomotive on the Hocking Valley Railroad. Three excellent papers on steam turbines put that subject on record in a very satisfactory way, and Mr. J. T. Nicholson read an important paper on the work of machine tools.

The paper by Prof. Goss is both historical and descriptive. Credit for the idea of stationary locomotive plants is given to M. Borodin, of the Russian Southwestern Railways. The paper describes the construction of the plants on the Chicago & Northwestern, at Purdue University, Columbia University and the Pennsylvania Railroad test plant at the World's Fair at St. Louis.

The paper by Mr. Churchward is presented in abstract in this issue. This plant is used for testing and also for "breaking in" locomotives, and the work done by the locomotives is partially absorbed by an air compressor operated from the carrying wheels.

The road test of a freight locomotive on the Hocking Valley Railroad, described in the paper by Mr. Hitchcock, is the first record we have seen in which a heat balance for the boiler is attempted. The data are unusually complete.

A paper by J. T. Nicholson describes elaborate experiments with a lathe tool dynamometer, conducted for the purpose of determining not only the work done by the cutting tool, but also that of moving the slide rest during the cutting operations. The records involve over 300 tests, with from 50 to 100 separate observations in each. The construction of the apparatus is described and illustrated. In the discussion Mr. Wicksteed characterized the appearance of the new tool steels as constituting the greatest revolution that had taken place in his lifetime, and Prof. Benjamin considered the experiments recorded in this paper the most important ever made. We shall print portions of this paper in another issue.

The De Laval steam turbine was described in a paper by Messrs. E. S. Lea and E. Meden. Among the interesting points brought out was the construction of the wheel in such a way as to minimize the disastrous results in case of breakage because of centrifugal force. The rotating part is thinned at the rim to accomplish this. The authors stated that it was possible to use peripheral velocities as high as 2,100 ft. per second.

Mr. Francis Hodgkinson, in a paper entitled "Some Theoretical and Practical Considerations in Steam Turbine Work," described the Westinghouse-Parsons type, presented the ideal turbine element, and discussed the expansion of steam in this turbine. The author considered other types of turbine, but gave special attention to that with which he has been identified. He recorded elaborate tests, made at the Westinghouse works, and describes the testing department, giving important records taken from it.

A third paper on the steam turbine was read by Mr. A. Rateau. Like the others, this contained references to other types, but specially concerned the author's turbine, which has been quite successful abroad. This paper also dealt with marine turbines and turbine-driven centrifugal feed pumps for boilers and turbines for driving fans.

The meeting was both profitable and enjoyable.

PERSONALS.

Mr. J. H. Fildes has been appointed master mechanic of the Lehigh Valley, with headquarters at Buffalo, N. Y.

Mr. Thomas Coyle has been appointed master mechanic of the Lehigh Valley at Weatherly, Pa., to succeed Mr. J. H. Fildes, promoted. Mr. Coyle is promoted from the position of general foreman at Perth Amboy.

Mr. L. L. Bentley has been appointed mechanical engineer of the Lehigh Valley Railroad, with headquarters at South Bethlehem, Pa. He has for several years held the position of chief draftsman.

W. F. M. Goss, Dean of the Schools of Engineering of Purdue University, has received the honorary degree of Doctor of Engineering (D. Eng.), bestowed by the University of Illinois.

Mr. M. McGraw has been appointed master mechanic of the Illinois Central at East St. Louis, Ill., succeeding Mr. Isaac Rova. Mr. McGraw has been roundhouse foreman at Burnside, Ill.

Mr. W. P. Richardson has been appointed mechanical engineer of the Pittsburg & Lake Erie to succeed Mr. R. V. Wright, who has resigned to become associate editor of the American Engineer and Railroad Journal. Mr. Richardson is a graduate of the University of Minnesota, and entered railroad service as draftsman with the Chicago Great Western Railway. He became chief draftsman of that road, and went to the Pittsburg & Lake Erie as chief draftsman in 1902.

Officers of American Locomotive Company.—The valuable services of Mr. A. J. Pitkin in this company have been recognized by his election as president to succeed the late Mr. Callaway. Mr. J. E. Sague has been elected first vice-president, to succeed Mr. Pitkin, and Mr. Leigh Best has been elected third vice-president, in addition to his office of secretary. Mr. R. J. Gross retains the office of second vice-president. The executive committee has been increased from five to six, and Messrs. Frederick H. Stevens and William M. Barnum have been elected members of that committee. Mr. C. B. Denny retains the office of treasurer, and Mr. C. E. Patterson that of comptroller.

Mr. J. M. Wallis a year ago resigned as general superintendent of the Pennsylvania Railroad Division of the Lines East of Pittsburg on account of ill health and has not engaged again regularly in railroad service. He is, however, prepared to undertake in a consulting capacity investigations and reports upon railroad problems for which his education, professional ability and wide experience have eminently fitted him. Mr. Wallis was graduated from Stevens Institute of Technology in 1876 and the following year entered the service of the Pennsylvania Railroad, and continued upon its staff until 1903. He advanced through the various courses of the very thorough motive power training of the road, following which he was consecutively superintendent of motive power of the Philadelphia & Erie; Northern Central; Philadelphia, Baltimore & Washington, and the Pennsylvania Railroad grand division. After this he was for a time acting general superintendent of the Pennsylvania Railroad division, then general superintendent of the Philadelphia & Erie Railroad and Northern Central Railway. He then returned to Altoona as general superintendent of the Pennsylvania Railroad division. Mr. Wallis was one of the most successful motive power officials ever in the service of the Pennsylvania and, having also been equally successful as an operating officer, his opinions are of the greatest value to those who, in connection with the rapid progress of the time, are in need of expert professional advice in difficult motive power and transportation problems. Mr. Wallis may be addressed at Seldon Post-Office, Gloucester County, Virginia.

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

CONTENTS.

MASTER CAR BUILDERS' CONVENTION.

The convention opened June 22 at the Grand Union Hotel, Saratoga, N. Y., with the largest attendance in the history of the association. After the usual formalities the association was addressed by Mr. H. H. Vreeland.

Speaking from the standpoint of one who had had a wide experience in steam railroad work and afterward in electric railroads, he referred to the introduction of electricity into heavy passenger service on the New York Central and Pennsylvania railroads in New York City, which presented a new problem to motive power men. This "revolution" in motive power would require a new character of experience in dealing with maintenance. Other "revolutions" had been gradual, on the order of evolution, but this was a substitution and a radical change in motive power which required more than expert carpenters' or blacksmiths' capacity. Referring to the extent of the new work, he said:

All your roads, and particularly those of these two great railway corporations that I have mentioned, as soon as they have installed electric traction in New York, will be handing over to their shops these new hybrid combinations, which are neither all cars nor all locomotives, but something of both, and it will take more than an expert carpenter or blacksmith to keep them in order.

For proof that I have not overstated the magnitude of the change under discussion, I fix here, in tabulated form, the total present electric generating capacity located at New York, so divided as to show at a glance the amount in operation at the present moment and that contracted for for near future delivery.

ELECTRIC GENERATING MACHINERY IN OPERATION OR CONTRACTED FOR TO TAKE PLACE OF STEAM LOCOMOTIVES IN VICINITY OF NEW YORK CITY.

	In Operation.		Contracted For.	
	K.-W.	Equivalent H.-P.	K.-W.	Equivalent H.-P.
Manhattan Railway	48,000	72,000	6,000	9,000
Brooklyn Elevated Lines	*20,000	30,000		
Interborough (subway)			48,000	72,000
L. I. Railroad			16,500	24,750
N. Y. C. Railroad			40,000	60,000
Total	68,000	102,000	110,500	165,750

* Estimated.

It will be noticed from this table that it is proposed to substitute for steam on the Interborough, the Long Island and the New York Central roads 156,750 h.p. units, or 54,750 units more than the Brooklyn elevated lines and the Manhattan Railway are at present developing. This all shows that within the next two or three years you are to have turned over to your care much of the machinery by means of which this tremendous volume of energy is to be translated into work, for adjustment on the vehicles you make and repair.

All this brings me to what, after all, is the most interesting element in the change, relating, as it does, to the individual worker. Academic and scientific men have done their work. Their problem has been solved—yours is yet to be.

The speaker counselled immediate steps in preparation, and brought the association face to face with the importance of the part the members must play in connection with the application of electric transmission to heavy transportation service. The speaker saw what successful long distance transmission meant to steam railroads. He desired to stimulate the ambition of his hearers to prepare for the new problem. He had found great difficulty in securing the right sort of men to deal with the problem presented by a large combination of street railways.

The presidential address of Mr. F. W. Brazier was a thoughtful presentation of the work before the association. A comparison of the problem of the master car builder of 37 years ago with that of to-day was drawn by contrasting a passenger car of the day of beginning of the association with that of to-day.

Thirty-five years ago the average coach would carry from 30 to 45 passengers and weighed about 14 tons; the cars were equipped with link and pin couplers; were carried on 4-wheel trucks with journals 3½ by 6 ins.; were lighted with oil lamps; had small windows; in some cases were without a clear story, and were heated with wood-burning stoves. The cost of a coach such as I have described was about $3,500.

To-day our standard coach is 72 ft. long over end sills; weighs from 52 to 55 tons; has a seating capacity of 86 passengers; is carried on 6-wheel trucks, with journals 5 by 9 ins.; has steel platforms and wide vestibules; is heated with steam heat and lighted with gas and electricity. To-day a wide vestibule coach is worth in the neighborhood of $10,000.

In December, 1867, there were 289 locomotives, 386 passenger equipment and 5,530 freight equipment cars in the United States.

On June 30, 1902 (the latest figures compiled) there were 41,628 locomotives, 37,090 passenger equipment and 1,503,949 freight equipment cars in the United States.

In comparing the equipment in service on June 30, 1902, with that in service at the organization of the Master Car Builders' Association in 1867, it will be seen that the number of locomotives has increased 144 times, passenger cars 96 times and freight cars 272 times.

Of all the suggestions offered by Mr. Brazier one stood out very prominently, originating as it did with the president of the Master Car Builders' Association, viz.: the consolidation of the Master Car Builders' and Master Mechanics' Associations. The speaker took the position that there was no longer sufficient reason for maintaining separate organizations. This is the first time the consolidation has been proposed and supported by a presiding officer of the Master Car Builders' Association. The opinions expressed outside of the convention seemed to be generally favorable to the union, and it is believed that a wiser step could not be taken in the interest of the officers of the mechanical departments of railroads.

A summary of the suggestions of the president is as follows:

1. Adoption of a standard coupler.
2. Standardization of the pivot pin and material to be used in its manufacture.
3. Investigation of coupler side clearance.
4. A standard formula for journal bearings and linings.
5. Standard specifications for waste for passenger and freight equipment lubrication.
6. An addition to the requirements of standard brake-beams, calling for a transverse test of brake-beams.
7. Standardization of steel freight cars.
8. A study of the 40 and 50-ton capacity box cars from a commercial standpoint.
9. Improvements in uncoupling appliances on couplers.
10. Adoption of a standard arch bar truck.
11. The introduction of adequate apprenticeship systems.
12. The consolidation of the Master Car Builders' and Master Mechanics' Associations.

These recommendations were referred to the executive committee for action.

By the report of the secretary a total membership of 581 was announced, and the report of the treasurer showed a balance of $3,469.68 on hand in the treasury.

COMMITTEE REPORTS.

Supervision of Standards and Recommended Practices was the first report to be considered. No very vital changes were recommended. In connection with the subject of standards the association was addressed by Mr. Edward H. Mosely, secretary of the Interstate Commerce Commission, who wished to see the closest co-operation between the association and the commission in the matter of standards with respect especially to safety appliances. The speaker complimented the association upon the improvement in safety appliances brought about by its rules. He advocated the employment of two air brake pumps on locomotives employed in hauling long trains. In connection with the safety appliance law the speaker emphasized the purpose of the commission to see safety of railroad employees advanced to the utmost possible extent. Among the important problems for the future, necessity for improving the rules regulating the loading of lumber and other long materials was prominently mentioned.

Brake Shoe Tests.—There was no report on this subject. Dr. Goss stated that whereas no shoes had been submitted to the committee, a number of shoes had been tested at Purdue. This led to the question whether the association was content with the present status of the brake shoe question. After a brief discussion the standing committee was requested to make tests of new shoes which are now in use by its railroads.

Tests of M. C. B. Coupler.—This committee recommended submitting the following to letter ballot for adoption as standard and recommended practice of this association:

Standard.

1. Coupler limit gauge changed to conform to new contour lines adopted January 1, 1904, and to have raised figures "1904" cast upon same, superseding present gauge shown on M. C. B. Sheet 11.

2. Knuckle limit gauge changed to conform to new contour lines adopted January 1, 1904, and to have raised figures "1904" cast upon same, superseding present gauge shown on M. C. B. Sheet 11.

3. Change note on M. C. B. Sheet 11, "Pivot pin must be 13½ ins. long from under side of head to center of hole for ¾-in. cotter pin, and must be either 1½ or 1⅝ in. in diameter," to "Pivot pin must be steel 1⅝ in. in diameter of sufficient length to permit applying a ¾-in. cotter pin through the pin below the coupling lug" in order to conform to present specifications.

4. Change in coupler specifications to provide for single coupler jerk test.

Recommended Practice.

1. Worn coupler limit and wheel defect gauge, as shown on Sheet D, superseding the present worn limit coupler and wheel defect gauges.

2. Twist gauge changed to conform to new contour lines adopted January 1, 1904, and to have raised figures "1904" cast upon same, superseding present gauge shown on M. C. B. Sheet G.

3. Drop test machine.

A. Modifications and betterments in the detail design of the machine and the redesign to accommodate single coupler jerk test, shown in report of Proceedings for 1903.

B. Changes to provide for separate knuckle test, shown in Proceedings for 1903.

4. Separate knuckle test. Specifications for.

In the discussion Mr. Bentley (B. & O.) advocated machine fitting of the knuckle pins in order to secure better fits and reduce the amount of lost motion which resulted from the wearing down of roughness in fitting. This opinion was supported by other speakers. The recommendations of the committee were ordered submitted to letter ballot.

Standard Location of Third Rail for Electrical Operation.—This report was accepted without discussion. It is to be presented in another issue.

Stenciling Cars.—This committee was continued for report next year.

Coupling Chains.—The committee was continued to make a united report next year.

Air Brake Hose Specifications.—In addition to proposed new specifications this committee proposed arrangements between the association and Purdue University for the test of hose at the laboratory of the university in order to secure definite data under uniform conditions of testing. The committee was continued and the executive committee instructed to make the necessary arrangements for such tests. Mr. Sanderson stated that air-hose couplings would continue to be pulled apart in yards because of the delay attending the observance of rules for uncoupling by hand. He advocated 1⅜-in. hose, and did not consider it advisable to use hose which was too expensive for commercial requirements. It was not desirable to use expensive hose, which was to be destroyed in a relatively short time by external injuries in service. The new specifications were submitted to letter ballot as recommended practice, the old specifications to be cancelled.

Draft Gear.—This committee recommended withdrawing the present "recommended practice" of the association because it has been outgrown. A spacing of 10 ins. between center sills of wooden cars and 12¾ ins. of steel cars was suggested. The committee recommended the abandonment of "continuous draft rigging." They suggested thicker followers, and recommended three designs of yokes for twin spring, tandem spring and friction draft gear, a standard which is badly needed. Mr. Hennessey wished to see the size of yoke rivets increased to

1⅜ in. in diameter, and to increase the width of yokes ½ inch. These suggestions were submitted to the committee on standards to report definite recommendations next year.

Stake Pockets.—This report is presented in abstract in this issue. It was referred to the committee on standards.

What Is the Best Preventive of Rust on Steel Cars?—This report is presented in abstract. Mr. West directed attention to the excellent staying qualities of white lead paints on steel cars. Mr. Hayward supported this from his experience, having noted that white lead lettering on steel cars usually stood out prominently even after the other paint on the cars had worn out. There was little desire on the part of the association to discuss the report.

At this point the following telegram was read by the president:

"At the annual meeting of the Central Association of Railroad Officers in convention assembled at St. Louis, the following resolution was unanimously adopted: Resolved, That this association urge upon the Master Car Builders' Association the fact that the use of so many types of automatic couplers is a serious detriment to the transportation departments of railroads, and that we strongly urge the association to adopt some type of vertical plane coupler, having a lock set, as standard. If one coupler cannot be agreed upon, that the number be increased, but not to exceed three or four.

"J. A. Gordon, *President*."

Outside Dimensions of Box Cars.—This committee had found it impossible to make substantial progress toward a standard car because of the variety of opinions covering framing. The report concluded with the following recommendations:

1. That the inside dimensions of box cars as approved by the American Railway Association, namely, 36 ft. long, 8 ft. 6 ins. wide and 8 ft. high, be submitted to letter ballot for adoption as standard.

2. For box cars on high trucks (4 ft. to top of floor):

	Ft.	Ins.
Height, top of rail to upper edge of eaves...........	12	6¾
Width at eaves, at above height, maximum..........	9	7

be submitted to letter ballot for adoption as standard.

3. For box cars on low trucks (3 ft. 6 ins.):

	Ft.	Ins.
Height, top of rail to upper edge of eaves...........	12	9¾
Width at eaves, at above height, maximum..........	9	7

be submitted to letter ballot for adoption as standard.

4. That the words and letters "Standard 12 ft. 6¾ ins. by 9 ft. 7 ins." be stenciled in 3-in. letters on the end fascia boards on all cars built to these dimensions.

These were ordered submitted to letter ballot.

Cast Iron Wheels.—This carefully considered report appears in abstract in this issue. The committee in the preparation of the report had conferred with the leading wheel makers and had secured their co-operation and assistance. Mr. Garstang presented the report, and stated that Mr. R. L. Ettinger, mechanical engineer of the "Big Four" railroad, had designed the wheels referred to in the report. This is considered the best report on wheels ever presented to the association, and was so characterized by a majority of the speakers in the discussion. Furthermore, the wheel manufacturers were a unit in support of the designs submitted by the committee. Mr. Waitt considered it remarkable that such cordial agreement could be had, and urged the adoption of these designs as recommended practice with a view of future advance to standards of the association. Mr. Muhlfeld (B. & O.) quoted the experience of ten years in support of the Baltimore & Ohio design of wheels, which differed materially from those of the committee. The discussion developed the fact that the Southern Pacific had used wheels like those of the report very successfully for several years. It was stated that flange breakages are not due to long continued action of the brakes, but to flange friction. This is an argument in favor of improved center plates and side bearings. Breakage of wheels was attributed to inequalities in braking, but Mr. Onderdonk (B. & O.) quoted tests indicating that wheels on which brakes had never been used had developed cracks in flanges. Mr. McIntosh believed these cracks to exist in the wheels when cast. He favored improved side bearings to relieve the flanges from friction. Mr. Muhlfeld reported favorable effect on flange breakage by the use of lateral motion trucks. The designs of the committee were ordered referred to letter ballot as recommended practice for a year's trial.

Revision of Rules for Loading Long Materials.—This year this report is of unusual importance because of a serious wreck which was caused last year by a load of lumber slipping off a car. It was voted to place the annual revision of these rules in the hands of a standing committee. The loading of ties on flat cars became prominent in the discussion, and it was decided to amend the rules as follows:

"Flat cars loaded with cross ties or fence posts will not be accepted for shipment."

The amended rules were referred to letter ballot.

Steam Line Connections.—This committee had found that some of the steam coupler manufacturers could not provide 1½-in. openings in the gaskets of couplers which they were making. Later it was found that some of them could do it. This complicated matters. It was thought necessary to establish a new contour because the dimensions furnished last year were not considered sufficient. There was also a question whether fixed or self-adjusting gaskets should be adopted. More time was required to settle the question. The committee was continued.

The Committee on Tank Cars was continued for another year.

Interchange Rules.—Mr. Sanderson proposed the adoption of the report of the arbitration committee as to changes in the rules as they stood, with the exception of the prices for repairs to steel cars, which was discussed separately. The motion was carried and, instead of hours and days of bickering over relatively small details, the interchange rules were disposed of in about 60 seconds. This really "took the breath" of the association. The arbitration committee made no radical proposals of changes and the rules, as to details, were practically eliminated from the discussion. No better exhibition could be given of the spirit of concord existing in the association this year, and the great confidence of the association in the arbitration committee was sufficiently indicated. It is to be hoped that this precedent will lead to entrusting the revision of the rules almost entirely to this judicial committee.

INDIVIDUAL PAPER.

"Use Of Steel In Passenger Car Construction." By William Forsyth.—The author's object was to direct attention to the great increase in weight of passenger cars, with a relatively small increase in capacity. The weight of passenger cars had increased about 5,000 lbs. per year for the past five years. He considered steel for frame construction, for lightness and increase of strength. Four designs of steel frame construction were included in the paper. In the discussion, Mr. Henderson referred to the safety features of steel frame cars in wrecks, and wished the association to consider fireproofing the woodwork of passenger cars. Mr. Barnum spoke of the use of steel in framing of postal cars. It was thought desirable that the association should advance steel frame designs as rapidly as possible in order to be in advance of the demand of the government in this service. Evidently the time for steel frame passenger cars has arrived. This subject was referred to a special committee for report next year.

TOPICAL DISCUSSIONS.

Advantages and Disadvantages of 2-in. Main Steam Pipes with 1⅝-in. Steam Hose.—Mr. Hennessey introduced the subject and asked for information. Mr. Ball stated that tests on 16-car trains made last winter indicated that 60 lbs. pressure sufficed in connection with 2-in. train pipes, whereas 80 lbs. were required with 1½-in. pipes, and the "Lake Shore" was fitting up with 2-in. train pipes. Reports from the New York Central were also favorable to the large pipes. Mr. McIntosh thought that 1½-in. pipe was sufficient after the steam was once brought to the rear of the train in heating up. Mr. Schroyer believed the pipe diameter to be less important than the large openings through the couplings. Mr. Ball wished to see the pressure on the hose reduced by the use of larger train pipes. He had found larger openings through the couplings very satisfactory.

To What Extent Does Friction Draft Gear Reduce Repairs and Expenses?—Opened by Mr. E. B. Gilbert. From a wide experience he quoted a cost of 4¼ cents per car per year for friction draft gear on 6,800 steel cars from 1897 to the present time, and in very heavy service. Mr. Gilbert discussed the proper methods of comparing friction and spring gears. His remarks will be printed in full in another issue.

To What Extent Will a More Rigid Inspection of Car Couplers at Terminal Points Reduce Accident and Repairs?—Mr. Macbeth opened the discussion by stating that a large number of break-in-two accidents were due to worn couplers. He strongly recommended stretching trains at terminals and rigid inspection of the condition of the couplers, as to wear, by a small gauge which could easily be carried in the pocket of the inspector. This would indicate whether knuckles are worn sufficiently to uncouple on the road. He recommended the adoption of such a gauge by the association. This subject developed the fact that break-in-twos are increasing daily and that couplers are now allowed to run in very defective condition.

Advantages and Disadvantages of Different Varieties of Side Bearings.—Introduced by Mr. L. H. Turner. The speaker stated that side bearings of the best construction would not suffice if the center-plates were not right. He advocated the use of frictionless side bearings with frictionless plates and properly constructed body bolsters. His remarks will be printed later.

Cannot the Present Method of Securing Coupler Yokes to Couplers for Freight Cars Be Improved.—Mr. Ball offered a design of a coupler yoke with a hinged connection between the coupler shank and the yoke. This would provide means for quick repairs by using a detachable yoke at interchange points. It would also provide lateral motion for couplers. The subject was referred to the executive committee for consideration next year.

Brake Beams, Proper Hanging of, to Secure Brake Shoe Clearance.—Opened by Mr. W. E. Fowler. The proper support for brake beams was from the trucks, so that they would not be affected by the springs. Long hangers were desirable, and they should have such angles as to cause the brake shoes to drop away from the wheels. Inside hung brakes were strongly advocated, both for passenger and freight cars. It was most important to obtain uniform piston travel, which was impossible if brake shoes were hung to the car bodies.

Stronger Draft Gear for Passenger Cars.—Introduced by Mr. H. La Rue. The shocks of heavy locomotives in starting heavy trains constituted an important problem. Mr. Henderson stated that with trains of 15 to 18 cars on the Santa Fe the ordinary draft gear was too weak and permitted the buffers to separate as much as 2 ins. Increased spring capacity was suggested as a remedy. Mr. Hennessey advocated friction draft gear as the ideal draft gear for passenger cars. Increasing spring capacity alone gave too much recoil. Excessive shocks should be received by frictional resistances. Mr. Herr stated that this was easy to accomplish providing sufficient space is available.

The officers for the year were elected as follows: President, W. P. Appleyard; first vice-president, Joseph Buker; second vice president, W. E. Fowler; third vice-president, G. N. Dow; treasurer, John Kirby; executive members, James McBeth, A. E. Mitchell and H. D. Taylor.

The retirement of President Brazier was made impressive by the presentation of the ex-president's medal by Mr. George A. Post in a remarkably fitting and worthy manner.

The convention was unusually satisfactory and successful. Businesslike conduct of the meetings and prompt, brisk discussion characterized them throughout.

MASTER MECHANICS' ASSOCIATION.

President W. H. Lewis called the convention to order June 27, the attendance being nearly as large as that of the Master Car Builders' Convention. The presidential address was an important contribution to current literature on the subject of motive power problems. Throughout, the speaker urged the members of the association to studiously consider not only the problems of the present, but to prepare for those which are to come. Special prominence was given to the influence to be introduced by electricity into motive power questions in the future. As to present problems, he laid particular stress upon the tendency to overload and overwork locomotives. In this connection he traced the development of the locomotives on the Norfolk & Western Railway, and referred to the table which was printed on pages 224 and 225 of our June number. This revealed a surprising extent of progress. One effect of the address, if it receives the attention it deserves, will be to cause a more careful study of locomotive operation looking toward more rational loading. The address is a paper for general managers as well as motive power officers. Locomotive failures constituted an operating as well as a motive power problem. The speed of trains had much to do with the so-called "failure of the big locomotive." The speaker recommended for consideration next year the following subject:

"What are the practices underlying the proper loading of locomotives on the basis of conducting transportation, with the greatest efficiency at the least cost, considering all the factors individually?"

The American Engineer tests and the proposed consolidation of the two associations received the support of the president.

A total of 791 members was stated in the report of the secretary. Last year the total was 751; 96 had been added during the year and the loss by all causes was 56. The treasurer's report showed a balance of $2,874.80 in the hands of the treasurer.

The proposed change in the constitution concerning representative membership was discussed, the purpose of the new membership to be appointed by railroad officials being to represent the roads in connection with scientific investigations conducted by the association and also in the adoption of standards. The amendment was passed. This subject will be referred to in a future issue.

COMMITTEE REPORTS.

Ton-Mile Statistics. Credit for Switch Engines.—This report appears in abstract in this issue. Mr. McIntosh called attention to the fact that many road engines were in switching service, and that the weight on drivers would not always give a fair ton-hour unit. He recommended using the adhesive weight of the locomotive. The recommendation of the committee was accepted with the proposed change as to adhesive weight and the matter was referred as a recommendation to the American Railway Association.

Coal Consumption of Locomotives.—Mr. H. T. Herr presented the report. He stated the desirability of a standard method of employing locomotive engineers and firemen and that the committee did not favor pooling of engines. Tests were recorded showing that the efficiency of locomotives as a whole had improved materially since the advent of large grates and heating surfaces. The "large locomotive" was shown to be highly advantageous from an operating standpoint. Grate area should be determined by a favorable rate of combustion. The most important observation of the report was the necessity for better methods of recruiting engineers and firemen and increasing their efficiency. In the discussion the bad effects of pooling were made prominent. The difficulty in securing satisfactory firemen was spoken of as serious. Good men could not be had. Mr. McIntosh believed the automatic stoker to be the only solution of the fireman problem. Mr. Barnum believed it necessary to arrange cab fittings more conveniently in order to aid firemen, particularly on large engines. He supported the automatic stoker, and urged investigation and development of this device. Mr. Walsh (C. & O.) thought that the passing of the control of engineers and firemen from the motive power to the operating departments had more to do with decreased efficiency of these men than pooling. Dr. Goss called attention to the fact that the committee did not speak enthusiastically of the large grate. Large grates required greater skill in firing. The discussion centered in the fireman question, and it became obvious that some important questions have been neglected in the development of big locomotives. Mr. McKeen (Union Pacific) emphasized the importance of good fuel records, which would bring the statistics before the individual firemen. He thought that "we ought to get after the coal chutes" and instal proper weighing devices for coal. This report was distributed too late for proper discussion.

Locomotive Front Ends.—Mr. H. H. Vaughan, chairman of the committee, explained the present standing of this question (The complete report appears elsewhere in this issue.), and the fact that the question to be decided was whether or not the association would provide funds for pursuing the tests. Mr. Vaughan moved that the executive committee be instructed to furnish funds for the tests when money is available. Carried.

Locomotive Driving and Truck Axles and Locomotive Forgings.—This subject was presented by Mr. Pomeroy, who explained that it was a report of progress in co-operating with the American Society of Mechanical Engineers, American Institute of Mining Engineers and the American Society for Testing Materials. It was stated incidentally that by the use of a new drill, test pieces may be cut from the ends of an axle without weakening the axle and without requiring the use of coupons. In the discussion Mr. Gillis considered it necessary to drill the full length of axle in order to insure the discovery of cavities in the metal if any existed. Mr. Walsh (C. & O.) stated that manufacturers would not give any guarantee whatever of freedom from "piping" unless axles are drilled. In view of this it was desirable that the committee should consider this factor. The committee was continued.

Boiler Design.—Dr. Goss presented this important report, which appears in abstract in this issue. The committee recommended laboratory tests for the determination of the rapidity of circulation in a boiler generating varying amounts of steam. It was shown that there was a great lack of definite information with respect to boiler design. Mr. Waitt proposed a resolution empowering the executive committee to raise a fund of $5,000, to be used under the direction of a special committee, for the purpose of conducting such tests. The resolution was passed.

Revision of Standards.—One of the important subjects this year was the revision of the specifications for firebox and boiler steel, which had not been revised for ten years. The committee recommended bringing the specification up to date to correspond with those of the American Society for Testing Materials. The proposed specifications for firebox and boiler steel were ordered submitted to letter ballot for adoption. This was a new departure for this association, but the subject was considered too important for less deliberate action. The proposed specifications for boiler tubes were similarly disposed of.

Piston Valves.—Mr. McIntosh presented the report, which contained records of elaborate tests for tightness of piston valves, conducted on the Norfolk & Western and "Lake Shore" railroads, which indicated surprising losses by leakage of piston and slide valves; one case recorded a loss of 2,880 lbs. of steam per hour. The best piston valve showed a leakage of 268 lbs. per hour, and the best slide valve 348 lbs. per hour. Piston valves leaked less than slide valves. This important report will be referred to in another issue.

Automatic Stokers.—Mr. J. F. Walsh in presenting the report spoke of the development of the automatic stoker and referred to the economic advantages of the device. It greatly reduced the work of the fireman. Reduction of repairs and regularity of service were also important. Stokers were most valuable on long firebox engines, hauling heavy trains over long divisions where the ordinary firedoor would be open two-thirds of the time. By proper manipulating, the stoker referred to in the paper could be increased 100 per cent in capacity. Dr. Goss believed that a large increase in efficiency should not be expected from locomotive stokers. A locomotive stoker must be able to respond instantly to sudden variations of load. It should be considered as an automatic shoveller as distinguished from stationary types. The stoker referred to in the paper was of the type from which success may be expected in locomotive practice. This stoker certainly did get coal into the firebox and it also distributed it uniformly. Those interested in the development of stokers should be greatly encouraged by this discussion to make renewed efforts toward the production of a satisfactory design. Mr. Walsh said that this stoker would spread coal evenly over the floor of a room which was 10 by 14 ft. in size, showing that it will easily take care of wide fireboxes. Mr. Forsyth thought that the thing to do was to put the present stoker to work without waiting for further development. Mr. H. T. Herr did not believe automatic stokers would save coal because of the necessity for using steam for its operation. Neither would stokers fire better than good men but the strong point of the stoker was its endurance. The stoker required about 300 lbs. of steam per hour. Dr. Goss believed that stokers would permit of using cheaper coal on locomotives as they had in stationary practice. This was one of the most, if not the most, important subject before the convention in its bearing upon the capacity of locomotives and repairs on fireboxes. In fact, whenever the fireman and firing were mentioned the discussion became very lively, indicating that everyone was deeply interested and greatly troubled in the matter of firing large locomotives.

Locomotive Frames.—Mr. L. R. Pomeroy, who had assisted the committee, was requested to present the report which was chiefly concerned with the question of frame breakage on large locomotives. A large number of frame designs were included in the report. These had been submitted to the leading steel foundrymen and specifications suggested by them were included. The report also compares wrought iron with cast steel. The latter material was strongly advocated by the committee, because of its strength and the fact that the frames were made all in one piece. Sensible design and suitable frame bracing were strongly urged. Mr. Pomeroy spoke favorably of the plate type of frames. Proper drainage of cylinders had an important influence on frame breakage. In the discussion Mr. McIntosh advocated construction which would reduce to a minimum the number of frame bolts. Mr. Vaughan described experiments which he conducted (on the L. S. & M. S. Ry. See AMERICAN ENGINEER, January, 1904) for the purpose of studying frame deflections. Water in the cylinder had produced actual stretching of large binder bolts, which led to fractures. Piston valve engines with single front frames required pedestal binders which positively would not stretch. The "clip" binder was generally considered by several speakers as better than the bolt binder.

Cost of Locomotive Repair Shops.—Mr. Soule explained the objects of the committee in its report and the reasons for the selection of the units used. The report was the only one which was received with applause. Mr. Barnum expressed the opinion that it was one of the most valuable ever brought before the association. It will be printed in full in this journal.

INDIVIDUAL PAPERS.

Grates for Bituminous Coal.—By J. A. Carney. This paper suggested doing away with dead grates entirely and that no drop grates be used unless they can be shaken. It also recommended 50 per cent. of air openings in grates, and that ash pans should have air openings of at least 25 per cent. of the grate area. Mr. Carney explained that the grate recommended in the report had been in successful use for 18 months. Mr. Player thought that the area of air openings under grates should be based on the flue area rather than the grate area. The grate referred to in the paper received favorable comment in the discussion.

Improved Tool Steels.—By Mr. W. R. McKeen. Tests of tool steels were described in this important paper, which should be placed before every railroad shop foreman. The comparisons were well drawn and the impression was made that special care is desirable in introducing the new tool steels in order to get the utmost out of them. In the discussion several speakers preferred other than "high-speed" steels for finishing cuts because of cost and smoother finish. Messrs. Seley and McIntosh spoke of the economic advantages of using holders and relatively small pieces of alloy steel rather than tools made from the bar.

Variable Speed Motors.—By Mr. C. A. Seley. This paper will be printed in this journal. It chiefly concerns tests made upon motor-driven machine tools and is a valuable record supplementing the report of the committee on this subject last year.

Technical School Graduates.—By Mr. R. D. Smith. The object of the author was to make suggestions looking toward a system which would retain them in railroad service. The paper appears in abstract in this issue. As usual, apprenticeship brought out a lively discussion, in which higher pay was urged as a necessity. Mr. McIntosh did not approve of regular courses of shop experience, preferring "to turn the boys loose in the shop to make their own way." One speaker referred to the objection to special apprenticeship on the part of labor organizations. Mr. Johnson (Canadian Pacific) cautioned the association against administering special apprenticeship in such a way as to discourage the regular apprentices. Mr. Walsh believed that men should be paid what they are worth without regard to whether they are technical school graduates or not. The discussion was disappointing, not a single new idea being mentioned.

Terminals for Locomotives.—By R. Quayle. This paper was received too late for advance distribution. It is an excellent review of the locomotive terminal problem, and discusses the factors in detail, laying special stress upon adequate facilities, and should be thoughtfully read by every operating official. Mr. Bentley, who presented the paper, did not know of a properly ventilated roundhouse.

TOPICAL DISCUSSIONS.

Grease Lubrication.—Favorable experience with the use of grease for driving boxes was reported by every speaker. It is evident that grease lubrication is an improvement over oil and the change seems to be likely to be permanent. Several speakers stated that hot driving boxes had been practically entirely overcome. Some trouble had been experienced, but they had been from mechanical defects. An important and necessary feature of grease lubrication was a continual pressure of the grease against the journal, as in the practice introduced by Mr. Elvin and known by his name.

Advantages of Screw Reverse Gear for Locomotives.—Mr. John Player (American Locomotive Company) introduced the subject with a statement of the disadvantages of screw gears. They occupy more room and are more complicated than lever gears. With piston valves there was no need of anything more powerful than a lever, and the speaker thought the lever gear good enough. Opinion was quite generally in favor of the lever, but several speakers believed it necessary to provide power reverse gear (either steam or air) for the largest engines. Others directed attention to the advantages of a lever whereby the condition of lubrication of the valves could easily be ascertained.

Air Spaces Under Grates.—Mr. F. J. Cole stated that there could hardly be too much space for air to enter ash pans. It was often difficult to obtain sufficiently large openings in the front and back ends of ash pans. As much opening as possible should be provided in front. The total air openings should not be less than 75 per cent. of the total flue openings. The discussion developed the fact that many locomotives have insufficient air openings. Mr. L. R. Johnson considered it desirable to supply ash pan openings equal to the tube area, as the area could easily be reduced if desired. Mr. West, however, spoke of excellent results with engines fitted with the Bates fire-door, with an opening 8 by 12 ins., which was never closed, this being the only entrance for air. Mr. Player supported Mr. Cole's recommendation as to large openings. Dr. Goss showed that any constrained area in the passages for gas or air required increased the work of the exhaust jet. The ash pan openings were easily controlled, and he believed that these openings should not be restricted. The ideal condition would be to avoid ash pans altogether.

Painting Locomotive Front Ends.—Mr. W. O. Thompson quoted satisfactory experience with Walker's smoke-stack black, thinned with Sipe's Japan oil in proportions of one part of Japan to two parts of stack black. Mr. Walsh recommended graphite for this purpose. Mr. Chase had found graphite, white lead and boiled oil to be the best paint. It cost 9 cents to apply one coat. No two speakers recommended the same thing.

Comments on three other topical discussions will be reserved until next month.

At the conclusion of the discussions Mr. Seley presented a proposed amendment for action next year. It provides for a committee of executive members similar to that of the Master Car Builders' Association.

The election of officers for the coming year resulted as follows:

President, P. H. Peck; first vice-president, H. F. Ball; second vice-president, J. F. Deems; third vice-president, Wm. McIntosh; treasurer, Angus Sinclair.

Out of a voting membership of over 700 only 47 votes were cast in the election of officers.

In an eloquent address Mr. George A. Post presented to the retiring president, Mr. W. H. Lewis, the medal which, through a pleasing and unique custom, is conferred by the Supply Men's Association each year. The convention then adjourned.

The *Railroad Gazette*, after nearly 50 years of publication in large form, appeared June 17 with leaves measuring 13 by 9¾ ins. While some criticism may be offered because the dimensions are not "standard," it is evident the purpose of the publishers was to turn out a paper decidedly attractive and easily readable. In this they have succeeded admirably. One important reason for changing the size and makeup of the *Railroad Gazette* is given in an announcement of the publishers that they have bought *Transport*, the leading railroad paper of England and the Colonies, and beginning July 8 will print in London under the name *Transport and Railroad Gazette*, an international edition of the combined papers.

Mr. A. H. Fetters has been appointed mechanical engineer of the Union Pacific Railway with headquarters at Omaha, Neb. Mr. C. E. Smyth has been appointed assistant mechanical engineer to succeed Mr. Fetters.

The B. F. Sturtevant Company.—This company announces the removal of its entire plant from Jamaica Plain to the new works at Hyde Park, Mass., where nine acres of floor space and every modern appliance put them in position to manufacture its well-known products more advantageously than ever before.

The Garrett Interlocking Draft Arm was exhibited at the Saratoga convention. It was developed by M. A. Garrett of the Farlow Draft Gear Company and is made in cast steel or malleable iron. These arms are connected to the bolster by dove-tailed joints and they completely fill the space between the bolster and end sill. Space sufficient for any draft gear is provided. The e draft arms protect the center sills and bring the pull of the draft gear upon the body bolster. The center pin must be sheared and bolster cocked before the center sills can be injured.

Oil cabinets with adjustable measuring devices were exhibited at the Saratoga conventions by S. F. Bowser & Co., Fort Wayne, Ind. These cabinets are very convenient for roundhouses and shops where oil of any kind is used. The cabinets are of various sizes and styles. By means of a pump lever exactly the desired quantity of oil is pumped from the storage tanks. A special cabinet as constructed for the engine rooms of naval vessels was exhibited. A large number of cabinets have been supplied to leading railroads for shops and roundhouses. They are also very convenient in the engine rooms of power houses.

Carey's Magnesia Coverings are described in a pamphlet issued by the Philip Carey Manufacturing Company, Lockland, Ohio, which treats briefly of the subject of heat insulation and magnesia coverings and illustrates a number of excellent applications. This company was represented and exhibited at the Saratoga convention. Their products are specially prepared for locomotive and other railroad uses.

TABULAR COMPARISON OF NOTABLE RECENT LOCOMOTIVES

ARRANGED WITH RESPECT TO TOTAL WEIGHTS

PASSENGER LOCOMOTIVES.

Type—Drivers	4-6-2	4-6-2	4-6-2	4-4-0	4-4-2	4-6-2	4-4-2	4-4-2	4-4-2
Type—Name	Pacific	Pacific	Pacific	Oil-burner Atlantic	Atlantic	Pacific	Vauclain Bal. comp.	Atlantic	Atlantic
Name of railroad	C. & A.	N. Y. C.	A.,T.&S.F.	S. P. Ry.	N. Y. C.	C.,R.I.&P.	C., B. & Q.	Santa Fe	C. & A.
Number of road or class	602	2799	1200	3022	3000	801	2700	287	553
Builder	Baldwin	American	Baldwin	Baldwin	American	American	Baldwin	Baldwin	Baldwin
Simple or compound	Simple	Simple	Simple	Vauclain Compound	Cole Bal. Compound	Simple	Compound	Vauclain Compound	Simple
When built	1904	1904	1903	1903	1904	1903	1904	1903	1903
Weight engine, total, pounds	221,500	215,000	215,180	200,030	200,000	192,800	192,000	187,000	183,820
Weight on drivers, pounds	135,110	141,000	140,800	102,190	110,000	130,000	100,000	90,000	103,690
Weight on leading truck, pounds	40,500	36,000	27,680	61,120	50,000	....	50,000	52,000	40,130
Weight on trailing truck, pounds	45,490	38,000	46,700	36,200	40,000	....	42,000	45,000	40,000
Weight of tender (loaded), pounds	166,600	127,000	....	....	121,600	....	....	....	166,600
Wheel base, driving, feet and inches	13-4	13-0	13-8	6-10	7-0	12-4	7-3	6-4	7-8
Wheel base, total, feet and inches	33-4	33-7½	33-9½	31-3½	27-9	31-10	30-2	29-6	27-0
Wheel base, total, eng. & tender, ft. & in.	62-8¾	59-0	62-10½	65-5¼	53-8	58-9	....	58-3½	56-3½
Driving wheel, diameter, inches	77	75	69	79	79	69	78	73	80
Cylinders, diameter inches	22	22	22½	15 & 25	15½	21	15 & 25	15 & 25	20
Cylinders, stroke, inches	28	26	28	28	26	26	26	26	28
Heating surface, firebox, square feet	179	178.65	122.8	155	175	164	166.4	190	191.2
Heating surface, arch tubes, square feet	....	27.35	....	....	23	....	....	....	....
Heating surface, tubes, square feet	2,874	3,570	3,402	2,883	3,248.1	2,940	3,050.5	2,839	3,056
Heating surface, total, square feet	3,053	3,776	3,595	3,038	3,446.1	3,104	3,216.9	3,029	3,247.2
Firebox, length, inches	108	96⅛	108	121	96⅛	84	96⅛	107 15-16	108⅛
Firebox, width, inches	66	75¼	71¼	63⅜	75¼	74	66¼	66	72¼
Grate area, square feet	49.5	50.23	53.5	....	50.23	42.2	44.14	49.4	54.2
Boiler, smallest diameter of, inches	70	72 1-16	70	66	72¼	66⅛	64	66	70
Boiler, height, center above rail, ft. & in.	9-5	9-5	....	....	9-3 1-16	....	....	....	9-5
Tubes, number and diameter of, in inches	245-2¼	303-2¼	290-2¼	346-2	390-2	300-2	274-2¼	273-2¼	326-2¼
Tubes, length, feet and inches	20-0	20-0	20	16	16	18-7	19	....	16
Steam pressure, pounds, per square inch	200	200	220	200	220	200	210	220	200
Type of boiler	Straight	Straight	Wagon top	Wagon top	Straight	Wagon top	Wagon top	Wagon top	Straight
Fuel	Bitum.	Bitum.	Bitum.	Oil	Bitum.	Bitum.	Bitum.	Bitum.	Bitum.
Reference in AMERICAN ENGINEER AND RAILROAD JOURNAL.	Apl., 1904 P. 133	Mar., 1904 P. 87	Dec., 1903 P. 443	Sept., 1903 P. 329	May, 1904 P. 184	Oct., 1903 P. 351	June, 1904 P. 212	June, 1903 P. 212 Sept., 1903 P. 334	Dec., 1903 P. 458

Note.—This table supplements that presented in this journal as an inset in June, 1903.

MOTOR-DRIVEN MACHINE TOOLS.

APPLICATIONS TO SPECIAL MACHINERY.

Under this heading in our May issue a number of special applications of motors to machine tools were presented, and the accompanying five engravings show others of equal interest.

Fig. 1 illustrates a motor-drive applied to a more highly specialized class of tool, this being the recently re-designed 50 by 10-in. automatic gear-cutting machine, with automatic worm hobbing attachment, built by Gould & Eberhardt, Newark, N. J. The motor, which is a Lundell direct-current motor, is most conveniently mounted upon an extension of the base at the rear out of the way, and drives direct through gearing. The switch and starting box for operating it are conveniently mounted upon a stand at the rear, so that the tool, while self-contained, is very compact.

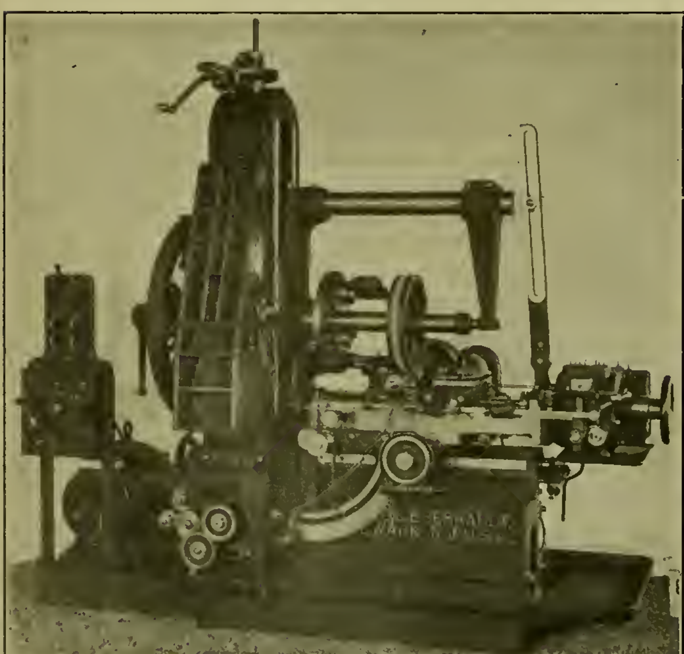


FIG. 1.—AUTOMATIC GEAR CUTTING MACHINE, WITH SELF-CONTAINED MOTOR DRIVE.—GOULD & EBERHARDT.

FIG. 2.—SPECIAL NILES PORTABLE FLOOR PLATE DRILL, WITH DIRECT VERTICAL-MOTOR DRIVE; AT THE WORKS OF THE BULLOCK ELECTRIC MFG. COMPANY.

TABULAR COMPARISON OF NOTABLE RECENT LOCOMOTIVES

ARRANGED WITH RESPECT TO TOTAL WEIGHTS

PASSENGER LOCOMOTIVES.						FREIGHT LOCOMOTIVES.						
4-4-2	4-4-2	4-6-0	4-4-2	4-4-2	2-6-4	0-6-6-0	2-10-0	2-8-0	2-8-0	4-6-0	2-8-0	0-8-0
Atlantic	Atlantic	10-wheel	Atlantic	DeGlehn Comp.	Suburban	Mallet Comp.	Tandem Comp.	Consol.	Consol.	Comp. S.-heater	Consol.	8-wheel switcher
Wabash	Vandalia	D. & H. Co.	P.&L.E.	Penna.	P. & R.	B. & O.	Sante Fe	L.S.&M.S.	N. Y. C.	Can. Pac.	Erie	C. & O.
620	51	502	305	2512	381		915	Class C	2498	1300	H.-12	8
American	Amorican	American	American	Soc. Als.	Baldwin	American	Baldwin	American	American	American	American	American
Simplo	Simple	Simple	Simple	Compound	Simple	Compound	Compound	Simple	Simple	Compound	Simple	Simple
1903	1904	1903	1903	1904	1903	1904	1903	1903	1903	1903	1900	1904
180,700	179,000	175,000	168,000	160,000	201,700	334,500	287,240	228,000	220,200	192,000	189,400	171,175
96,700	109,500	131,500	96,000	79,500	120,860	334,500	234,580	202,900	200,000	141,095	165,900	171,175
46,000	....	43,500	....	46,500	19,120	....	23,420	....	20,200	50,925	23,500	....
38,000	....	....	....	34,000	61,720	....	29,240	....	....	....	....	....
130,000	....	120,000	145,000	132,500	....	143,000	....	148,000	137,500	122,000	126,400	121,160
7-6	7-0	15-0	7-0	7-0½	12-6	30-8	19-9	17-3	17-0	14-10	17-0	13-7½
30-11½	27-3	26-4	26-10	23-6½	30-9	30-8	35-11	26-5	25-11	26-1	25-3	13-7½
56-0	57-10¾	53-7½	57-2	59-5	....	64-7	66-0	57-10	60-7	54-6	51-4½	45-7¾
83	79	72	72	68 3-16	61⅝	56	57	57	63	62	62	51
21	21	21	20	14 3-16 & 23⅝	20	20 & 32	19&32x32	23	23	22 & 35	21	21
26	26	26	26	25 3-16	24	32	32	30	32	30	28	28
177	177.1	179.68	166.85	181.1	156.3	219	210	203	189.77	180	167	132 13
....	....	78.54	24.41	....	....	....	....	29	30.23	....	....	....
2,499	2,923.3	2,405.5	3,750.2	2,435.7	1,825.5	5,366	4,586	3,725	3,717	2,312.6	2,224	2,572.97
2,676	3,100.4	2,663.72	2,941.46	2,616.8	1,981.8	5,585	4,796	3,957	3,937	2,492.6	2,391	3,705.10
102	96⅛	119⅞	102	120	94	108	108	108	105 1-16	102⅛	113	80
63	75¼	102	65⅝	54	105	96	78	73¼	75¼	70¼	96	70
43.7	50.2	84.85	46.27	33.9	68.5	72	58.5	55	54.89	49.82	75	38.8
64¼	70⅝	66¼	67-0	59½	66	84	78¾	80	81⅝	70½	68	67
9-4	....	9-5	....	9-9½	9-0 front 9-2.4 back	10-0	....	9-11	9-6	9-3½	9-11	9-4½
294-2	351-2	308-2	330-2	....	447-1¾	436-2¼	391-2¼	460-2	458-2	248-2 & 22-5	298	351-2
16-4	16	15	16-0	14-5¼	9-0	21	20-0	15-6⅛	15-6	14-8	13-2 3-16	14-0
215	200	200	200	227	200	235	225	200	200	200	200	200
Wagon top	Straight	Culm burner	Straight	Straight	Wagon top	Straight	Wagon top	Wagon top	Straight	Wagon top	Straight	Wagon top
Bitum.	Bitum.	Anth.	Bitum.	Bitum.	Anth.	Bitum.	Bitum.	Bitum.	Bitum.	Bitum.	Anth.	Bitum.
Dec. 1903 P. 437	Apr., 1904 P. 153	Aug., 1903 P. 285	Nov., 19[illegible] P. 421	June, 1904 P. 203	Oct., 1903 P. 364	June, 1904 P. 237	Oct., 1903 P. 372 Nov., 1903 P. 398 May, 1904 P. 176	Nov., 1903 P. 416 Dec., 190[illegible] P. 439 Jan., 1904 P. 12	Jan., 1904 P. 16	Sep., 1903 P. 317	June, 1903 P. 348	May, 1904 P. 184

Note.—This table supplements that presented in this journal as an insel in June, 1903.

In Fig. 2 is illustrated an interesting drive upon a special Niles portable floor-plate drilling machine which is in use at the works of the Bullock Electric Manufacturing Company. The motor, which is a vertical Bullock direct-current motor, is mounted directly upon the top of the column and is geared to the vertical-splined driving shaft of the machine without the use of bevel gearing—this is alone a great advantage, but the compactness and simplicity afforded by this arrangement is the most important feature.

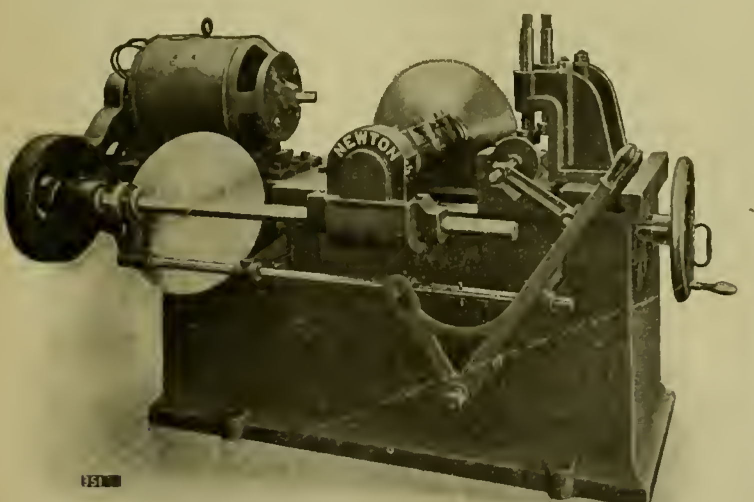


FIG. 3.—DIRECT GEARED MOTOR DRIVE UPON A COLD-SAW CUTTING-OFF MACHINE.—NEWTON MACHINE TOOL COMPANY.

Figs. 3 and 4 illustrate additional examples of motor applications to special metal working machinery, the advantages of which will be seen at a glance. The former, a Newton No. 2 cold saw cutting-off machine, is conveniently driven by a Bullock motor which replaces the former belt drive. The latter, a Ferracute punch press for metal stamping work, well shows the advantage of electrical driving for this class of tools; the drive is, in this case, the smallest part of the tool. The motor used upon the punch is the spherical-type steel-frame motor, built by the Northern Electric Manufacturing Company, Madison, Wis., and operates at constant speed.

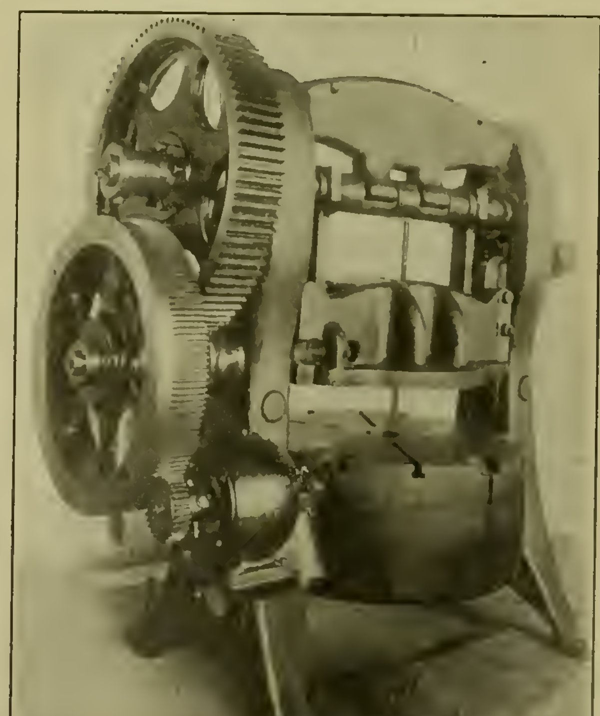


FIG. 4.—CONSTANT SPEED DRIVE FOR A HEAVY FERRACUTE PUNCH PRESS.—NORTHERN ELECTRIC MFG. CO. MOTOR.

The drive upon the grindstone, Fig. 5, a Brown & Sharpe special trough mounted, is very conveniently arranged. The motor, a Bullock direct-current machine, is located at the rear and drives through a combination of gearing and silent chain. The starting box is conveniently mounted at the side of the tub and is protected from splashing by a hood. This drive is of special interest as showing the extent to which individual

FIG. 5.—AN INTERESTING APPLICATION OF MOTOR-DRIVING TO A GRINDSTONE.—BULLOCK MOTOR WITH SILENT-CHAIN DRIVE.

driving is coming to be used in the operation of small tools, the advisability of this being a much discussed point at present.

HARD SERVICE FOR WHEELS.—In order to keep the wheels of the cars of the Boston Elevated Railroad in good condition it is necessary to grind them every two weeks. The crooked road wears the wheels into polygonal form in a short time and heroic measures are necessary to keep them in condition to prevent noise in operation.

The Rand Drill Company is sending out a mailing card which is a decided novelty. It is in the shape of the new "Imperial" hammer, the address being written on the barrel and a 1-cent stamp fitting into the handle.

HIGH SPEED STEAM LOCOMOTIVE TRIALS IN GERMANY.

Because of the speed of 117.32 miles per hour, attained by an electric locomotive on the experimental track between Marienfeld and Zossen, near Berlin, the results of the speed trials of steam locomotives on this track have been awaited with interest. The steam locomotive tests began last February and have just been completed. Consul Frank H. Mason reports the results, and they are not superior to the speeds of ordinary service on the Camden and Atlantic City line of the Philadelphia & Reading. As a test of electric vs. steam locomotives the trial shows nothing, because the electric locomotives operated singly and the steam locomotives hauled trains of six and three 30-ton cars. Four locomotives were compared.

The first locomotive was built by the Egestorf Machinery Company, of Hanover. It is a 4-4-2 type, and with six cars attained an average speed of 68.97 miles per hour. With three cars the speed was 79.41 miles.

The second locomotive was built at Grafenstadt, a compound, also of the 4-4-2 type. With six cars this engine made 73.32 miles per hour, and with three cars, 76.42 miles.

The third was a 4-4-0 locomotive, built by Borsig, and is similar to the standard passenger engine of the Prussian State Railways. It has a Schmidt superheater, and was designed by Herr Garbe. This engine, with only 963 sq. ft. of heating surface, gave higher speed than the first two, which were specially designed and built for the trials. Its speed with six cars was 79.53 miles per hour, and with three cars 84.5 miles per hour. The horse-power developed approximated 2,000.

The fourth locomotive, which headed the list for speed, is the design of Mr. Wittfield, of the Prussian State Railways, and the cab in front, and is to be exhibited at St. Louis. Both en-
was built by Henschell & Sons, of Cassel. It is arranged with
gine and tender are encased in a sheathing of steel, giving a smooth exterior surface to reduce the wind friction. This is a 4 4-4 type 4-cylinder balanced compaund. It has 2,766 sq. ft. of heating surface and weighs 76.8 tons. This engine gave a speed of 79.53 miles per hour with six cars, and 85.12 miles with three cars.

OIL FUEL TESTS—NAVY DEPARTMENT.

The Oil Fuel Board of the Navy Department has made public its conclusions from its recent experiments. Some of the most important of them are:

"No difficulty should be experienced by an intelligent fireroom force in burning oil in a uniform manner.

"While the use of steam as a spraying medium will undoubtedly prove most satisfactory for general purposes, the result of the tests show that the consumption of fuel oil cannot be forced to as great an extent with steam as the atomizing agent as when highly heated compressed air is used for this purpose.

"In every oil fuel installation special provision should be made for the removal of the water that will collect from various sources at the bottom of the supply tanks.

"The evaporative efficiency of crude and refined oil is practically the same, no matter from what locality the oil may come. The danger of using crude oil is much greater.

"In order to provide a uniform supply of oil to the burners the oil should be heated by some simple means.

"Where oil is used as a fuel in a Scotch boiler the introduction of retarders in the tubes will undoubtedly increase the evaporative efficiency of the boilers.

"Where crude petroleum has undergone a slight refining or distillation, no ill effects result to modern steel boilers. From the standpoint of endurance of the boiler, the advantage, if any, is with oil. Crude oil, however, by reason of its searching and corrosive effects, has a greater tendency than refined oil to attack the seams and tubes of modern boilers. For marine work, therefore, no crude petroleum should be used, and particularly for ships making long voyages the fuel oil should undergo some mild distillation before being placed in the tanks.

"Under forced draft conditions and with water tube boilers, and with the use of oil as fuel, the solution of the smoke question is nearly as remote as ever. Where a limited quantity of oil is burnt in a Scotch boiler, however, and retarders are used in the tubes, crude petroleum should be smokeless."

The Chicago Pneumatic Tool Company report an excellent condition of their business. President Duntley has forwarded orders from England for 275 machines, fifty of these being rock drills for South Africa. Twenty-five compressors have been ordered for use in Europe, and nine large "D. S. C." compressors have been ordered by the Pennsylvania Railroad. The factories at Franklin, Cleveland and Detroit are running at their full capacities.

STEAM TURBINE TEST.—A pamphlet containing the results of an elaborate test of a direct converted Westinghouse-Parsons turbine, made by Messrs. Dean & Main, has been received from the Westinghouse Machine Company, Pittsburgh. The record is admirably complete, and shows the effect of superheating. Presumably copies may be had by addressing the Westinghouse Company's Publishing Department, Pittsburgh, Pa.

The Canadian Rand Drill Company, Sherbrooke, Quebec, have just closed with the Canadian Westinghouse Company, of Hamilton, Ont., for installation of a Rand-Corliss compound, power-driven, air compressor, to be installed in their new plant. This machine is designed to furnish air for the various pneumatic appliances throughout the works, and is to be driven by a Westinghouse motor, through a Morse chain drive. The International Coal and Coke Company, Coleman, Alberta, have just placed an order with the Canadian Rand Drill Company, Sherbrooke, Quebec, for a 300 h.p. steam driven Rand duplex compressor of the very latest type.

THE GISHOLT BORING MILL.

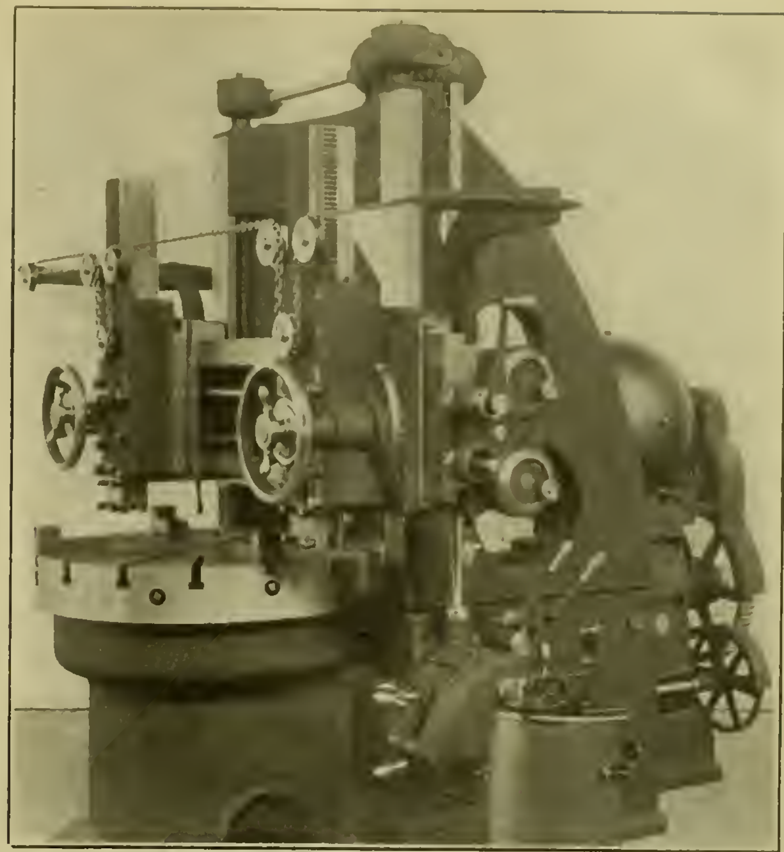
The accompanying engravings illustrate the vertical boring mills manufactured by the Gisholt Machine Company, Madison, Wisconsin. The design embraces several novel and very useful ideas in machine tool construction.

The drive of the machine is of the single pulley, constant-belt speed variety, which has heretofore been used principally in small machines where a variable speed in the spindle was required. The application of this class of drive to machines of this particular character is a decidedly unique idea. While this principle has been used in small machines, as stated, it has been demonstrated a most successful drive in the way it has been adapted to the Gisholt mill. The position of the drive at the rear of the machine brings it entirely out of the way and yet the handiness of the operating levers gives absolute control without necessitating a change of position on the part of the operator. The absence of the old familiar cone pulley is one of the conspicuous features of this mill.

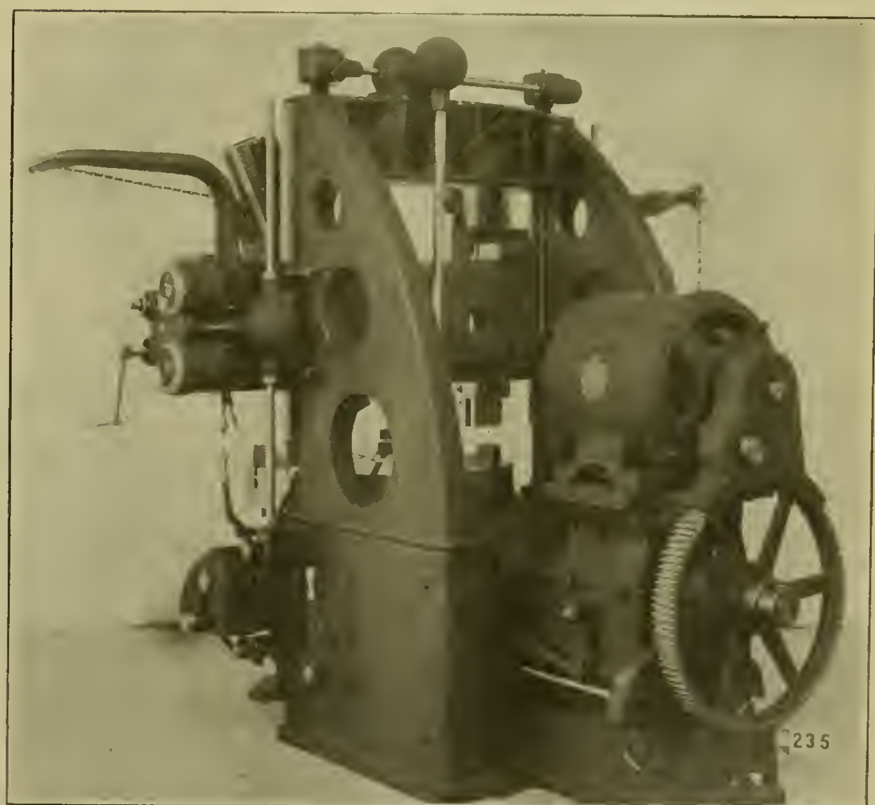
The headstock of this machine is of the friction class, self-oiling, which has been used with such great success by this company on its well-known turret lathes. This form of headstock gives complete control of the table, enabling the operator to instantly stop or start the table, or to move it but a fractional part of a complete revolution without the necessity of starting and stopping the motor or changing in any way the belt connection. It is becoming more evident every day in direct-connected machine tools that the combination is far from satisfactory unless there be introduced somewhere between the motor and the driving mechanism a friction device of some kind. Otherwise it becomes necessary when the tool is stopped to stop the motor, a time-consuming operation of no small importance.

The headstock of the Gisholt mill is so designed that a variable-speed motor with an increase of 50 per cent. above normal will give an almost ideal arrangement of speeds. Thus a very moderate-priced motor equipment only is required in conjunction with this mill. Six mechanical changes of speed are given by this form of headstock, all of which are immediately obtainable by the use of conveniently-located levers. The levers are, of course, non-interfering. The illustrations show how conveniently all operating levers are placed. The operator has every lever within easy reach of his customary position, and the starting and stopping device is controllable from either side of the machine. The changes of speed being all obtained by gearing either through the friction clutch or direct, and the elimination of the cone and belt-style drive, with its attendant shifting and slipping of belts, makes this device far superior in every way. Such an arrangement makes the handling of the machine very satisfactory to the operator, as it requires only the shifting of a lever to get the desired change of speed. Twelve speeds of the table are obtainable.

The heads are entirely independent of each other and may be set to any angle. They are



GISHOLT BORING MILL. SIDE VIEW, SHOWING FEEDING MECHANISM AND CONTROLLING HANDLES FOR THE DRIVE.

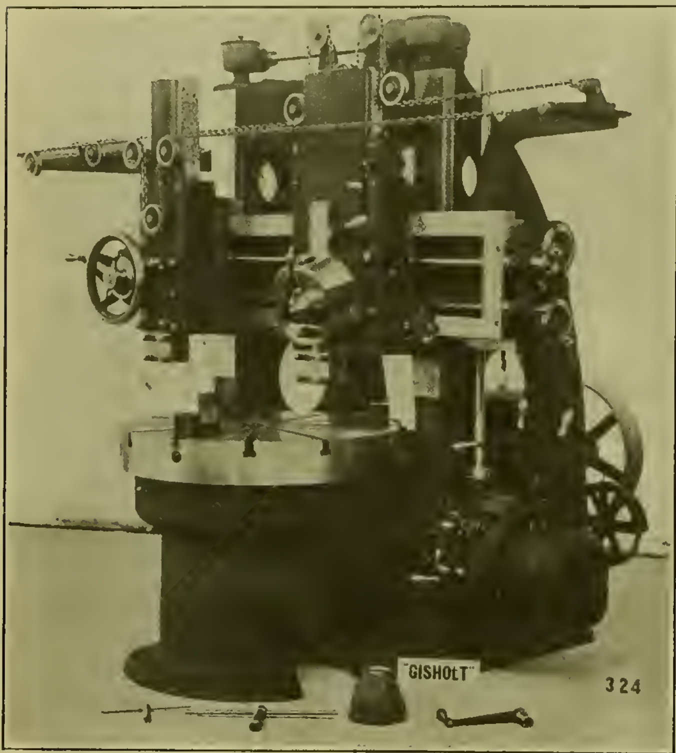


REAR VIEW OF GISHOLT BORING MILL, SHOWING ARRANGEMENT OF MOTOR DRIVING AND BULLOCK MOTOR.

NEW BORING MILL, GISHOLT MACHINE COMPANY. EMBODYING A NUMBER OF EXCELLENT FEATURES.

controlled by feed mechanisms located on either side of the machine. The feeds, both vertical and horizontal, are also independent and may be operated by power or by hand. A range of ten feeds is given. Each head is fitted with a positive stop so that the centre of the downslide may be brought to coincide with the centre of the table.

The machines are so arranged that the right-hand head may, when desired, be removed and replaced by a turret head, which



THE NEW GISHOLT BORING MILL, SHOWING COMBINED USE OF PLAIN AND TURRET HEADS.

in addition to its vertical movement may be swiveled to any angle. It is provided with an automatic tripping device. A screw-cutting attachment may be also employed when desired. The feed-tripping device with which this machine is fitted is automatic in its action. By an index dial the operator is able to set the feeds for throwing out at any point desired, either vertical or horizontal, and with very little or no calculation on his part. The mere setting of the tripping device stops the tool accurately at any predetermined point. These dials are plainly shown at the end of the cross-rail. Micrometer index dials, with which both feed-rods and feed-screws are fitted, read to 0.001 inch. Such an arrangement is most convenient, to say nothing of its time-saving qualities. Much calipering is done away with and this arrangement certainly reduces it to a minimum.

All gears on the machine are accurately cut and are incased, and in its general outlines the machine presents a massive yet exceedingly neat appearance. The metal is well distributed and is calculated to withstand the strains attending the work of heavy cutting at high speed. Being practically self-contained no special foundation is required.

The cross rail is of a very rigid construction and, of course, is raised and lowered by power. The table may be a universal combination chuck fitted with three movable top jaws, or a face-plate with independent jaws may be substituted when desired. The table is powerfully geared, being driven by a spur pinion. The spindle revolves on a large self-oiling babbitted surface.

At present these machines are being made in six sizes: 34-in., 42-in., 54-in., 60-in., 64-in. and 74-in. The company will show the mills at the St. Louis Fair, the exhibit being located in Machinery Hall, Block 14, Aisles F and 3.

MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

XIV.

The importance of the use of the change-gear variable-speed driving mechanism for the drives of drilling machines is rapidly becoming known to users of machine tools and is being regularly specified by them upon orders of new radial drills for general classes of work. The facility with which drilling speeds can be adjusted to the particular class of work in hand is remarkable and affords a very convincing proof of the value to be derived from the use of this improvement. The actual economies that have been effected in many cases from the use of this improvement have been more than sufficient to warrant its application, even upon old drills.

The Dreses Machine Tool Company, Cincinnati, Ohio, have recently perfected a new gear mechanism of this type for use upon the drive of their well known radial drill, which embodies a very interesting principle. This we are permitted to describe in this article, in which is shown a general view, Fig 59, of the 60 in. Dreses radial drill thus equipped and driven by an electric motor, and also details of the main variable speed driving mechanism, Fig. 60, and of the change gear arrangement upon the arm, Fig. 61, by which additional speeds are made available. It is also to be noted that this company has, for some time, been equipping their drills with variable-speed feeding-mechanisms, which operate upon the change-gear principle.

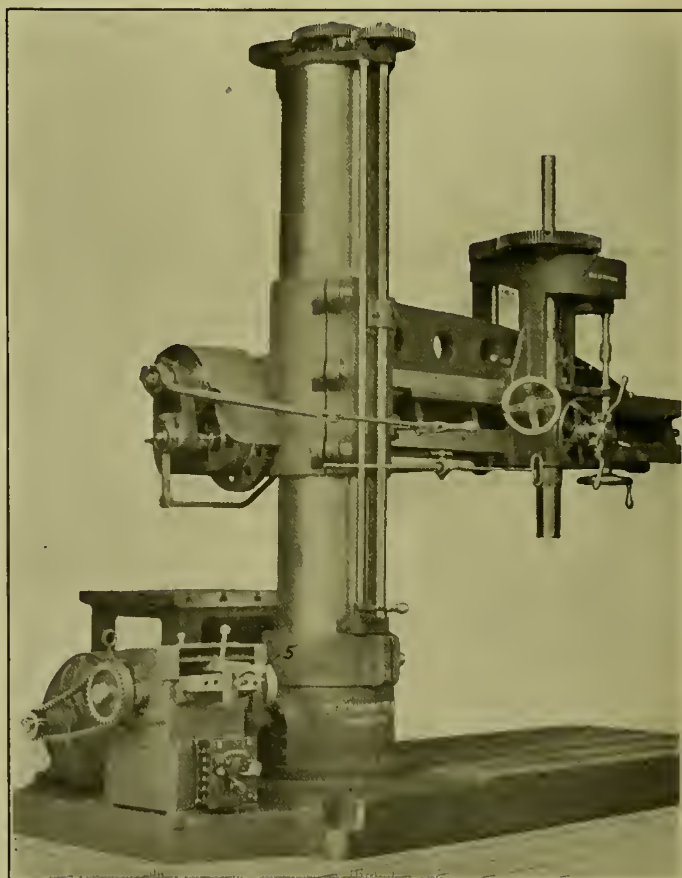


FIG. 59.—THE NEW DESIGN OF DRESES RADIAL DRILL, SHOWING APPLICATION OF GEARED VARIABLE-SPEED MECHANISMS.

The main variable-speed driving mechanism is, as shown in Fig. 59, located at the rear of the drill column upon an extension of the base, in place of the usual driving cone pulley. As ordinarily applied, this carries the main driving pulley of the tool, but as the tool here shown is equipped for direct driving by an electric motor, the belt driving pulley is replaced by a silent chain sprocket. This variable-speed mechanism is operated upon a modification of the cone gear and shifting pinion principle, by which, in this case, seven different speeds are made available; but, as shown in Fig. 60, the two cones of gears do not operate in mesh, and also the arrangement of the shifting pinion upon a rocker frame is a decidedly new departure.

This speed variator has two shafts, 1 and 2, each with seven gears to it, proportioned for seven speeds in geometrical progression. These cones of gears are not in mesh with each other, but all are fixed to their shafts, except the largest driven gear on the variable speed shaft 2, which is connected to it by a pawl and ratchet arrangement.

A connection between this ratchet gear and the smallest gear on the driving or constant-speed shaft 1, is formed by an idler pinion, 3, causing the driven shaft to run always at the slowest speed. When the speed of the variable-speed shaft, 2, is increased by proper adjustment of pinion, 4, the ratchet fixed on this shaft runs ahead of the pawl in the loose gear, but in this way shaft 2 is always kept in motion.

The lever with handle, 5, shown in front of the speed variator, is mounted and swings at the rear on a rocker frame, 6, and is so arranged that it can be shifted lengthwise or cross-

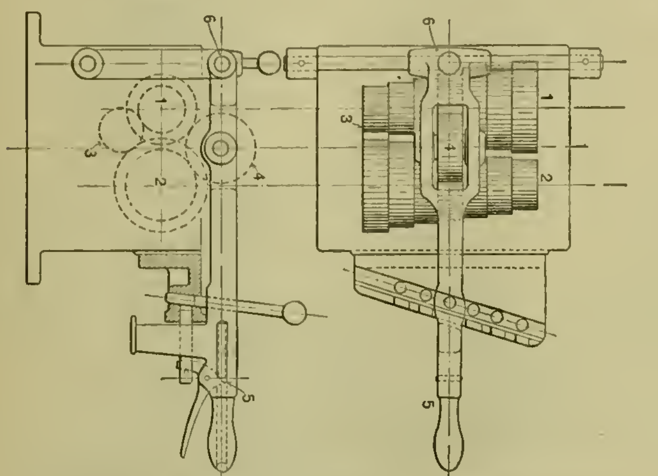


FIG. 60.—DETAILS OF THE MAIN DRIVE VARIABLE-SPEED MECHANISM USED UPON THE NEW DESIGN OF DRESES RADIAL DRILL.

wise. It carries a gear, 4, forming connections between the different gears on the two shafts, 1 and 2, so as to produce the different speeds. The latch with plunger below the handle locks the handle vertically and the knob pin horizontally, all as shown diagrammatically in Fig. 60.

The holes for locking in the index plate are drilled to suit the correct positions of the intermediate gear in mesh with the cone gears. No engagement can be made unless the intermediate gear is in the correct position. Though the entire momentum from rest to the different speeds does not thus require to be overcome, as the variable speed shaft runs always at the lowest speed, the shock from low to high speeds proved to be still too great and a frictional connection between the drill shaft and variator had to be introduced. This friction is similar to a planer feed friction and is adjusted to carry the heaviest load of the drill, but slips when taxed beyond this.

The power is transmitted to the drill spindle in the usual way by a horizontal shaft near the base, a pair of mitre gears and central shaft in column, two spur gears on top of column and outside vertical shaft, V, carrying a sliding mitre gear. This mitre gear engages with the mitre gear on short shaft, A, having fixed on it the pinion B, and the two loose friction gears C and D. Pinion B is arranged to mesh with friction gear E, and C with friction gear F, both on shaft H. Friction gear D drives gear F indirectly by means of an intermediate pinion, G, journaled in the gear casing.

The double friction clutch arrangements in gears E and F are operated by the lever combination J, which, when engaged with one or the other, changes the speed according to the proportion of the gears, this being in geometrical progression with the range of the cone pulleys. The double friction between gears C and D is operated by the lever combination K; when engaged with C, the spindle runs fast right handed, but when engaged with D, on account of the intermediate gear G, it is faster in reverse, in accordance with the different diameters of the two gears C and D.

It is obvious that by clutching D to shaft A, a slow forward speed and fast reverse is obtained by engaging the friction between C and F alternatively. By clutching F to H and operating the friction between C and D a fast forward and a slightly increased reverse speed of the spindle is brought about.

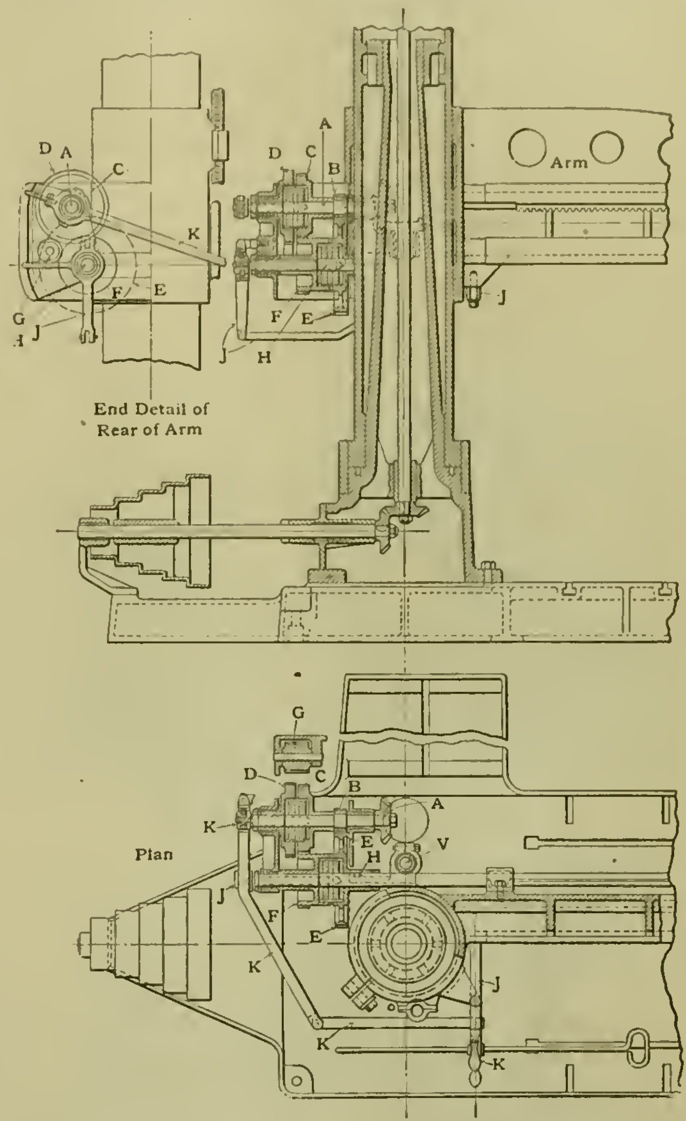


FIG. 61.—DETAILS OF THE CHANGE-GEAR MECHANISM UPON THE REAR END OF THE ARM OF THE DRILL FOR OBTAINING ADDITIONAL SPEEDS AT THE SPINDLE.

The power feed to the drill spindle is of the geared type. It has six changes and is variated by shifting the knurled knob on the feed rod engaging the respective gears by key and feather.

The Pintsch Lighting System.—A statement from the Julius Pintsch Company, of Berlin, to the Safety Car, Heating and Lighting Company, of New York, embraces very comprehensive statistics of the application of the Pintsch system of lighting to the railroad cars, locomotives, buoys and beacons throughout the world. The figures given below show that 130,000 cars, 5,800 locomotives and 1,700 buoys and beacons are equipped with this system, and that 372 gas works are in operation to manufacture gas for the Pintsch system of lighting, which has been adopted by the majority of the railroads and lighthouse departments of the world. In Germany 45,200 locomotives and 5,583 cars are so lighted. The United States stands second, with 23,500 cars, and England third, with 21,100 cars.

Gould Coupler Company.—The offices of this company have been moved from 25 West 33d street to 1 West 34th street, New York City.

A NEW DESIGN OF CUTTER AND REAMER GRINDER.

The Becker-Brainard Milling Machine Company.

An interesting new design of cutter and reamer grinder has recently been perfected and placed upon the market by the Becker-Brainard Milling Machine Company, Hyde Park, Mass., which will be received by those interested in machine shop operation with more than usual interest. It embodies many new ideas and has a much greater range than most tools of this type. It is unlike other cutter grinders in that it requires no extra fixtures for handling any style of milling cutter or reamer. It has two separate knees, each provided with its own slides. The cutter to be ground is transferred from one to the other for the different operations on the side and teeth. The following cuts will explain the operations on the several different styles of cutters shown:

Fig. 1 gives a view of the machine as regularly made, from which we get a very good idea of the weight and proportion as a whole. Here also may be seen the two different knees mentioned above. On the left hand side of the machine is the main knee, which swivels around the supporting column and carries the head and tail stock for grinding cutters on centers, or with bar inserted in place of the head stock center and tail stock removed. Cutters are ground by sliding them on the bar in front of the wheel, which insures a cutter ground straight and true with the hole. On the right hand side is a novel arrangement for grinding the end mills, or the side teeth of straddle mills and inserted tooth cutters. This sliding head can be swivelled for grinding bevel or dovetail mills, and is provided with a plunger finger, which is always set on the center. The object in this arrangement is to do away with many of the devices ordinarily used for this work, and it is also unnecessary to use any other than a 7-inch emery wheel, as shown.

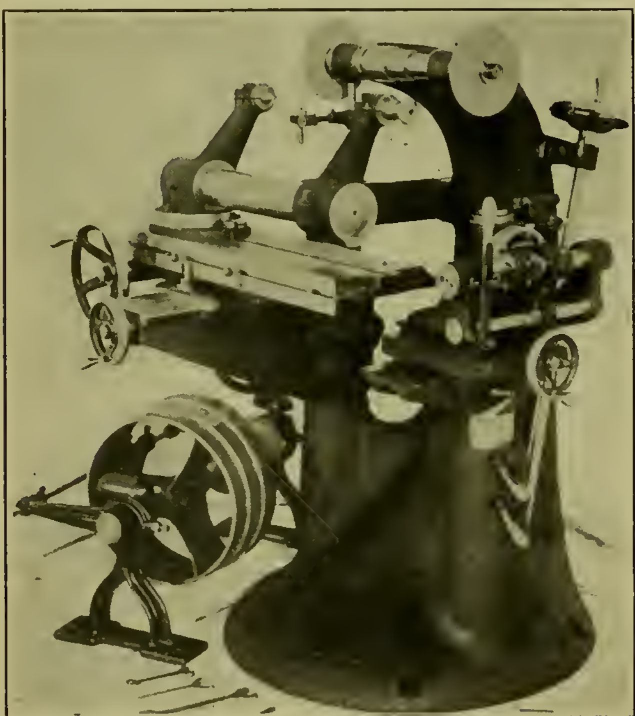


FIG. 1.—BECKER-BRAINARD CUTTER AND REAMER GRINDER.

In Fig. 2 the machine appears as arranged with motor driving. This is a view of the model which is on exhibit at the Becker-Brainard Milling Machine Company's space No. 13, Machinery Hall, Louisiana Purchase Exposition, St. Louis, Mo.

Figs. 4 and 5 show good illustrations of the improved manner of handling work on the machine, showing as they do straddle and end mills in both positions. This also shows how the clearance is obtained on the end and side teeth.

Fig. 3 presents a front view of the sliding head set for grinding bevel cutters. In Fig. 6 is shown a large inserted tooth-face mill in the sliding head that is probably the most difficult cutter to handle on any grinder without using special fixtures. The sliding head arrangement on this machine makes this a very simple operation.

This machine has a capacity for all styles of cutters up to 14 ins. diameter and 14 ins. long. It is designed distinctively as a cutter and reamer grinder to fill the long felt want for a machine capable of grinding heavy cutters of large diameter and long face, which are used on the large column and planer type milling machines, also the large diameter inserted tooth cutters. The machine will take care of all styles and sizes of cutters, including plain, straddle, form and end mills, being made especially stiff and heavy to eliminate vibration which frequently occurs in most of the lighter grinders.

The machine is provided with two columns, one of which has a knee, with saddle and table, which has 6 ins. of vertical adjustment, and will swivel around the column in either direction. The adjustable vertical column is graduated so that seting can be instantly made to give the proper angle of clearance of cutter for different diameters of emery wheels used.

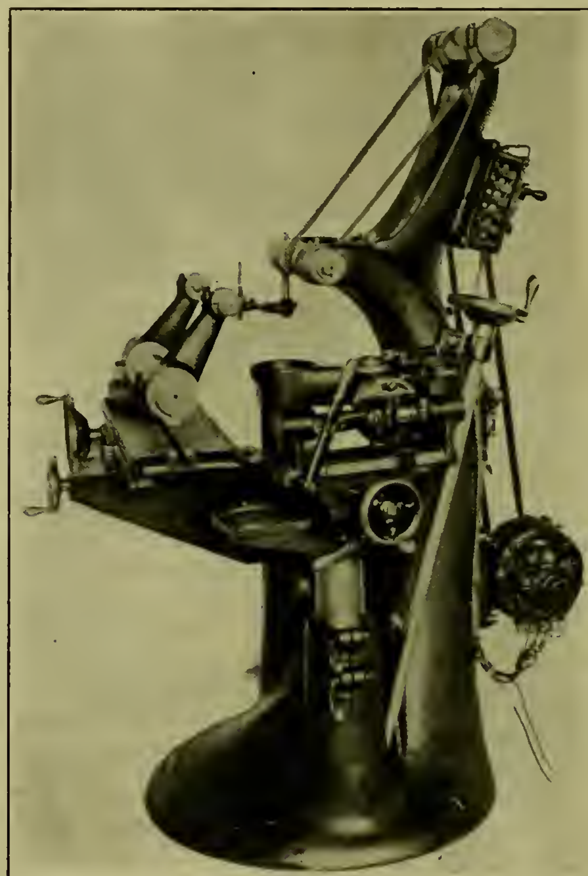


FIG. 2.—SHOWING THE MACHINE ARRANGED FOR MOTOR DRIVING.

The table on the saddle is fed by rack and pinion, having a longitudinal feed of 20 ins. and cross feed of 7 ins., and is provided with graduated swivel head, which carries a bar on which to slide cutters while being ground. Head and tail centers are also provided for holding end mills and reamers which have to be ground on centers.

With the other cutter grinders on the market it is necessary, in order to grind side, face and angular mills, to use special fixtures, which consume more or less time in setting, whereas with this machine this is unnecessary, as a second column is provided with swivel carriage carrying two cross slides, the top cross slide having 7 ins. and the lower cross slide 9 ins. adjustment at right angles. On the top slide is mounted a graduated swivel head, or holder, which slides on a bar having a travel of 5 ins., used for grinding the end teeth of cutters and end mills.

Thus cutters of all description can be ground without any change of fixtures, and much faster than the old methods of cutter grinding.

SPECIFICATIONS.

Centers swing 14 ins. and will take between same	14 ins.
Maximum length that can be ground between centers	14 ins.
Longitudinal feed of table	20 ins.
Cross feed	8 ins.
Elevation of knee on column	6 ins.
Side knee elevation	10 ins.
Lower cross slide	9 ins.
Top cross slide	7 ins.
Cutter head slides on bar	5 ins.
Weight	1,570 lbs.

TESTING PLANT ON THE GREAT WESTERN RAILWAY, ENGLAND.*

BY G. J. CHURCHWARD.

The Great Western Railway Company have recently put down in their erecting shop at Swindon a plant for testing locomotives. This machine consists of a bed made of cast-iron, bolted on a concrete foundation, with timber baulks interposed for the lessening of vibration. On this bed five pairs of bearings are arranged to slide longitudinally so that they may be adjusted for any centres of wheels that are to be put upon the plant. In these bearings axles are carried having wheels fitted with steel tires, on which the locomotive runs. These axles are also fitted with drums on which band-brakes act for absorbing wholly or in part the power developed by the engine. Outside these band-brakes, pulleys having an 18-in. face are provided at each end of the axle for driving link belts, by which it is intended to transmit the major portion of the power developed by the engine to air-compressors, so that it may not be wasted.

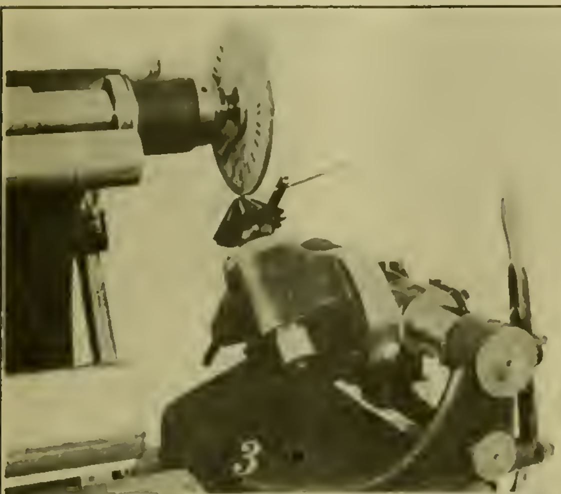
The hydraulic brakes will then only absorb just enough power to enable them to govern the speed of the engine. These brakes are actuated by a water-supply from an independent pump, the outlet of this water-supply being throttled either by a stop-valve or by a throttle actuated by a centrifugal governor. This latter device enables the speed of the engine to be set at any required number of revolutions and kept constant.

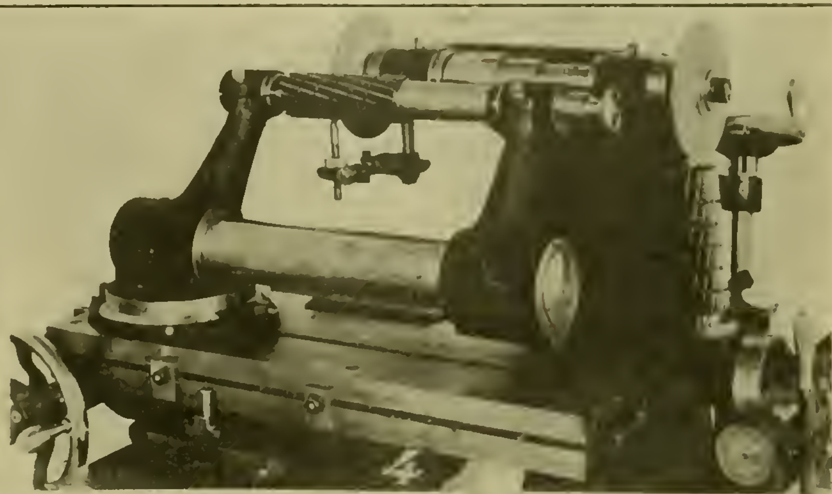
The carrying wheels are 4 ft. 1½ ins. diameter. The main bearings are 14 ins. long by 9 ins. diameter. The tire of the carrying wheels is turned to approximately the same section on the tread as the rails in use on our line. This plant is intended not only for the purpose of scientific experiment, but also to do away with the trial trips of new and repaired engines on the main line. It has, therefore, been necessary to make it rapidly adjustable to take engines having wheels of different centres. The main bed is provided with a rack, and each pair of bearings is provided with a cross shaft having a pinion at either end. These cross shafts are driven from a longitudinal shaft through suitable clutches. This longitudinal shaft is operated by electric motor and is capable of being reversed. The engine is run over the machine on an elevated frame which carries it on the flanges of its tires clear, electrically, and drops the engine into position on the carrying wheels with their bearings till they are vertically underneath the wheels of the engines to be tested. The frame is then lowered electrically and drops the engine into position on the carrying wheels.

When running engines on trial trips it is essential that the bogie and trailing wheels of engines so fitted should be run as well as the driving wheels, in order that the axle-boxes may take a good bearing, and be seen to be in satisfactory condition before handing the engine over for traffic. To accomplish this the carrying wheels are all coupled together by a suitable arrangement of belts and jockey pulleys. It, therefore, follows that even when a locomotive having a single pair of driving wheels is run on the plant, all the carrying wheels are rotating and in turn run the bogie and trailing wheels of the locomotive. The jockey pulleys are necessary to retain the proper tension on the belts when the bearings are moved longitudinally.

Owing to the varying height of the footplates of different classes

*From a paper read before the American Society of Mechanical Engineers, June, 1904.





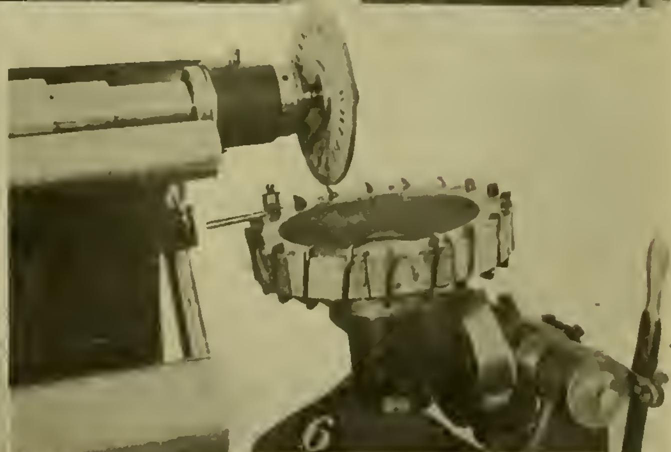


FIG. 3.—FRONT VIEW OF SLIDING HEAD GRINDING BEVEL CUTTER.

FIG. 4.—GRINDING SIDE AND END OF TAPER SHANK OF END AND SIDE MILL.

FIG. 5.—GRINDING FACE AND SIDE OF STRADDLE MILLS.

FIG. 6.—SLIDING HEAD, GRINDING LARGE INSERTED TOOTH FACE MILL.

NEW DESIGNS OF CUTTER AND REAMER GRINDER—BECKER-BRAINARD MILLING MACHINE COMPANY.

of engine, it has been found necessary to provide a firing stage which can be rapidly adjusted vertically. A large coal bunk is provided in connection with this stage and also weighing machines. Two water tanks are mounted on the same platform, for measuring the water used when running, these tanks being emptied alternately when the consumption test is being made.

Under the platform a dynamometer enables the drawbar pull of the engine to be taken, and this, together with counters on the wheels, will enable the actual drawbar horse-power to be measured, and so compared with coal and water consumption for various classes of engines. As engines of different lengths are to be tested, and of necessity have to be fixed at the trailing end to the dynamometer, it is necessary to have a sliding chimney for carrying off the steam and smoke from the engine when running. This has been provided in the form of a long box, having a steel plate running on rollers forming its lower surface, which plate carries a large bell-mouthed chimney. This box not only enables the chimney to slide longitudinally, but will also form a receptacle for ashes and any other matter ejected by the engine, which will be retained and can be examined both for quantity and quality.

It is hoped that this plant will enable many questions of the relative economy of different classes of engines, either simple or compound, to be settled definitely. The question of superheating might be investigated on it, as also the efficiency of various forms of smokebox arrangements. The effect of various percentages of balancing can be investigated, and, in fact, any of the experiments which are at present being made on the road may be made on this plant, with the great advantage that any engine which may be selected can be placed in position ready for testing, and all connections made in a time probably not exceeding an hour.

From a supplementary paper, by Mr. W. F. Pettigrew, the following is taken:

RESULTS REQUIRED IN THE TESTING OF LOCOMOTIVES.

Mean boiler pressure. Throughout journey.
Total coal used. Exclusive and inclusive of lighting up.
Coal burnt per hour. Running time and journey time.
Coal burnt per square foot of grate area per hour of running time and of journey time.
Coal burnt per I.H.P. per hour running time and journey time.
Coal burnt per train-mile, engine-mile, ton-mile, and per pound. Pull on drawbar per mile, also per hour.
Calorific value of 1 lb. of coal in B.T.U.
Ashes in smokebox, in ashpan, in firebox, total percentage.
Total water evaporated.
Water evaporated per hour running time and journey time.
Water evaporated per square foot of total heating surface per hour, both running time and journey time.
Water evaporated per I.H.P. per hour. Running time.
Water evaporated per train-mile and per engine-mile.
Water evaporated per pound of coal, exclusive and inclusive of lighting up.
Water evaporated per hour. From feed temperature and equivalent from and at 212 deg. F.
Maximum I.H.P.
Mean I.H.P. calculated from indicator cards from work done.
Curve of horse-power. (Mean height.)
Maximum speed.
Mean speed. Exclusive and inclusive of stops.
Actual running time and journey time.
Train and engine miles.
Time from lighting up to taking out fire.
Temperature of water in boiler at time of lighting up.
Maximum and mean vacuum at base of chimney.
Maximum and mean vacuum, level with top of blast pipe.
Maximum and mean vacuum at middle of middle row of tubes.
Maximum and mean pressures through fire-hole door.
Maximum and mean pressures through ashpan.
Maximum and mean temperatures of smokebox gases.
Efficiencies of engine, boiler, and engine and boiler combined.
Maximum gradient.
Coal stated includes that used while standing for ——— hours.
Maximum and mean pull on drawbar.
Maximum and mean load hauled in tons, exclusive of engine tender, passengers, and luggage.
Maximum and mean number of vehicles hauled.
Maximum and mean number of journals.
Mean load per journal.
Back pressure at maximum I.H.P. and maximum speed.
Heat (in B.T.U.) carried away by the products of combustion.
Heat expended in evaporating the water.
Heat lost by radiation, imperfect combustion, and evaporative moisture in coal.
Heat converted in work per minute.
Heat taken up by the feed-water per minute.
Relative consumption of coal based on pull of drawbar.
Relative consumption of coal based on pull of I.H.P.
Relative consumption of coal based on pull of ton-mileage.
Relative consumption of coal based on pull of calorimeter tests.
Relative value of coal = Relative consumption multiplied by cost per ton delivered.

The results obtained should all be shown graphically by means of diagrams, which should give the profile of the line run over.

PUBLICATIONS.

The Metric Fallacy and Metric Failure In The Textile Industry, By F. A. Halsey and S. S. Dale, New York. D. Van Nostrand Co., 23 Murray street, 1904. Cloth, 231 pages. Price $1.00.

This book is a vigorous and carefully considered attack upon the metric system and constitutes an effort in the direction of preventing proposed compulsory legislation in favor of the use of the metric system. Those who follow the proceedings of the American Society of Mechanical Engineers know of Mr. Halsey's uncompromising opposition to the metric system and the book under review contains his arguments as presented to that society. The authors show the general undesirability of metric units and they prove beyond a doubt that the supposed universal and exclusive use of metric measures in the so-called metric countries merely amounts to the addition of a new unit to those which have already been in general use, and that instead of simplifying measures the metric system in those countries has added to the confusion or "Continental Chaos," as Mr. Halsey puts it. The book needs to be understood or it appears to be an unnecessary work. Of course the metric system will come into universal use if it is what it is claimed to be, and no books can stop it. But the object of this work is to prevent legislative action by those who do not know the shortcomings of the metric system and the experience of foreign countries in its use. Undoubtedly Mr. Halsey's efforts have been effective in carrying out his object. He certainly has prepared a powerful brief in the case against the metric system.

Transactions of the American Society of Mechanical Engineers. Vol. 24, 1903. The Annual Report of the 46th and 47th Meetings of the Society. 1,563 pages, fully illustrated. Published by the Society, from the Library Building, 12 West Thirty-first street, New York City.

This volume contains the papers and reports presented at the New York meeting of the society for 1902 and at the Saratoga meeting for 1903. The list of papers presented at these meetings embraces a wide range of subjects, many of which are of general interest. The final report of the committee upon the standardization of steam-engine testing appears in this volume; this and the discussion on the preliminary forms of the report of this same committee occupy 136 pages. Another valuable paper upon the subject of "The Bursting of Emery Wheels," by Mr. Benjamin, was presented at the Saratoga meeting, supplementing his former paper of the previous year. The only report presented that bears directly upon railroad operation, however, is a paper entitled "A Rational Train Resistance Formula," by John B. Blood. This volume of the Transactions is one of the largest that has been pubilshed; it contains 1,563 pages and is nearly 3 ins. thick.

A Clean Chimney. The Economical Burning of Coal Without Smoke. By A. Bement. Published for private circulation by Peabody Coal Company. Chicago, 1904.

This little book of 50 pages treats of the subject of correct methods of burning soft coal, particularly washed coal. It was written for the Peabody Coal Company by Mr. Bement, who is a specialist in combustion and is thoroughly qualified to present this subject. It is intended for firemen, engineers, and proprietors of steam plants, and is an excellent brief treatise on the subject of economical and smokeless use of coal.

The Ashton Valve Company, Boston, Mass., announces that J. W. Motherwell has become associated with its railroad department, with headquarters at 160 Lake street, Chicago, Ill. Mr. Motherwell has, for the past eleven years, been connected with Fairbanks, Morse & Co.

The Standard Scale and Supply Company.—This company announces the removal of the word "Limited" from its name, and the limited partnership, with a capital of $75,000, has been succeeded by a corporation with the same title, with an authorized capital of $600,000, of which $450,000 has been issued. This change followed the completion of the new factory at Beaver Falls, and the abandoning of the old one at Bellefonte, Pa. The new factory is up to date in all respects, and is electrically equipped. The offices of the company are at 211 Wood street, Pittsburgh, Pa.

Graphite as a Lubricant.—The Joseph Dixon Crucible Company, Jersey City, N. J., have issued the eighth revised edition of this pamphlet, which illustrates the many and varied applications of graphite to the lubrication of machinery. The subject is considered both scientifically and practically.

National Car Coupler Company.—This company has issued an excellent illustrated catalogue devoted to its complete line of couplers and accessory devices. Among them are the Hinson emergency knuckle, the National centering yoke, National steel platform and buffer and the Hinson draft gear. Each of these is described in the text by aid of engravings showing the devices themselves and working drawings illustrating their application.

Corrington Air Brake Company.—"Bulletin No. 1," just issued by this company, contains an illustrated description of their new air-brake system, and by aid of remarkably fine halftone engravings from wash drawings the leading features of the apparatus are clearly presented. The text describes the system, concerning which an article appeared on page 146 of our April number. The illustrations include two large folding plates showing a complete freight equipment, and another illustrates the passenger equipment, tender and car equipment, shown in connection with the consolidated engineer's valve. This bulletin is a remarkably fine piece of catalogue literature.

Air and Gas Compressors.—The Rand Drill Company, 128 Broadway, New York, has issued a miniature compressor catalogue which illustrates and briefly describes some of its standard types of air and gas compressors. The lists are necessarily condensed in order to present the information in small volume, but they are sufficient for the selection of a compressor of suitable type and size for ordinary requirements. Each compressor is illustrated on a separate page, and in every case a reference is given to the particular catalogue in which a complete description of the machine is presented. This little pamphlet contains a list of branch offices through which complete information may be obtained.

Haverhill Eclipse Dry Dust Fire Extinguisher.—Adreon & Co., Security Building, St. Louis, Mo., have issued a 24-page pamphlet illustrating and describing the Eclipse dry dust fire extinguisher. This consists of a long tin receptacle fitted with a loop for hanging against the wall, and it contains a fluffy dust which is said to have remarkably effective qualities for extinguishing incipient fires. The chemical dust is not poisonous, and will not explode, freeze, corrode or deteriorate. The pamphlet contains explanations of the use of the extinguisher, and letters from various concerns, chiefs of fire departments and others as testimonials. The superior claims of this extinguisher over those involving the use of liquids are strongly urged. It is stated that among others using these extinguishers are the United States Government and the Standard Oil Company. Information may be obtained from Mr. D. R. Niederlander, secretary Adreon & Co., Security building, St. Louis, Mo.

Works of Westinghouse Electric and Manufacturing Company.—A handsome publication bearing this title has just been received from the Westinghouse Company's publishing department. It illustrates by excellent half-tone engravings exterior and interior views of the various departments of the enormous establishment of this company at East Pittsburgh. It is devoted to a description of the plant, and conveys an impression of its gigantic character and efficient management, combined with efforts in the direction of improving the welfare of the workers. The booklet traces the development from the organization in 1886, with a force of 200 men, to the present time, when 9,000 persons are employed in this wonderful plant at East Pittsburgh. The sociological aspect of the works and their surroundings adds to the interest and importance of this pamphlet, which is unique in literature of this character. One cannot fail to admire the organization and methods which are described.

"South African Rock Drill Tests" is a convincing leaflet just published by the Rand Drill Company. It is a fac-simile reproduction of a page taken from the Johannesburg (South Africa) *Star*, and contains an account of the now famous drill tests carried on by the Engineers' Association of the Witwatersrand. The circular is folded and addressed on the back, and has been mailed to all lines and mine owners. The verbatim report of the engineers is in favor of the drills of American make, and Mr. Docharty supplements his article by the remark that "The 'Slugger' approaches the ideal."

Pumping Machinery.—Messrs. Fairbanks, Morse & Co. have issued a new pumping machinery catalogue, "No. 48 C," which presents complete information with respect to their very large line of pumps of all descriptions and arranged for all of the usual methods of driving. In supplying machinery of this kind this company keeps close watch of the requirements of purchasers and keeps its line of equipment up to the demands by continual improvements. Those who have not already procured this catalogue, and are interested in machinery of this character, should take immediate steps to secure a copy. In addition to illustrated descriptions of the various types of pumps, a great deal of information is presented which will be useful to the purchaser in determining the size of the pump required, and also in ordering repair parts.

Twist Drills and Accessories.—The Morse Twist Drill and Machinery Company, of New Bedford, Mass., has issued a new 272-page catalogue of its products. That such an extensive catalogue is required to illustrate its drills, reamers, milling cutters, gauges, dies, taps and other specialties indicates the large variety of the products of this concern. It is impossible to enumerate all of the features of this catalogue, which is the largest and most complete ever issued by this company. It is sufficient to say that it is an excellent book of reference for its line of manufacture. Special attention is directed to the new "Twentieth Century Drill," of which both body and shank are ground on centers after hardening, insuring true running and accurate size. This drill has a large amount of radial clearance, which reduces greatly the friction of the drill in the hole. Among the new tools illustrated are shell drills, indexed cases for sets of drills, counterbores with interchangeable blades and guides, adjustable caliper gauges, standard reference disks, cotter mills, gear cutters, gear-twisting machines, and bench center and straightening presses.

The Baldwin Locomotive Works.—An exceedingly attractive pamphlet has been prepared for use in connection with the exhibit of the Baldwin Locomotive Works at the St. Louis Exposition. It opens with a brief history of the works, and describes in an interesting way the first locomotive built by them, and successively the locomotive completing each 1,000 which they have turned out, the descriptions being accompanied by excellent half-tone engravings. This record constitutes a continuous history of the development of the steam locomotive in the United States, leading up to the twenty-third thousandth, which was completed at these works last year, and the twenty-fourth thousandth, which forms part of the present exhibit at St. Louis. Following this portion of the pamphlet is a record of a fast run of the twenty-fourth thousandth locomotive, which is a Vauclain balanced compound, on the Santa Fe. The remainder of the book is taken up with figures and dimensions of a number of typical steam locomotives, and the pamphlet closes with descriptions of electrical locomotives and trucks for elevated railway service. The engravings are remarkably fine and the letter press is of the very highest standard adopted by these works.

Allis-Chalmers Company.—Mr. C. C. Tyler has been appointed general superintendent of all the works of the Allis-Chalmers-Bullock interests in the United States. He has had an exceedingly wide experience in the management of large machine shops, among which are the works of the Westinghouse Electric and Manufacturing Company at East Pittsburgh, of which he was recently superintendent, and before going to Pittsburgh he was widely known as a successful works manager. Mr. Tyler is believed to have no superior in this country in design, construction, equipment and administration of manufactories. In entering upon this new and enlarged field he is sure to carry with him the congratulations of the engineering profession. This appointment is another evidence of the strength with which the Allis-Chalmers organization is being completed.

MASTER MECHANICS' ASSOCIATION.

THIRTY-SEVENTH ANNUAL CONVENTION.

SARATOGA, N. Y., JUNE 27 TO 29.

ABSTRACTS OF REPORTS AND PAPERS.

AUTOMATIC STOKERS.

COMMITTEE—J. F. WALSH, J. G. NEUFFER.

Saving in Fuel.—The only comparative test that your committee has been able to make shows that there is a saving of not less than 7 per cent. when using the stoker, as compared to the work done by a first-class fireman. This, of course, would indicate a considerably greater saving as compared with locomotive firemen as they are ordinarily found. In the case mentioned the engine equipped with the stoker was in service over its run 6 h. and 30 m., while the engine that it was compared with was only 4 h. and 7 m. going over the same length of division. The saving in coal when using the stoker is no doubt very largely due to the fact that when using the stoker the coal is much more evenly distributed, and the furnace door remains closed all the time.

Smoke.—When using the stoker the smoke is very much lighter in color, indicating, of course, a much more thorough consumption of the gases. The darkest color, when the stoker is used, is not more than brown, while most of the time the emission from the stack shows pure steam.

Reducing the Work of the Fireman.—When the stoker is used the fireman has to raise the coal from the level of the coalbin of the tender into the hopper of the stoker, a distance of about 30 ins. This is more than when firing directly into the furnace, but it must be remembered that when the stoker is used the fireman is not required to throw the coal at all. With the coal-conveyor in service the labor of raising the coal into the hopper will be entirely dispensed with, and the work of the fireman becomes simply that of an expert in charge of an efficient machine.

Saving in Repairs to Firebox.—There is no doubt that with the stoker in use very much less trouble with leaky flues will be found, on account of maintaining a more even heat in the firebox. The sheets of the firebox will last longer for the same reason. It has been proven that corrugation in fireboxes is due largely to the changes in the temperature in the fireboxes.

Regular Steam Pressure.—When using the stoker the steam pressure may be kept absolutely constant. This is due to the regularity with which the coal is placed on the grates, the evenness with which it is placed there, and also the fact that the furnace door not being open, the furnace is not cooled by the inrush of air.

Service in Which the Stoker Will Prove Most Valuable.—It is the opinion of your committee that on the ordinary American type of engine there is no necessity whatever for the stoker, as the fireman, of course, must be there anyway, and the work is not such that an ordinary man cannot execute it with ease, but with the long-firebox type of engine on a long run over a division comparatively free from grades, where the engine is loaded to its maximum capacity all of the time, is where we believe the stoker will be found the most valuable, as a machine will not tire, and consequently will enable the engine to carry the maximum pressure all of the time and get the full benefit of the tractive power of the engine over a long continuous trip. This cannot be done with the hand-firing method on the type of engine above mentioned where the runs exceed 75 miles in length.

Capacity of the Stoker.—The present type of stoker will throw about 3,000 lbs of coal per hour. A modern type of passenger engine, with 46 sq. ft. of grate surface and burning 200 lbs. of coal per square foot of grate per hour, will require about 9,200 lbs. of coal per hour. The stoker, as it is built at present, will not accommodate such a firebox, but we see no reason why the speed cannot be increased and the size of the trough so increased that a larger amount of coal will reach the firebox at each stroke.

BEST PRACTICE IN PAINTING LOCOMOTIVES.

REPORT OF COMMITTEE OF MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.

We desire to submit the following suggestions:

First—As the passenger locomotives run in connection with passenger equipment cars, they should be treated in the manner of finish in all respects equal to the cars.

Second—Freight locomotives should be painted mainly for durability. From this we would not like to be understood as stating that any kind of painting is good enough for the freight locomotive and no attention paid to surfacing, for we consider a certain amount of filling on the rough parts in the line of economy, because it facilitates the cleaning when locomotives are in service.

Third—Castings and woodwork on which a good surface is desired should be made as smooth as possible before the application of paint material.

Fourth—We discourage the painting of locomotives in roundhouses, and would recommend that whenever possible they be run into the paintshop for the finishing coat of varnish.

Fifth—For painting new parts we consider the following good practice: First day, sand-blast and apply the priming coat of paint; second day, drying; third day, second coat; fourth day, putty and fill rough places with knifing surfacer; fifth day, first coat of rough stuff; sixth day, second coat of rough stuff; seventh day, guide coat and rub; eighth day, two coats of color; ninth day, stripe and letter; tenth day, varnish with finishing varnish; eleventh day, drying; twelfth day, varnish with finishing varnish. When absolutely necessary the above practice can be shortened two days by applying two coats of rough stuff in one day and applying the second coat of varnish on the following day by eliminating the day allowed for drying.

Sixth—For repainting locomotives undergoing repairs we submit the following schedule, which can be varied as conditions and circumstances may require: First day, prepare and apply priming coat where necessary; second day, putty and knifing surfacer; third day, color; fourth day, stripe and letter; fifth day, finishing varnish; sixth day, finishing varnish.

On account of the difference in the condition of the paint and varnish on locomotives when they are returned to the shops for repairs, we believe that much should be left to the judgment of the foreman painter as to what operations can be added or omitted in order to expedite the work without detriment to its durability and appearance. These schedules are based on the time required for cab and tank, it being understood that the other parts are being coated by the same method as rapidly as the machinists' work will permit.

Seventh—We would like to emphasize the importance of having locomotives properly cleaned while they are in service, not only to make them more pleasing to the eye, but in order to obtain the best results from the paint material which has been applied.

Eighth—In the way of labor-saving appliances and facilities we would recommend the sand blast, the material-saving paint sprayer, the potash vat, the stationary scaffold, suitable mixing benches, paint stockroom (where conditions warrant it).

TON-MILE STATISTICS—CREDIT FOR SWITCH ENGINES.

COMMITTEE—C. H. QUEREAU, G. R. HENDERSON, G. L. FOWLER.

This committee recommended the substitution of the "ton-hour" for the usual "6 miles per hour" basis for credit for the work of switching locomotives, the ton-hour being advocated as a fairer unit for comparing engines of varying weights and capacities. The ton-hour is obtained by multiplying the total weight of the engine (excluding tender) in tons by the number of hours in service.—EDITOR.

"TECHNICAL SCHOOL GRADUATES: WHAT CAN BE DONE TO RETAIN THEM IN THE RAILROAD SERVICE AFTER THE COMPLETION OF THEIR SPECIAL APPRENTICESHIP?"

BY MR. R. D. SMITH.

A great many roads have inaugurated a system of special apprenticeship. It is doubtful whether these systems are identical on any two roads. The time of service varies as does also the nature of the work required. The object desired is the same in all cases, however. It is to so blend the man's theoretical and practical knowledge that by the time he has finished his special apprenticeship the combination produced may be of more value to the railroad than either of these attributes taken separately.

It has been a noticeable fact that a great many special apprentices never complete their service as such, or, if they do complete it, they do not remain with the railroad very long after having done so.

The causes of this condition are various. It is very often the case that a special apprentice finds the work is not to his liking. There is nothing very unusual about this. A technical graduate is usually twenty-two or twenty-three years old and at this age may not have definitely decided upon the line of work he intends to follow. Upon trying railroad work he may not find it to his liking and gives it up. This is as it should be, and is best for all concerned. There should be no effort made to hold men at work which they do not like.

The wages received during their special apprenticeship are in some cases immeasurably low. Some railroads start these men at the rate of 10 cents an hour. Such a rate is not very much of an inducement when we compare it with the rates paid in other lines of work.

The majority of technical graduates have been educated at their parents' expense, and when they leave school they feel that they do not want to be dependent any longer. They feel that they should earn at least enough to support themselves. This is hard to do at the rate of 10 cents an hour. It is true that this is more than the regular apprentice receives, but we must remember that the regular apprentice usually lives at home, or, if he does not, be receives help for a year or two. Then, again, the special apprentice is older, and his needs are greater. If he succeeds in supporting himself he does so at a considerable sacrifice. After the first year his wages are increased and the struggle for existence is not so hard. However, there are a great many who do not consider the experience worth the sacrifice which it entails.

After the term of apprenticeship has been served the idea is that, as previously stated, the man's theoretical and practical knowledge should be so blended that the combination will be of more value than either of these attributes taken separately. Consequently, upon the completion of his special apprenticeship course the technical graduate should be paid at least a full-paid mechanic's wages. I believe that investigation will show that in a great many cases this is not done. When it is not done it indicates either that the man has not developed the properties which he was expected to develop by taking a special course, or else that the railroad is trying to retain him for less than his services are actually worth. If the former is the case, it were charity to inform him of the fact and advise him to seek other fields; if the latter is the case he is liable to seek other fields of his own accord or have others seek him.

If the apprentice has served four years he has reached the age where he wants a little more tangible remuneration than experience. He wants to feel that he is worth at least as much as another man who has served the same length of time as a regular apprentice. As a matter of fact, if he is not worth as much as a full-paid mechanic the railroad has failed to obtain the results it aimed at.

All through his special apprenticeship the man has been looking forward to obtaining a position of some kind upon the completion of his course. Unless he does receive such a position he is likely to go elsewhere. He can not be blamed for this, because for four years he has been neither one thing nor the other in the shop or on the road. He has been a sort of supernumerary. He begins to feel that he wants a position of some kind, no matter what it is, which he will know that if he is not filling some one else must; in fact, a vital place in the organization. As a matter of fact, he has spent four years with this as his aim. His intention has been to fit himself for an executive position on the railroad. The railroad company on its part has implied that it would be in need of him if he proved himself capable. Consequently, if, at the end of his special apprenticeship, he does not secure a vital position of some kind he is liable to seek work elsewhere. I recall to mind the case of a special apprentice whom I knew who had this complaint to make. Whenever he was asked what he was doing he could never give a satisfactory answer. He was neither apprentice nor mechanic nor boss. He did not fill any particular place. He was just working for the railroad. I believe that this is the principal cause of the special apprentice leaving railroad service. He has been expecting something which has not materialized and consequently he leaves the service.

The question arises, Why has not the expected position been forthcoming? Evidently it is due to one of two reasons. Either there is no place for him or else there are better men for the place.

Let us consider the last reason first, and see how well the special apprentice is qualified to hold a position as foreman.

In all probability he has not spent more than six months in any one department. This has been only long enough to give him a general idea of the running of the department. He has not been in it long enough to become thoroughly familiar with its workings. He must be rather an exceptional man in order that his superior will have enough confidence in his abilities to believe that he can run a department successfully when he has had but six months' experience in that kind of work.

Whenever a vacancy occurs there are usually some men in the ranks who are eligible to the position on account of their long experience in the department. As before stated, the superior officer is assuming considerable responsibility when he fills such a vacancy with a special apprentice rather than taking a man whose knowledge and experience in the work would make him the logical man for the place.

I believe this is one of the chief reasons why promotions are not forthcoming when the special apprentice expects them. Unless he has shown exceptional ability there is some hesitancy about promoting him to an executive position. In other words, he is not exactly the kind of a man he was expected to be at the end of four years.

The object of the special apprentice course is to make the man a specialist in railroad work. The indications are, however, that we have not gone far enough. His instruction has covered the whole mechanical field and at the end of his apprenticeship we have not the specialist we desire. Have we not been trying to do too much when we try to familiarize the man with half a dozen or more trades, the operation of car and locomotive shops and of engines on the road in four years' time? I believe that the result is that at the end of four years the man is still far from being a specialist. He has a general idea of these things, but he has not been in any one department long enough to become thoroughly familiar with it. The field he has been trying to cover is too large to be covered in the required time. I believe that better results would be obtained by not trying to do so much, but doing what is done more thoroughly, so that at the end of the four years the man would be a specialist. This could be done by offering different courses, each covering a separate field. By offering three courses the work would be subdivided enough that a man would become more of a specialist. These courses should be arranged to cover the following work:

First. Car building and repairs: The four years' work could be divided as follows: Six months in the freight-car shop on truck and body work; six months in the passenger-car shop; four months in the paint shop; four months in the wood mill; four months in the car blacksmith shop; six months in the car machine shop; four months in the yard; four months in the drawing-room; four months in the testroom, and the last six months at large.

Second. Locomotive building and repairs: The four years' work could be divided as follows: Ten months in the machine shop; six months on the floor; nine months in the boiler shop; nine months in the blacksmith shop; four months in the drawing-room; four months in the test-room, and the last six months at large.

Third: Locomotive operation: The four years' work could be divided as follows: Three months in the roundhouse as helper; two months in truck gang; one year as fireman; three months as boiler washer; six months with boilermaker; eight months with machinist; four months in drawing-room; four months in test-room, and six months at large.

The last six months of each course could be devoted to such work as the master mechanic saw fit. For instance, there might be one department in which he intended to place the man at the completion of his course. The last six months could very profitably be spent in that department.

By confining the special apprentice to one of these three lines of work he would doubtless be of more value at the end of his apprenticeship than he is under the present system. He would be a specialist in the particular line of work he has followed. There would not be the hesitancy there is at present about placing him in a position. He would surely be more competent under this system than he is under the present one. It is true he would not have had experience in all the departments, but at the same time he will not be entirely ignorant concerning them. If he has been at all observant he will have a general idea of the work in the other departments. At any rate, he will in all probability have a better idea of the work outside of the departments in which he has worked than will a master mechanic who has risen to his position from a mechanic.

The latter man will probably have, on account of his having risen from the ranks, one decided advantage over the special apprentice. He will understand his men better. He has worked by their sides and lived with them. He will appreciate their likes and dislikes and anticipate their ways of thinking and looking at things.

The better an officer is acquainted with the men under him the more successfully will he be able to deal with them. This is a fact which is lost sight of to a great extent in the special apprentice course.

It will enable him to look at all questions of shop management from two diametrically opposite points of view. He will not be nearly so liable, when the time comes, to give orders to do things which will antagonize the men in the shop if he knows and understands them thoroughly.

It is a notable fact that, as a rule, men who have come up from the ranks are more successful in the handling of men than the technical graduate. This, we believe, is due to their better knowledge of the persons with whom they have to deal.

The successful man is not so much the man who can do a great deal himself, but rather the one who can manage and direct the other men to concerted action and thus quickly attain the desired result.

So long as we insist on having a special apprentice system I believe that better results can be obtained by following the course as outlined above. To my mind, however, the special apprentice system is, at least, a poor one. The technical graduate is put in the shop and is given the best of opportunities to learn. He is given a great deal more attention than the ordinary apprentice. He is favored, and what is worse he expects it. On this account I am afraid that in a great many cases we turn out men who would have been a great deal better off if they had been given to understand that their advancement depended entirely on their own exertions. We favor them and turn out a hothouse plant which, when finally transplanted, can not stand the cold blast of competition. At the same time that the special apprentice is being favored, the general effect on the shop is not good. When the other men in the shop see the technical graduate rushed ahead they are not likely to be nearly as energetic as when they see that all men are being treated alike. The more you take away from a man his prospect for promotion, the less valuable he becomes. If every man in the service feels that his chance for promotion is as good as that of any one else you will have an organization which will do business and be free from discord.

Technical men are needed in railroad work and the need becomes greater every day.

In the February number of the American Engineer and Railroad Journal is a description of a plan by means of which the London & South-Western Railway hopes to obtain technically educated men from among its apprentices. This appears to be a step in the right direction. Time alone will tell how it will work out.

In the meantime the railroads are feeling the need of technical men, and the question is how to get them and keep them. If it is possible to hire these men without offering them any special inducement or making any promises I believe it would be the best way. This can frequently be done where a man is wanted for special work. He should be paid what he is worth, the same as any other man. By doing this the apprentices' and journeymen's ambitions are not stifled, and at the same time the technical man is put on his mettle, because any advancement which he receives will be due solely to his own efforts. If this cannot be done and it is absolutely necessary to have special apprentices, let us not attempt to do so much with one man. Let us make a specialist of him and a specialist who can be used.

In the meantime, let us not forget the regular apprentice. First of all, let us be more careful in the selection of these boys. Too often there is practically no attention paid to the boy himself. He is often the boy who could not get along at school, or who would not go there, or probably his parents have not been able to manage him at all. As a last resort he is sent to the shop to learn a trade, not because of any ability he has shown or is likely to show, but it may be he has some influential friend who has spoken for him, or probably his father is working for the railroad and he is employed because he is the son of his father. This turns the shop into a reform school.

It may be that the apprentices' wages are not high enough to draw a desirable class of boys in all communities. If such is the case, it would pay to increase them and then insist upon a certain standard.

After we have done this let us make the regular apprentice feel that we are interested in his welfare. Let us encourage him to improve himself technically. Let us help him in every way we can and make him feel that he stands in line of promotion. By doing this I believe we will be able to obtain just as good men in the future as we have in the past, and the technical graduate will be at the front with the rest if he proves himself worthy.

LOCOMOTIVE FRONT ENDS.

COMMITTEE—H. H. VAUGHAN, F. H. CLARK, R. QUAYLE, A. W. GIBBS, W. F. M. GOSS, G. M. BASFORD.

Your committee on locomotive front ends begs to report that, at a meeting held soon after its appointment, and after a full discussion, a subcommittee was formed consisting of Messrs. W. F. M. Goss, G. M. Basford and H. H. Vaughan, to draw up a schedule of the tests which are needed to more perfectly define the action of the front end. This subcommittee recommended that work proceed in accord with the following outline:

Series No. 1. This series of tests is to include experiments on a large engine having a front end not less than 75 ins. in diameter, the tests being designed to confirm or correct the deduction made from the results already obtained on an engine having a 54-in. front end in the tests conducted by the AMERICAN ENGINEER, the proposed tests to be carried only so far as may be necessary to indicate the proper factor to be used in comparing large and small front ends. This series of tests to include the following variables:

Straight and Taper Stacks.

Stack diameter, 11¾ ins., 15¾ ins., 19¾ ins., 23¾ ins.
Stack heights, 16½ ins., 26½ ins., 36½ ins., 46½ ins., 56½ ins.
Nozzle heights, 20 ins. and 10 ins. below center, on center and 20 ins. above center.

All tests to be made in triplicate. It is thought unnecessary to run tests at varying cut-offs and speeds except for check runs, as the influence of these factors was decided in the previous tests. These tests will include all that is necessary to determine completely the relation between stacks and nozzles for any diameter of front ends. It is estimated that they will occupy twenty days.

Series No. 2. This series to be made in connection with a front end arranged with an inside false top slightly above the top row of flues, the stack extending from the inside false top. It is thought probable that the results of these tests will agree closely with those obtained from the previous series when comparisons are based on measurements defining nozzle position as measured from the top of the stack. In so far as this may prove true, the test will simply be confirmatory of previous results. To make this test it will be necessary to fit a false inside top to the smokearch and obtain new bases, two in number, to apply the experimental stack to the false top. The series to include the following variables:

Stack diameters, 11¾ ins., 15¾ ins., 19¾ ins., 23¾ ins.
Stack heights, 16½ ins., 26½ ins., 36½ ins., 46½ ins., 56½ ins.
Nozzle position, 20 ins. and 10 ins. below center, on center and 10 ins. and 20 ins. above center.

It is estimated that this series will occupy ten days.

Series No. 3. This series to be in connection with a front end fitted with inside taper stacks without false top and and smokebox. It is thought to be unnecessary to experiment on straight stacks, as these have already been shown to be inferior to taper. The series to include the following variables:

Stack diameters, same as for Series No. 2.
Three different amounts of projection of stack into the front end.
Two different heights of outside stack.
Nozzle positions, 20 ins. and 10 ins. below center and on center.

The experimental stacks for this series to be made of sheet iron. If as the tests of this series proceed it appears that the results obtained are directly comparable with those obtained from Series No. 2, but simply slightly inferior on account of different action through the absence of the false top, this series will be abridged. It is estimated that this series will occupy six days.

Series No. 4. This series to include the use of a single draft pipe. The series to include the following variables:

Draft pipes diameter, 9 ins., 13 ins., 17 ins., 21 ins.
Draft pipes of each diameter to be tested in two different lengths.
Nozzle position, 20 ins. and 10 ins. below center, on center and 10 ins. above center.
Stack diameters, 11¾ ins., 15¾ ins., 19¾ ins., 23¾ ins.
Stack heights, 16 ins., 26 ins. and 46 ins.

It is assumed that it will not be necessary to experiment with both lengths of draft pipe in connection with all nozzle positions, the purpose being to include draft pipes of widely varying lengths and very low nozzle positions. Experimental draft pipes necessary for this series will be made of sheet iron. It is estimated that this series will occupy sixteen days.

In presenting this outline the subcommittee expressed the hope that members of the committee would be able to supply such portions of the equipment as the sheet iron inside stack, draft pipes, etc., so as to make the expense to the association as small as possible. They also give emphasis to the fact that if the tests as outlined can be carried out, the results will definitely settle the relation between stack and nozzle for any height of stack on any size of front ends, value of the draft pipes and their proportions for best results, and the value of inside stacks both with and without false tops. It is evident also that if the full purpose of the subcommittee can be carried out, the whole front end of any diameter may be designed by reference to definite formulæ, which will insure maximum performance.

Having received the report of the subcommittee, Mr. Vaughan, as chairman, acting in behalf of the undersigned, your full committee addressed the following letter to the executive committee of the American Railway Master Mechanics' Association:

"The committee appointed to assist the *American Engineer and Railroad Journal* in continuing tests inaugurated by them on the subject of locomotive front ends begs to advise you that a decision has been reached as to the further series of tests which it is desirable to carry out in connection with this subject at Purdue University, and that these tests and the expense of conducting same will be as follows:

"Series 1. Test on a large engine to complete the determination of the relation between stacks and nozzles with reference to which complete information has been obtained on an engine having a front end of 54 ins. in diameter in the tests that are already completed. The cost of this series will be as follows:

Equipment	$200.00
Testing expenses	500.00
	$700.00

A portion of these expenses may be avoided if, as it is hoped, certain railroad companies will contribute a portion of the equipment.

"Series –. Test to determine the proper proportion of stack to be used on front end having inside stack with false top. The cost of this series will be as follows:

Equipment	$100.00
Testing expenses	250.00
	$350.00

"Series 3. Test to determine correct proportion of stacks for front ends having inside stacks without false tops. The cost of this series will be as follows:

Equipment	$ 50.00
Testing expenses	150.00
	$200.00

"Series 4. Test to determine relation of stack and nozzle with single draft pipes. It has been decided not to experiment with double draft pipes as it is considered that the single draft pipes will answer all practical purposes and will avoid a great deal of expense, the double draft pipe problem being exceedingly complicated. The cost of this series will be as follows:

Equipment	$100.00
Testing expenses	500.00
	$600.00

"In addition to the above expenses it will be necessary to make an initial expenditure to cover the expense of changing the engine, getting the large engine into place and moving the engine at present on the testing plant, changing roof of the building slightly and other miscellaneous items in connection with this change, not including freight, as it is hoped that this can be arranged for with the railroad companies transporting the test engine. This expense will amount to $200.

"It will also be necessary to adapt the present equipment, indicator, draft gauges, etc., to the test engine, also spend a certain amount in fitting up the present experimental stacks, obtaining a new set of experimental nozzles, etc., which expense will amount to $100.

"Recapitulating the total cost of the tests which the committee desires to carry out will be as follows:

Change of locomotives	$ 200.00
Engine equipment	100.00
Test Series No. 1	700.00
Test Series No. 2	350.00
Test Series No. 3	200.00
Test Series No. 4	600.00
	$2,150.00

"In accordance with the committee's instructions we would apply to you for the necessary funds to carry out this important work. I would ask that immediate action be taken on this question as it is exceedingly important that we get to work at once if the work is to be completed during the present year. I am also pleased to be able to add that the North-Western Railway, through the kindness of Mr. Quayle, has offered to contribute their quota of expenses in furnishing material, so that I have no doubt that we can reduce the total expenditure below the sum mentioned above.

"It should be mentioned that in the above estimate, no amount is allowed for the service of Professor Goss, who will direct this work, and it is hoped that the series may be completed under this amount as it is not intended to run any series of tests further than is necessary to determine the best form of stack to be used; allowance has, as we consider, been made for difficulties in discovering the best proportions which may occur during the tests.

"H. H. VAUGHAN, Chairman."

In reply to this communication the secretary made the following statement with reference to the action of the executive committee:

"Referring again to yours of September 11, addressed to the executive committee of the Master Mechanics' Association, regarding the funds necessary to continue the tests on 'Locomotive Front Ends.' I presented this matter to the executive committee at a meeting held in New York City on November 23. The committee did not authorize this expenditure, inasmuch as the constitution provides:

"'All expenditures for special purposes shall only be made by appropriation acted upon by the association at a regular meeting.'

"JOS. W. TAYLOR, Secretary."

In view of this decision your committee felt that it was impossible to take any further steps in the matter, and that its only course was to report to the association the status of affairs and make a formal request that sufficient money be appropriated to enable the tests to be carried out. This we now formally and respectfully do.

(*To be continued.*)

The New York Continental-Jewell Filtration Company has recently closed, through its Chicago office, contracts with the Waterloo Water Company for a filter of 500,000 gallons daily capacity; with the Chicago & Eastern Illinois Railroad for a filter of 500,000 gallons daily capacity, to be installed at Villa Grove, Ill., and with the Southern Pacific Company for a filter plant of 400,000 gallons daily capacity, to be installed at Yuma, Ariz.

MASTER CAR BUILDERS' ASSOCIATION.

Thirty-eighth Annual Convention.

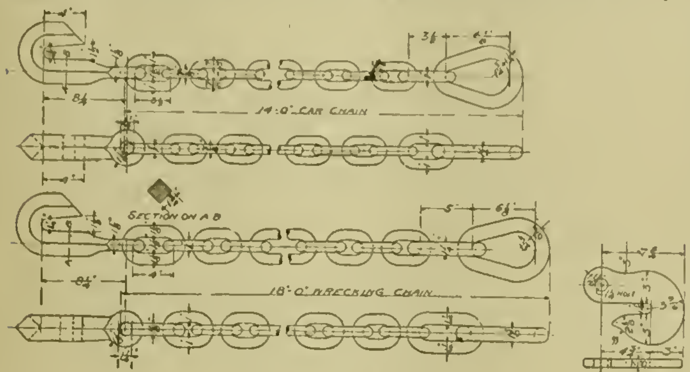
Saratoga, N. Y., June 22 to 24.

ABSTRACTS OF REPORTS.

COUPLING CHAINS.

COMMITTEE—R. P. C. SANDERSON, R. L. KLEIN, R. B. RASBRIDGE, JAMES MACBETH.

Your committee would recommend these chains for recommended practice of the association, with the idea that the association could set a fair value on such chains according to the market price which might prevail from year to year, and when it is desired for such chains to continue over different roads with a double load they



CHAINS RECOMMENDED.

could be continued to destination at the M. C. B. cost, and in case the chains are returned same cost figure could be used in counter-billing without reference to the identity of the individual chain, so long as the chains conform to the M. C. B. proposed recommended practice.

STAKE POCKETS.

COMMITTEE—J. S. CHAMBERS, W. E. FOWLER, J. E. KEEGAN, R. P. C. SANDERSON, M. DUNN.

The conclusions resulting from the votes and recommendations of the committee are:

1. That a standard stake pocket be adopted.

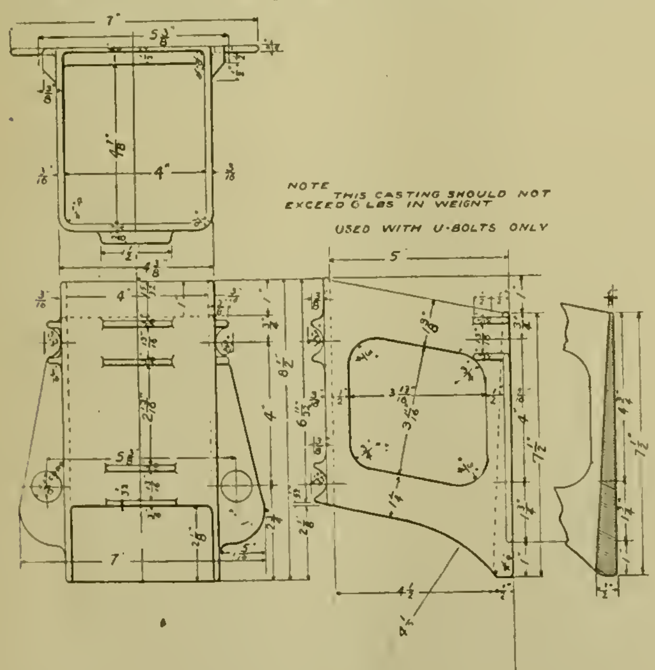


PLATE 1.

2. That inside dimensions of same be 4 ins. wide, 5 ins. deep.
3. That a tapering wedge be used, as shown on plates Nos. 1 and 2.
4. That the method of securing stake pockets to both wooden and steel construction be by U-bolts, held by nuts or riveted.
5. That malleable iron be used as standard construction.
6. On a 40-foot car that *not less* than ten pockets be applied, in the following manner: Measuring from center of car, pockets to be applied equal distance from each side of center.

On a 35-ft. car *not less* than nine pockets to be applied; first pocket in center of car and balance of pockets spaced equal distance.

On 32-ft. cars *not less* than eight pockets; measuring from center of car, pockets to be spaced equal distance from center of car.

If any roads desire that pockets be placed closer at ends of car and wider apart at center, this can be done.

CAST-IRON WHEELS.

COMMITTEE—WM. GARSTANG, G. R. HENDERSON, W. H. LEWIS, E. D. NELSON, A. KEARNEY, H. J. SMALL.

Your committee, instructed to confer with the Cast-Iron Wheel Manufacturers and jointly to submit designs and specifications for cast-iron wheels for cars of 60,000, 80,000 and 100,000 pounds capacity, reports as follows:

The importance of the work and the desire to submit for adoption a report that the members of this association could feel assured had received the fullest and most careful consideration by the joint committee, has been the aim throughout the year. Very shortly after the 1903 convention the first meeting of these committees was held, and throughout the year there have been meetings, correspondence and tests carried on with the view of confirming in every way possible the wisdom and accuracy of each recommendation; we therefore present this report with great confidence.

The designs of wheels are shown by complete drawings 1, 2, 3 and 4. Drawing No. 1 showing a 600-lb. wheel recommended for cars of 60,000 lbs. capacity, drawing No. 2 showing a 650-lb. wheel recommended for cars of 80,000 lbs. capacity, drawing No. 3 showing a 700-lb. wheel recommended for cars of 100,000 lbs. capacity, and drawing No. 4 showing a composite drawing of the three wheels for reference purposes.

SPECIFICATIONS.

For 33-in. Cast-Iron Wheels Weighing 600, 650 and 700 Pounds.
For Cars of 60,000, 80,000 and 100,000 Pounds Capacity.

1. Chills must have the same inside profile as shown by M. C. B. drawings of wheel tread. The inside diameter of chill must be the M. C. B. standard of 33½ ins., measured at a point 2⅝ ins. from outside of tread of wheel.

2. Wheels of the same normal diameter must not vary more than one-fourth (¼) of an in. above or below the mean size measured on the circumference, and the same wheel must not vary more than one-sixteenth (1-16) of an in. in diameter. The body of the wheel must be smooth and free from slag, shrinkage or blowholes. The tread must be free from deep and irregular wrinkles, slag, chill cracks and sweat or beads in throat, and swollen rims.

3. The wheels must show clean gray iron in the plates, except at chaplets, where mottling to not more than one-half (½) in. from same will be permitted. The depth of pure white iron must not exceed one (1) in. nor be less than one-half (½) in. in the middle of the tread, and shall not be less than three-eighths (⅜) in. in the throat, for wheels weighing six hundred (600) lbs. It

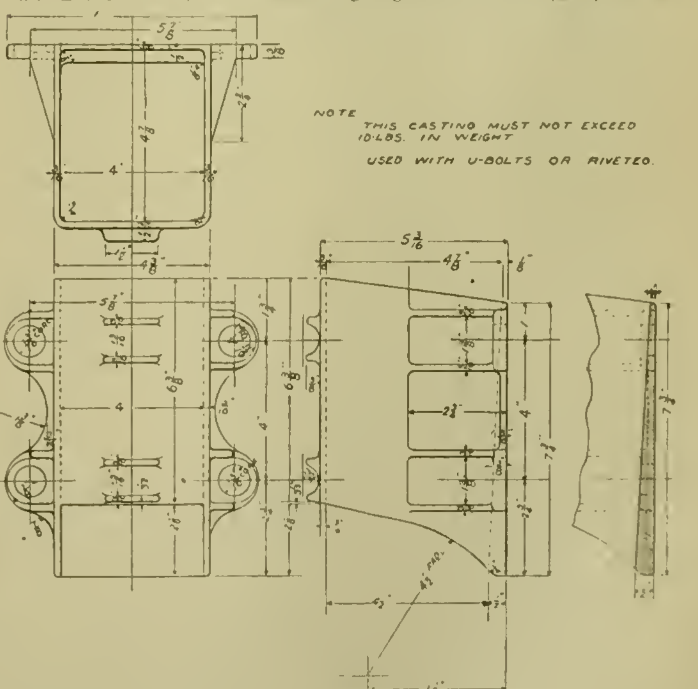


PLATE 2.

shall not exceed one (1) in. in the middle of the tread nor be less than seven-sixteenths (7-16) in. in the throat for wheels weighing six hundred and fifty (650) lbs., and shall not exceed one (1) in. in the tread or be less than one-half (½) in. in the throat for wheels weighing seven hundred (700) lbs. The depth of white iron shall not vary more than one-fourth (¼) of an in. around the tread on the rail line in the same wheel.

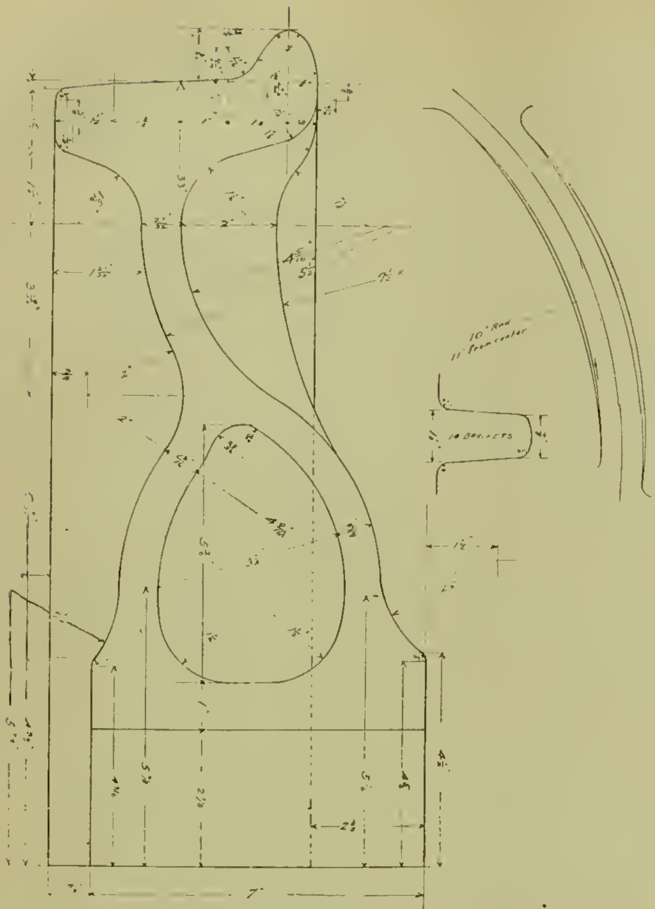


PLATE 1.—33 IN. 600-LB. CAST IRON WHEEL FOR 60,000-LB. CARS.

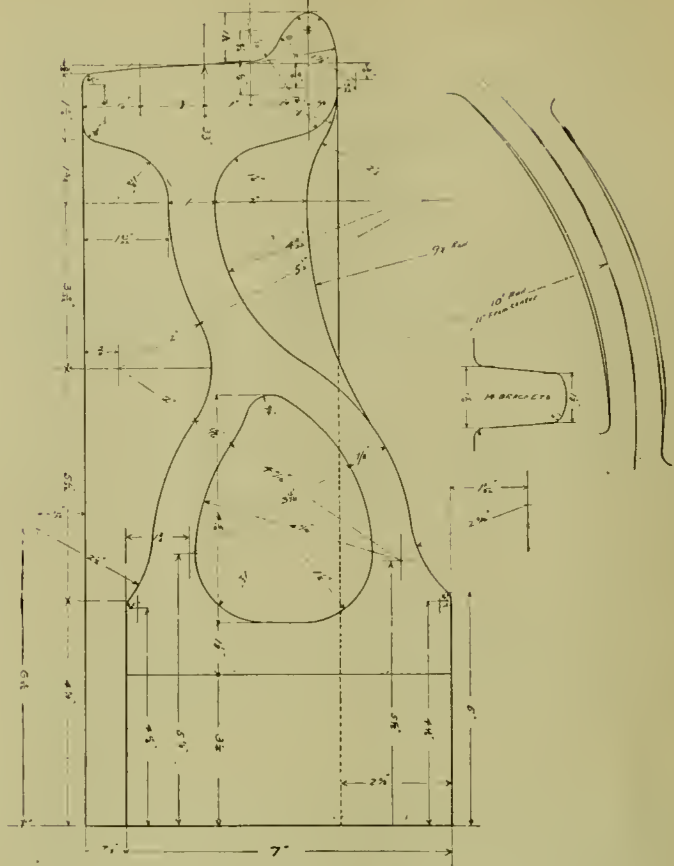


PLATE 2.—33 IN. 650-LB. CAST IRON WHEEL FOR 80,000-LB. CARS.

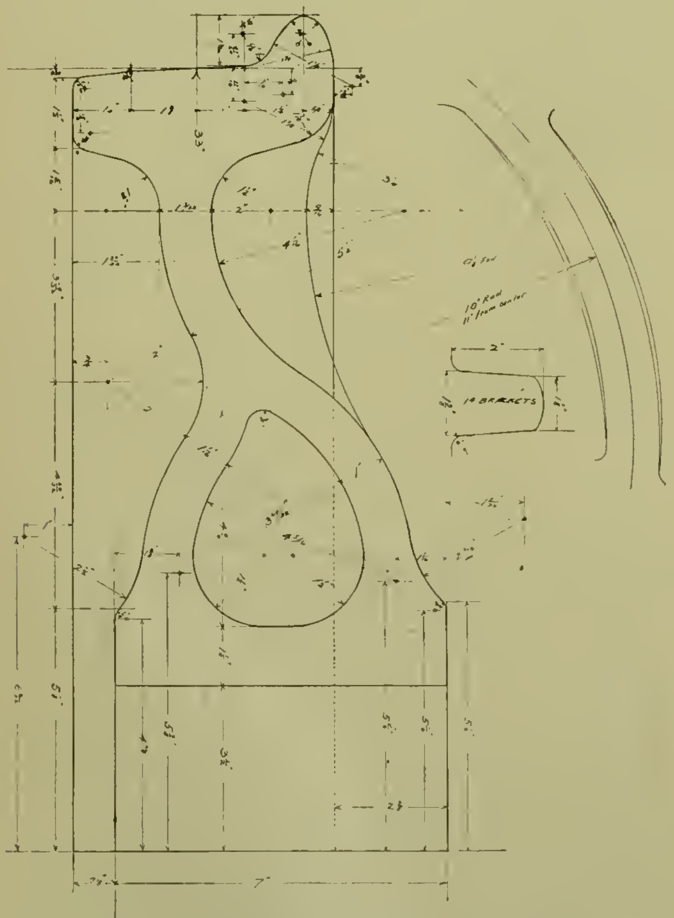


PLATE 3.—33 IN. 700-LB. CAST IRON WHEEL FOR 100,000-LB. CARS.

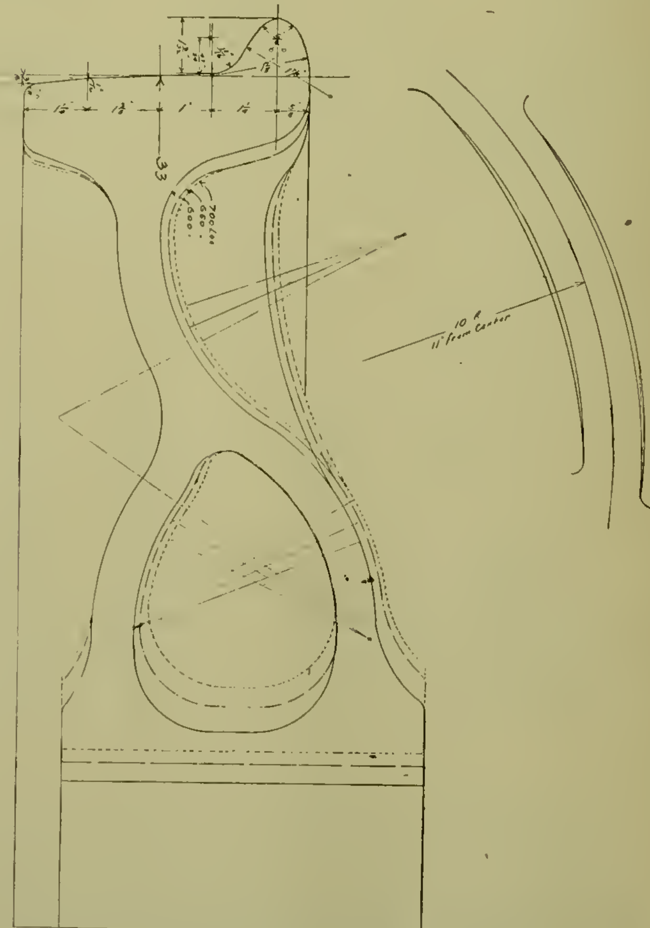


PLATE 4.—PROPOSED 33 IN. 600, 650 AND 700-LB. CAST IRON WHEEL.

4. For each hundred wheels which pass inspection and are ready for shipment, two representative wheels shall be taken at random, one of which shall be subjected to the following tests:

The wheel shall be placed flange downward on an anvil block, weighing not less than seventeen hundred (1,700) lbs., set on rubble masonry at least two (2) feet deep, and having three supports not more than five (5) ins. wide to rest upon. It shall be struck centrally on the hub by a weight of two hundred (200) lbs. For six hundred (600) lb. wheels, ten (10) blows falling from a height of nine (9) ft. For six hundred and fifty (650) lb. wheels, twelve (12) blows falling from a height of ten (10) feet, and for seven hundred (700) lb. wheels, twelve (12) blows falling from a height of twelve (12) feet. Should the test wheel stand the given number of blows without breaking in two or more pieces, the inspector will then subject the other wheel to the following test:

The wheel must be laid flange down in the sand and a channel way one and one-half (1½) ins. wide and four (4) ins. deep must be molded with green sand around the wheel. The clean tread of the wheel must form one side of the channel way, and the clean flange must form as much of the bottom as its width will cover. The channel way must then be filled to the top with molten cast-iron, which must be hot enough, when poured, so that the ring which is formed when metal is cold shall be solid or free from wrinkles or layers. The time when the pouring ceases must be noted, and two minutes later an examination of the wheel must be made. If the wheel is found broken in pieces, or if any crack in the plate extends through or into the tread, the one hundred wheels represented by the tests will be rejected.

5. In case of the drop tests, should the test wheel break in two or more pieces with less than the required number of blows, then the second wheel shall be taken from the same lot and similarly tested. If the second wheel stands the test it shall be optional with the inspector whether he shall test the third wheel or not; if he does not do so, or if he does, and the third wheel stands the test, the hundred wheels shall be accepted as filling the requirements of the drop test.

6. The lower face of the weight of two hundred (200) lbs. shall be eight (8) ins. in diameter, and have a flat face.

7. Wheels shall not vary from the specified weight more than 2 per cent.

8. The thickness of the flange shall be regulated by the maximum and minimum flange thickness gauges adopted by the M. C. B. Association.

9. All wheels must be numbered consecutively in accordance with instructions from the railroad company purchasing them, and shall have the number, the normal weight of the wheel, also the day, month and year when made plainly formed on the inside plate in casting, and no two wheels shall have the same number. All wheels shall also have the name of the maker and place of manufacture plainly formed on the outside plate in casting.

10. Individual wheels will not be accepted which (1) do not conform to standard design and measurements; (2) are under or over weight; (3) have physical defects described in section 2. Any lot of one hundred wheels submitted to test will not be accepted (1) if wheels broken do not meet the prescribed drop test; (2) if the wheel tested does not stand the thermal tests; (3) if the conditions prescribed in section 3 are not complied with.

11. All wheels must be taped with M. C. B. standard design of wheel circumference tape having numbers 1, 2, 3, 4, 5 stamped one-eighth (⅛) in. apart, the figure three (3) to represent the normal diameter, 103.67 ins. circumference, the figure one (1) the smallest diameter and the figure five (5) the largest diameter.

AIR-BRAKE HOSE SPECIFICATIONS.

COMMITTEE—L. G. PARISH, T. S. LLOYD, J. MILLIKEN, F. H. SCHEFFER, H. SWOYER.

The original specifications for air-brake hose provided for a woven hose with seamless tubing. The present specifications do not cover this feature; therefore your committee has taken this into consideration in making up proposed specifications, as it is thought advisable to allow this form of air-brake hose to be used if it will meet the tests.

In view of the fact that air-brake hose made to M. C. B. specifications by the several manufacturers do not give the same length of service, a number of roads have found it advisable to keep service records in order to determine the life of hose made by the different manufacturers. Two of the most notable points brought out in these records are the rapid falling off in the friction between the layers of duck after a comparatively short life, and damage at the nipple end of the hose due to separating cars without uncoupling the hose by hand.

It is found that nearly all of the hose tested stand the bursting pressure satisfactorily after being in service for some length of time, showing that the present bursting test, calling for 500 lbs. pressure for 10 minutes, is higher than necessary.

This service record to a large extent should determine whether the present specifications are correct. The study of these records has developed the fact that it is not always the M. C. B. specification hose that gives the longest life. It is a well-known fact that at least 80 per cent. of air-brake hose fail on account of unfair usage for which the manufacturer is not responsible, in view of which your committee has recommended a specification which should give as long life as the present M. C. B. standard. In view of the fact that it can be manufactured for at least 7 cts. per foot less than the present M. B. standard, the saving to the railroads should be very large.

There has been much said and written on this subject, showing conclusively that everybody is alive to the fact that the life of an air-brake hose is governed largely by the treatment it receives in service. The most destructive practice we have to contend with is pulling cars apart without uncoupling hose by hand. We find that the responsibility in some cases lies with the motive-power department and in other cases with the transportation department. If the hose in large terminal yards were cut by the inspectors, this damage would be largely decreased. If the responsibility is divided between the yard men and inspectors, there is no way of stopping the abuse on account of the responsibility being divided. Attempts have been made to correct this evil, but without much success. The principal fault lies in the fact that great pressure is brought to bear on the yard men and inspectors to switch trains as quickly as possible, the cost per car handled through the yard being used to a great extent to measure the efficiency of the men. Your committee would recommend that the responsibility for parting air-brake hose by hand be placed entirely on the motive-power department in terminal yards, and that united action be taken by all railroads to put a stop to the present abuse.

The location of angle cock and train pipe has not been given the proper attention. At the present time M. C. B. recommended practice specifies that train pipe be located 13 ins. from the center line of car, and that it be turned to an angle of 30 degs. Your committee would call attention to the importance of this recommendation and would recommend that it be made M. C. B. standard. At the present time these features are not being given proper attention. The improper location of train pipe and angle cock brings about a condition which is fully as bad as pulling the cars apart without uncoupling hose by hand. The standard 22-in. hose is of sufficient length if the angle cock and train pipe are located as per M. C. B. recommended practice. If, however, the train pipe is located over 13 ins. away from center line of car and the angle cock vertical, the distance is greatly increased, and when the slack is taken out of the couplers the hose is ruptured on account of excessive strain. This is a condition which should receive immediate attention.

On account of excessive damage to hose at the nipple end, your committee has considered it best to increase the inside diameter ⅛ in. This will not increase the cost of manufacture to any great extent, and the increased size will not bring the cost above hose manufactured with enlarged ends. This will give a little larger diameter at the nipple end, where it is greatly needed.

Particular attention is also called to the damage which is done to the inner tube by improper mounting of hose. Air machines for mounting hose, if not properly made, do great damage to the inner tube. It is also very important that the hose be so applied to cars that the heads will register properly when they are coupled. If it is necessary to twist them in order to couple, the danger from burst hose is greatly increased on account of the liability of hose bursting when the slack is taken up on the train.

There are a great many other points which might be touched on in connection with the abuse of air-brake hose, but your committee does not feel it necessary to call attention to these minor details, as everyone should be thoroughly familiar with them. It requires close attention on the part of shop men and inspectors to see that hose receives proper treatment.

Specifications and test for air-brake hose were adopted as recommended practices, advanced to standard in 1903. These specifications are herewith modified as follows:

(1) All air-brake hose must be soft and pliable, and not less than two-ply nor more than four-ply. They must be made of rubber and cotton fabric, each of the best of its kind made for the purpose; no rubber substitutes or short-fiber cotton to be used.

(2) The tube must be hand-made, composed of three calendars of rubber. It must be free from holes and imperfections, and in joining must be so firmly united to the cotton fabric that it cannot be separated without breaking or splitting the tube. The tube must be of such composition and so cured as to successfully meet the requirements of the stretching test given below. The tube to be not less than 3-32 in. thick at any point.

(3) The canvas or woven fabric used as wrapping for the hose to be made of long-fiber cotton, loosely woven, and to be from 38 to 40 ins. wide, and to weigh not less than 20 and 22 oz. per yard, respectively. The wrapping must be frictioned on both sides, and must have, in addition, a distinct coating or layer of gum between each ply of wrapping. The canvas wrapping must be applied on the bias. Woven or braided covering should be so loose in texture that the rubber on either side will be firmly united.

(4) The cover must be of the same quality of gum as the tube, and must not be less than 1-16 in. thick.

(5) Hose is to be furnished in 22-in. lengths. Variations exceeding ¼ in. in length will not be permitted. Rubber caps not less than 1-16 in. nor more than ⅛ in. must be vulcanized on each end.

(6) Hose must be furnished in 22-in. lengths. Variations exceeding ¼ in. above or below this will not be accepted. The inside diameter must not be less than 1⅜ ins. nor more than 1 7-16 ins., nor must the outside diameter exceed 2 ins. Hose must be smooth and regular in size throughout its entire length, except at a point 2½ ins. from either end, where the inside calendar of rubber may be increased 1-16 in. for a distance of ¼ in. toward either end and then tapering to the regular diameter.

(7) Each length of hose must have vulcanized to it a badge of white or red rubber, as shown. On the top of the badge the name of the purchaser, on the bottom the maker's name, on the left-hand end the month and the year of manufacture, and on the right-hand end the serial number and the letters "M. C. B. Std." The letters and figures must be clear and distinct, not less than 3-16 in. in height, and stand in relief not less than 1-32 in., so that they can be removed by cutting without endangering the cover. Each lot of 200 or less must bear the manufacturer's serial number, commencing at 1 on the first of the year and continuing consecutively until the end of the year.

For each lot of 200, one extra hose must be furnished free of cost.

(8) Test hose will be subject to the following tests:

BURSTING TEST.

The hose selected for test will have a section 5 ins. long cut from one end, and the remaining 17 ins. will then be subjected to a hydraulic pressure of 100 lbs. per square inch, under which pressure it must not expand more than ¼ in. nor develop any small leaks or defects. The section will then be subjected to a hydraulic pressure of 400 lbs. per square inch for 10 minutes, without bursting.

FRICTION TEST.

A section 1 in. long will be taken from the 5-in. piece previously cut off, and the quality of the friction determined by suspending a 20-lb. weight to the separated end, the force being applied radially, and the time of unwinding must not exceed 8 ins. in 10 minutes.

STRETCHING TEST.

Another section 1 in. long will be cut from the balance of the 5-in. piece, and the rubber tube or lining will be separated from the ply and cut at the lap. Marks 2 ins. apart will be placed on this section, and then the section will be quickly stretched until the marks are 8 ins. apart, and immediately released. The section will then be re-marked as at first and stretched to 8 ins., and will remain so stretched 10 minutes. It will then be released, and 10 minutes later the distance between the marks last applied will be measured. In no case must the test piece break or show a permanent elongation of more than ¼ in. between the marks last applied. Small strips taken from the cover or friction will be subjected to the same tests.

(9) If the test hose fails to meet the required tests, the lot from which it was taken may be rejected without further examination and returned to the manufacturer, who shall pay the freight charges in both directions. If the test hose is satisfactory, the entire lot will be examined, and those complying with the specifications will be accepted.

WHAT IS THE BEST PREVENTIVE OF RUST ON STEEL CARS?

COMMITTEE—H. S. HAYWARD, J. S. LENTZ, W. G. GORBELL, T. H. RUSSUM, C. E. FULLER.

1. *For New Cars.*—(*a*) The steel should be thoroughly cleaned of all rust and furnace scale before the car is assembled. (*b*) All joints before assembling should be thoroughly coated with coal tar. (*c*) After car is assembled all grease should be thoroughly removed from the steel and same given a good coat of carbon or graphite paint on the outside and underneath, and the inside a heavy coat of crude petroleum, coal tar applied hot, or some similar substance. (*d*) The outside to be given a second coat of graphite or carbon paint, as may be desired.

2. *For Old Cars.*—(*a*) All scale and rust should be removed wherever it appears on the car, by steel brushes or scrapers, and in the case of the inside of the car by any of the above methods or by the use of pneumatic hammers or mauls. (*b*) After all scale and rust have been removed the car should be thoroughly cleaned with steel scrapers or wire brushes and blown out with air, in order to present a clean surface for the paint. (*c*) The methods of painting recommended for new cars should be followed out in the case of old cars, after a clean surface is obtained.

3. As some of the most prolific causes of deterioration of steel cars are the loading of same with hot billets, the use of mauls, bars, etc., on the outside to assist in the unloading of cars, and the allowing of cars loaded with soft coal to stand a long time with the load on same, it is recommended that steps be taken to do away with these practices as much as possible.

Your committee believes that if the above recommendations are followed out, and if care is taken to repaint the outside of and underneath cars at least every eighteen months or two years, coating the inside with crude petroleum or coal tar about once a year, excellent results will be obtained.

SUBJECTS.

COMMITTEE—J. T. CHAMBERLAIN, C. A. SCHROYER, J. S. LENTZ.

FOR COMMITTEE WORK DURING 1904-'05.

1. The use of steel in passenger car construction.

Your committee is informed that an individual paper will be presented at the convention on the above subject, and believes it is of sufficient importance to require further investigation by a committee of the association.

2. Specifications and tests for bolsters, brake beams, etc.

This association has just installed at Purdue University, Lafayette, Ind., a drop-test machine for M. C. B. couplers. The machine is available for testing other parts of cars, and it is suggested that we make use of our property to study the question of specification and tests for bolsters, brake beams and such other car details as require tests of that character to determine their strength and efficiency.

3. Grain doors.

The Central Traffic Association has suggested the adoption of a suitable grain door to meet the requirements of large-capacity cars. Your committee believes the subject is worthy of investigation.

4. Flexible car trucks vs. rigid trucks.

To consider what flange wear of wheels, if any, is reduced over rigid trucks, and what difference, if any, exists as to absorption of power.

5. Recent designs of heavy trolley-car trucks.

To see if the prevailing combination of iron and wood trucks in passenger-car service cannot be superseded by a lighter, stronger and cheaper all-steel truck.

6. Axles.

To investigate the practice of some roads of turning car axles so that there is a shoulder behind the wheel hub, which hub is faced and wheels mounted to 1-16 in. of this shoulder, it being claimed derailment will not attend a loose wheel when this practice is followed.

(To be continued.)

EXHIBITS AT THE CONVENTIONS.

MASTER MECHANICS' AND MASTER CAR BUILDERS' ASSOCIATIONS.

Acme Supply Co., Chicago, Ill.
Adams & Westlake Company, The, Chicago, Ill.
American Balance Valve Company, Jersey Shore, Pa.
American Brake Shoe and Foundry Company, Mahwah, N. J.
American Locomotive Equipment Company, Chicago, Ill.
American Steam Gauge and Valve Company, Boston, Mass.
Aurora Metal Company, Aurora, Ill.
Baltimore Railway Specialty Company, Baltimore, Md.
Bettendorf Axle Company, Chicago, Ill.
Bowser, S. F., & Co., Fort Wayne, Ind.
Buckeye Steel Castings Company, Columbus, Ohio.
Case Manufacturing Company, Columbus, Ohio.
Chicago Car Heating Company, Chicago, Ill.
Chicago Pneumatic Tool Company, New York.
Cleveland Car Specialty Company, Cleveland, Ohio.
Columbus Steel Rolling Shutter Co., Columbus, Ohio.
Commonwealth Steel Company, St. Louis, Mo.
Consolidated Car Heating Company, Albany, N. Y.
Consolidated Railway Electric Lighting and Equipment Company, New York.
Corrington Air Brake Company, Matteawan, N. Y.
Crandall Packing Co., Palmyra, N. Y.
Crane Company, Chicago, Ill.
Crosby Steam Gauge and Valve Company, Boston, Mass.
Damascus Brake Beam Company, St. Louis, Mo.
Davis Pressed Steel Company, Wilmington, Del.
Dickinson, Paul, Chicago, Ill.
Dixon Crucible Co., Jersey City, N. J.
Drouve G., Co., Bridgeport, Conn.
Duner & Co., Chicago.
Fabrikoid Company, Newburgh, N. Y.
Fairbanks Company, New York.
Fairbanks, Morse & Co., Chicago, Ill.
Farlow Draft Gear Company, Baltimore, Md.
Federal Company, Chicago, Ill.
Federal Manufacturing Company, Cleveland, Ohio.
Flannery Bolt Company, Pittsburgh, Pa.
Forsyth Bros. Company, Chicago, Ill.
Franklin Manufacturing Company, Franklin, Pa.
Franklin Railway Supply Company, Franklin, Pa.
Garlock Packing Company, New York.
Gisholt Machine Company, Madison, Wis.
Gold Car Heating and Lighting Company, New York.
Gould Coupler Company, Depew, N. Y.
Hammett, M. C., Troy, N. Y.
Handy Car Equipment Company, Chicago, Ill.
Hayden Manufacturing Company, N. L., Columbus, Ohio.
Holland Company, Chicago, Ill.
Homestead Valve Manufacturing Company, Homestead, Pa.
Illinois Malleable Iron Company, Chicago, Ill.
Johns-Manville Company, New York.
Kennicott Water Softener Company, Chicago, Ill.
Keystone Drop Forge Works, Chester, Pa.
Kindl Car Truck Company, Chicago, Ill.
Kinnear Manufacturing Co., Columbus, Ohio.
Lodge & Shipley Machine Tool Company, Cincinnati, Ohio.
Manning, Maxwell & Moore, New York.
Manufacturers' Railway Supply Company, Chicago, Ill.
Martin Car Heating Company, Chicago, Ill.
Mason Regulator Company, Boston, Mass.
McConway & Torley Company, Pittsburgh, Pa.
McCord & Co., Chicago, Ill.
Merritt & Co., Philadelphia, Pa.
Metal Plated Car and Lumber Company, New York.
Michigan Lubricator Company, Detroit, Mich.
Midland Railway Supply Company, Chicago, Ill.
Modern Tool Company, Erie, Pa.
Moran Flexible Joint Company, Louisville, Ky.
National Car Coupler Company, Chicago, Ill.
National Lock Washer Company, Newark, N. J.
National Malleable Iron Company, Cleveland, Ohio.
Norton, A. C., Boston, Mass.
Norton Emery Wheel Company, Worcester, Mass.
Pearson Jack Company, Boston, Mass.
Peckham Manufacturing Company, New York.
Pierce, Charles F., New York.
Pittsburgh Spring and Steel Company, Pittsburgh, Pa.
Pyle National Electric Headlight Company, Chicago, Ill.
Rand Drill Company, New York.
Safety Car Heating & Lighting Co., New York.
Schoen Steel Wheel Company, Pittsburgh, Pa.
Simplex Railway Appliance Company, Hammond, Ind.
Standard Car Truck Company, Chicago, Ill.
Standard Coupler Company, New York.
Star Brass Manufacturing Company, Boston, Mass.
Sterlingworth Railway Supply Company, Philadelphia, Pa.
Symington Company, T. H., Baltimore, Md.
Underwood & Co., H. B., Philadelphia, Pa.
United States Metal and Manufacturing Company, New York.
Waugh Draft Gear Company, Chicago, Ill.
Walworth Manufacturing Co., Boston, Mass.
Western Railway Equipment Company, St. Louis, Mo.
Western Tube Company, Kewanee, Ill.
Wells, F. L., Chicago, Ill.
Westinghouse Air Brake Company, Pittsburgh, Pa.
Wheel Truing Brake Shoe Company, Detroit, Mich.
Wood, G. S., Chicago, Ill.

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL

AUGUST, 1904.

CONTENTS.

TURNING TIRES AND FINISHING PISTON RODS.

To the Editor:

Some months ago you printed a statement of the time consumed in turning locomotive tires in the shops of the Chicago Great Western Railway to the effect that three pairs were turned per day; but you did not state the number of hours. A pair of 56-in. flanged tires have been turned in the Union Pacific shops at Omaha, in 1 hour, 45 minutes, including the time from picking them up to setting them down finished.

An extension piston rod is centered, straightened, roughed, finished and threaded, for $2.60.

Tires are bored for 30 cents each, including the time required for handling.

These figures may interest your readers.

Geo. W. Thompson.

These figures will interest our readers. We shall be glad to know of records as good or better.—Editor.

ENGINE FAILURES.

To the Editor:

The editorial in your May number entitled, "What Are Your Locomotives Doing?" the remarkable series of letters in your June number on the subject of overloading locomotives and your references to foreign practice in the matter of preventing engine failures lead me to send you a statement covering our failure report for the month of April.

With power in good order the cost of operation must necessarily be materially decreased. I believe, as suggested by you, that with first-class supervision in the care of locomotives, the failures can be lessened quite materially and in fact done away with altogether, more especially delays that originate from steam failures caused from so called "poor fuel." We do not experience a failure from this particular cause from one month's end to the other and in fact we have not had a steam failure that can be attributed to the quality of the coal in the last two years.

The following comparison may interest the readers of the American Engineer and Railroad Journal:

RECORD OF ENGINE FAILURES, MONTH OF APRIL, 1904.

Date	Eng.	Train	Location	Engineer	Delay. Hrs.	Delay. Min.	Cause.
29th	53	8	On run	......	0	20	Steam pipes leaking.

CLASSIFICATION OF FAILURES.

Steam failures	1
Total	1
Unavoidable failures	1
Could have been avoided	0
Employes disciplined for failures	0
Total delays all failures	20 min.
Total number tons reduced	None
Average delay per failure	20 min.
Average number tons reduced per failure	None
Mileage passenger engines	94,570
Mileage freight engines	96,372
Miles run per failure, passenger	94,570
Miles run per failure, freight	96,372
Total mileage, all engines	232,730
Average monthly mileage, all classes	2,804
Number engines in service	83

COMPARISON.

	Apl. '04.	Mch. '04.	Apl. '03.
Total number failures	1	7	14
Total delays all failures	20m.	20h. 40m.	58h. 45m.
Total number tons reduced	None.	5,730	957
Average delay per failure	20m.	2h. 37m.	4h. 12m.
Average number tons reduced per failure	None.	819	68
Mileage passenger engines	94,570	92,360	77,661
Mileage freight engines	96,372	89,531	115,900
Miles per failure, passenger	94,570	92,360	12,943
Miles run per failure freight	96,372	12,790	14,375
Total mileage, all engines	232,730	222,507	227,473
Average monthly mileage, all classes service	2,804	2,589	2,774
Number engines in service	83	77	82

Engine failures may be reduced by close attention and hard work, but the results pay for the effort.

General Master Mechanic.

186,000 GALLONS OF WATER AND TONS OF SCALE.

To the Editor:

On a trunk line connecting New York with Chicago there is a water station where it is estimated 186,000 gallons of water are used in every twenty-four hours. This water, according to analysis, contains 34.67 grains per gallon of solid material, of which 31.77 grains are scale-making. This means that in every thousand gallons of water there are 4.54 lbs. of scale-making material, and in 186,000 gallons there would be 844.44 lbs. In one month of thirty days this would amount to over twelve and one-half tons of scale-making material going into locomotive boilers, and month after month at this point tons of scale-making salts find their way into the engines which take water at that place.

The above illustration of the amount of scale-making material a bad water contains is not by any means extravagant, as there are numerous waters containing a far higher percentage.

A locomotive costs on an average $15,000 and for such an expensive machine there should be nothing but the best treatment, not only in regard to its handling, but also in the selection of its food and drink, which is the coal and water, which should be sufficiently pure to get the best results; for like a human being a large percentage of impurities cause the machine to clog up, with various complications setting in, such as corroded sheets, scale-covered tubes, with other internal complications, from which this valuable piece of apparatus is put out of business and shopped for repairs.

It is estimated that the average locomotive uses 5,000,000 gallons of water per year. As such an enormous amount of material is used it would seem as though it ought to have the most careful study as regards its action in the locomotive boiler from the point of view of economy and efficiency.

The action of the different impurities in the water are somewhat similar to the action of different drugs on the system, some causing more trouble than others. The incrusting solids are calcium carbonate, calcium sulphate, calcium chloride, magnesium carbonate, magnesium sulphate, magnesium chloride, iron, alumina and silica. The calcium carbonate, magnesium carbonate, iron alumina and silica give a mud or sludge in the boiler. The calcium sulphate and magnesium sulphate and chloride give a hard scale. The last two, however, must be first decomposed and changed to magnesium oxide. The calcium chloride and magnesium chloride are corrosive solids. The non-crusting solids, alkali sulphate, alkali chloride, alkali carbonate, are only troublesome when present in too large quantities when they produce foaming. The alkali carbonate, if present in small amounts, is helpful by neutralizing the action of the scale-making salts by changing them to carbonate when they are precipitated as a light mud.

For a great many years it has been fully realized that something ought to be done to put off or alleviate the laying aside of this august patient, the locomotive, in the erecting shop, either for temporary or general repairs. Consequently large doses of various salts and concoctions have been forced into the internal organs of this faithful but much abused locomotive by the most unexpected way through the tank in which these various salts are dissolved and in an unexpected manner they are led by the injector, which by suction rushes the dissolved soda-ash or other salt into the presence of its foes, calcium carbonate, calcium sulphate, calcium chloride, magnesium carbonate, magnesium sulphate and magnesium chloride, and then the fight is on. Molecules of soda-ash, which is carbonate soda, attack molecules of sulphate of lime and form molecules of sulphate of soda and carbonate of lime. The former salt, sulphate of soda, is harmless unless in large quantities and goes out of sight in the water. The carbonate of lime is light and can be blown out and does not cause as much trouble as sulphate of lime. In this fight other scale-making salts are attacked and changed from scale-making and corrosive to much less harmful salts. These different molecules of calcium, magnesium, carbonic acid, sulphuric acid, hydrochloric acid, were troublesome in their former combination as carbonates, sulphates and chlorides of calcium and magnesium, yet, in the presence of soda-ash, which is a purifier, and at high temperature as in the locomotive boiler, it tears apart and forms new compounds which are not as dangerous and troublesome to the engine and helps to keep off the fatal sickness caused by the scale which is being taken in by the several thousand gallons of water used each day. In the water mentioned above, 1,000 gallons contained 4.54 lbs. of scale-making material, and in the 186,000 gallons used in one day it equaled 844.44 lbs., which in one month of thirty days amounted to 12½ tons. If treated before it entered the boiler, probably about 3.7 lbs. per 1,000 gallons, 688.2 lbs. for the 186,000 gallons and about 10 tons for the month, of scale-making material would be removed.

It would seem, therefore, that the treatment of water before allowing it to enter the locomotive boiler would be economical and secure greater efficiency for the engine.

As was said before, it has been estimated that the average locomotive uses 5,000,000 gallons of water a year. Supposing the water used contained on an average 7, 14, 21, 28, 35 and 42 grains per gallon of scale-making material, which would equal for the year, 5,000, 10,000, 15,000, 20,000, 25,000 and 30,000 lbs. to be blown out, washed out or left behind to cover the inside of the boiler. The blowing and washing out cost money and time and the scale formed on the tubes and boiler necessitates the use of larger amounts of fuel and thereby increased expense. It has been said one-sixteenth of an inch of scale on the inside of a boiler necessitates the consumption of 12 per cent. more fuel to generate the same amount of steam, one-quarter of an inch of scale requires 38 per cent. more fuel, while three-quarters of an inch of scale causes a loss of 90 per cent. of fuel.

The above, if only partially true, in actual practice would not only be expensive, but tend toward overloading the digestive apparatus, and if the coal was as poor as some I have analyzed it would tend to produce a case of acute dyspepsia in the firebox, which, while causing only temporary troubles, yet cannot be lost sight of.

W. B. Landon,
Meadville, Pa. Chemist Erie Railroad.

NEW LOCOMOTIVE AND CAR SHOPS.

McKees Rocks, Pa.—Pittsburg & Lake Erie Railroad.

VII.

DISTRIBUTION OF POWER.

As stated in one of the earlier numbers of this series of articles, elaborate provisions were made for the distribution of power to the various shop buildings of the McKees Rocks shops by electrical transmission. It is thought that the many special features and radical departures from former practice involved in this installation will be of more than usual interest, and the plans are herein carefully reviewed. The details of the electrical system of distribution are very completely shown on the accompanying diagram.

The incandescent lights and the constant-speed motors for certain of the machine tools, the cranes, and for the heating, ventilating and blast fans, are operated at 240 volts. The arc lights, as was noted in the article on the power house (May, 1904, page 173), are operated at 120 volts, which necessitated the installation of a 3-wire system and rotary balancer.

The machine tools, which are driven by variable-speed motors, on the multiple voltage system, are divided up into three groups, the division being such that each group requires about the same amount of power and is on a separate circuit. The advantage of this is that if anything should get out of order on one of these circuits only one-third of the tools in the shop will thus be affected, and, moreover, the difficulty can be more easily located than if all the tools were on the same circuit.

The wires are carried from the switchboard in the power-house to the long wire duct or tunnel in the machine shop, through terra cotta conduits. The location of these conduits, as well as the wire tunnel and also of the wire boxes, which lead from the tunnel, are shown on the floor plan of the machine and erecting shop, which was presented on page 454 of the December, 1903, issue. This long wire tunnel, which extends the full length of the machine shop, is 3 ft. 6 ins. wide, 4 ft. deep, and its walls and floor are of concrete. At every 8 ft. 3 ins. along each side of the tunnel, two wooden blocks are built into the concrete, one near the top and the other near the bottom of the wall. Upright planks are fastened to these blocks and carry the wrought-iron clamps for supporting the wires. The wires for the arc and incandescent lighting are supported on one side of the tunnel, and those for the machine tool motors and power on the other side.

The wire boxes, which lead from the tunnel and which carry the wires for the machine tool motors and incandescent lights, are 12 ins. wide and 5 ins. deep. Their centres are only 5 ft. 6 ins. apart, and they extend crosswise of the machine shop for its full width. Those wire boxes on each side of the columns, which support the roof trusses, extend into the erecting shop, and are stopped off about opposite the middle of the pits. The construction of the wire boxes is described and illustrated in connection with the description of the machine shop floor in the December, 1903, issue, pages 455-456.

The wires to each tool are carried through the wire boxes in insulated pipe (loricated conduit). The wiring was done after the floor was laid and, as the tunnel is not very wide and the pipes would of course have to be put in from that end, it was necessary to put them in in 5-ft. lengths and couple up enough of these lengths to reach the desired point. An elbow was then put down through a hole in the floor and connected to the end of the pipe. The pipe was guided into the elbow by passing a piece of rope of about the same diameter as the inside of the pipe through the elbow and drawing the rope into the pipe a short distance by means of a "snake." The straight lengths of pipe were coupled together quite securely, but the elbow was not tightly secured, so that if at any time it was desired to remove the pipe it could easily be disconnected at the elbow and then removed piece by piece. The pipes to the variable-speed motors each contain six wires, four for the multiple voltage system and two for the incandescent light.

In locating the machine tools in the machine shop no attention was paid to the location of the wire boxes. When the tools were connected up it was found that owing to the short distance between the wire boxes the wires in all cases could

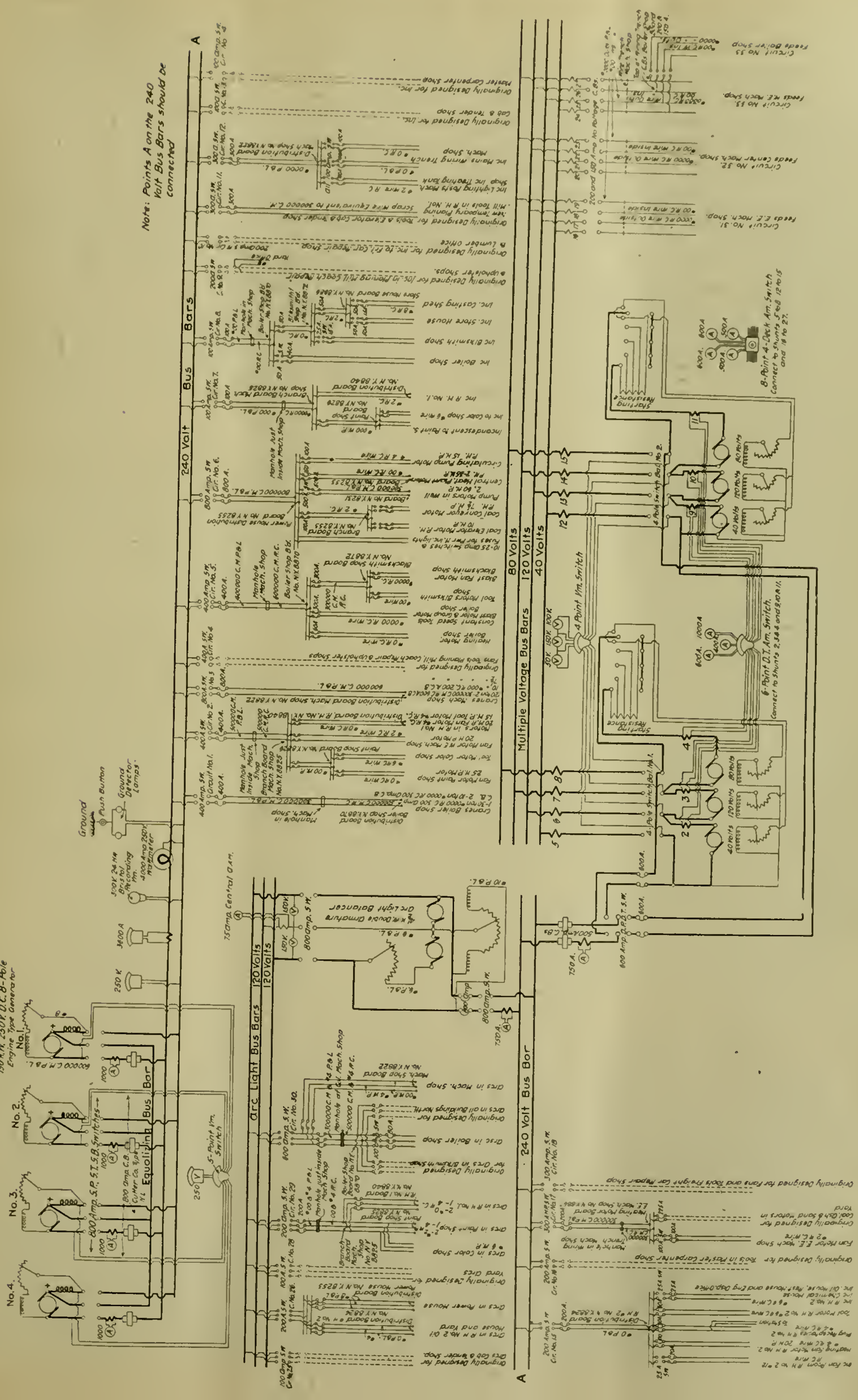


DIAGRAM SHOWING ELECTRICAL DISTRIBUTION OF POWER.

McKEES ROCKS SHOPS—PITTSBURGH & LAKE ERIE RAILROAD.

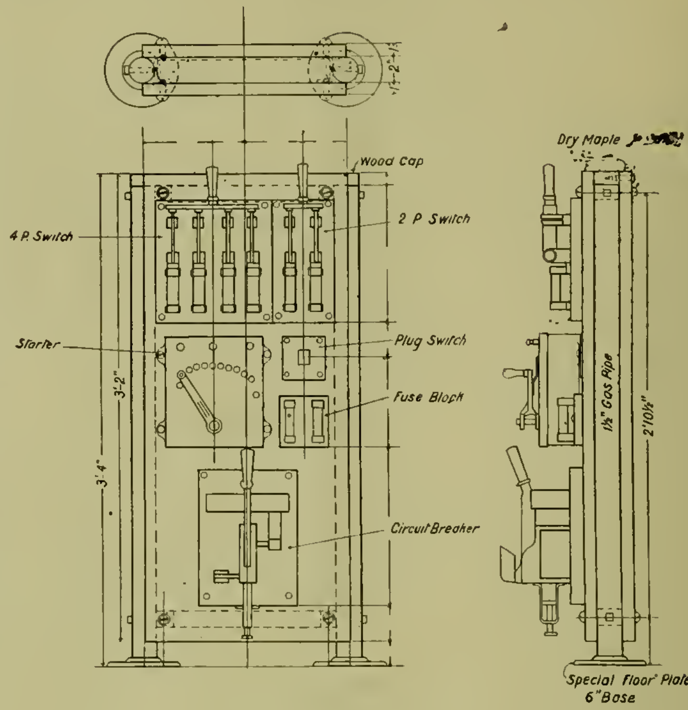
be brought through the floor at about the right spot, to be most convenient.

This method of wiring the machine tool motors has several advantages. The wires are placed under the floor, where they are entirely out of the way and yet are easy of access if they need attention. New tools can readily be added at any point in the shop and can be wired without tearing up the floor.

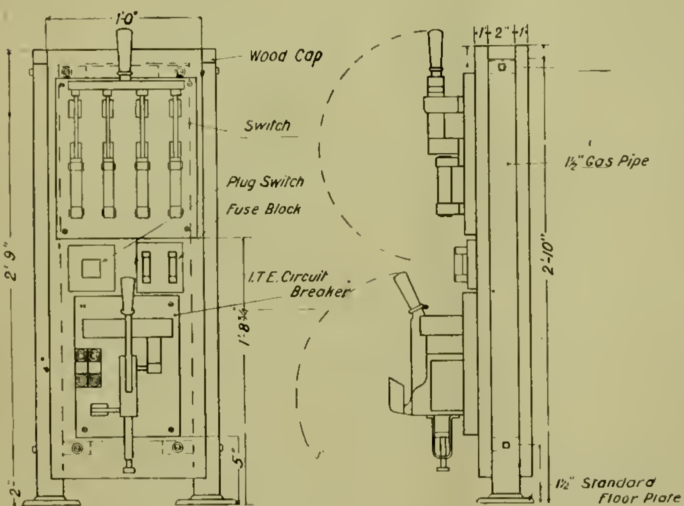
Each tool is furnished with a panel board, which carries the switch, fuse block, circuit-breaker and a plug switch for an incandescent light. In most cases the controller is placed on the machine tool itself at the most convenient point for the operator, but in the case of some tools, such as the shapers, which were described in the July, 1904, issue, page 261, the panel board can be so placed that the controller can be attached to the back of it and at the same time be convenient to the operator. As it is very seldom necessary for the operator to use either the switch, fuse block, circuit-breaker or plug switch, the panel, when it contains only this apparatus, is usually placed in an out-of-the-way position where it will not interfere with the movements of the operator and yet be close to the tool so that it can readily be reached if necessary; it is, of course, also placed so that passers-by will not carelessly come in contact with the apparatus on it.

The use of these panel boards is to be preferred to the practice of placing the above-mentioned apparatus on the frame or bed of the machine tool. It presents a much neater appearance, allows a standard arrangement of the apparatus, and simplifies the wiring. The panel boards, as used at McKees Rocks, are of a very neat and substantial design, and are so fastened to the floor that they are very stiff. The three types of panels which are used are shown in the accompanying drawings. The designs of the panels are practically the same, except that there is a difference in size due to the additional apparatus, which must be carried in some instances.

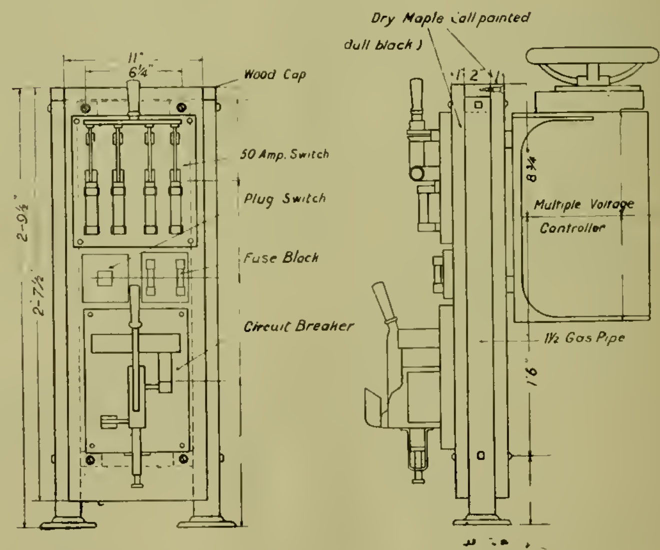
Panel A is the type which is used in the greater number of the others, special 6-in. floor plates are used. Such a panel is used with the Pond car wheel borer (May, 1904, page 193), which has an auxiliary motor for the hoist, and also with the Pond 72-in. boring mill (May, 1904, page 193), which has an auxiliary motor for raising and lowering the cross rail.



TYPE C.



TYPE A.



TYPE B.

MACHINE TOOL PANEL BOARDS FOR ELECTRICAL APPARATUS.

instances. The dry maple boards are fastened to the wrought-iron straps which are bolted to the pieces of 1½-in. gas pipe. The pipes are firmly attached to the floor by means of 1½-in. standard floor plates, which are fastened to the floor by four lag screws. The opening between the boards at the top is closed by a wooden cap, and the electrical apparatus is located as shown.

Panel B is practically the same as A, except that it is arranged to carry a controller on one side.

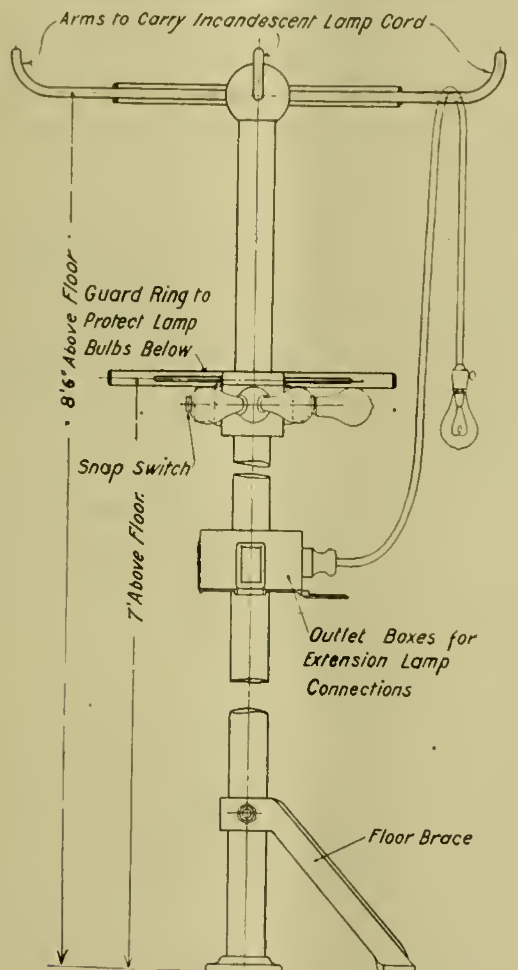
Panel C is used with tools which are equipped with an auxiliary constant-speed motor in addition to the motor for the main drive. It carries in addition to the switch, circuit-breaker and fuse block for the main motor and the plug switch for the light, a starter and switch for the constant-speed motor. To insure stiffness for this panel, which is considerably larger than

Circuit-breakers are placed at each machine tool in order to fully protect each tool. Where this is not done and only one breaker used in a circuit a motor might become dangerously overloaded at one of the tools and the tool be injured without overloading the circuit enough to throw out the breaker, particularly if the other tools on the circuit happened to be running light at the time.

The electrical apparatus on the panel boards was selected with a view to strength and durability. The circuit-breakers are the I. T. E. type, manufactured by the Cutter Manufacturing Company. The fuse blocks are the Noark cartridge type, manufactured by H. W. Johns-Manville Company, New York. The switches are of a special design, and were made by the W. S. Hill Electric Company.

The wiring at the machine tools, from the panel board to the controller and motor, has been very nicely taken care of, and deserves special notice. The wires are enclosed in loricated conduit and in some special cases in a flexible conduit. This protects them and keeps them out of the operator's way and also presents a very neat appearance. Although the panel boards, controller and motor are in most cases placed at different parts of the tool yet the wires which connect them are not in evidence except at the motor connection. The pipe which carries the wires is painted the same color as the tool and in most cases is so placed that it would hardly be noticed unless attention was particularly directed to it.

Examples of the method of wiring some of the tools and of the location of the panel boards, etc., is quite clearly shown on some of the half-tones which were used in illustrating the series of articles which have appeared in the American Engineer on "The Application of Individual Motor Drives to Old Machine Tools at the McKees Rocks Shops." Fig. 22 on page



LAMP POST USED BETWEEN PITS IN ERECTING SHOP.

441 of the December, 1903, issue shows quite clearly the manner of wiring one of the vertical drill presses. The panel board could not be placed directly over the wire box, and the pipe containing the wires is turned to the left after it comes through the floor. The pipe passes from the back of the panel board up alongside the motor brackets and over to the controller. The wires to the motor pass through the short length of pipe which is connected to the above pipe by a junction box, which is located directly above the motor. The panel board is the same as Type A. Another panel of this same type is shown on page 14 of the January, 1904, issue in connection with one of the slotters.

Another example of the wiring is plainly shown on the radial drill press, illustrated on page 54 of the February, 1904, issue. The motor, controller and panel board are all carried on the revolving part of the tool. A long piece of flexible conduit, which is manufactured by the Western Electric Company, extends from the floor to a junction box, from which pipes lead to the panel board, controller and motor. On Figs. 37 and 42, pages 88 and 89, of the March, 1904, issue, the wiring of two of the turret lathes is partially shown. In these cases flexible conduits are used for carrying the wires from the controller to the motor. Other examples of wiring are shown on the driving wheel lathe, page 129, April, 1904, issue, and on the planers, page 214, of the June, 1904, issue.

In the boiler shop the feed wires are carried overhead. Most of the machine tools are arranged along one of the side walls, and the connection to these tools is made through pipe which passes down along the wall.

LIGHTING.

In the erecting shop arc lights are hung half way between the pits, alternating one at each side of the bay; also one arc at every third truss above the traveling cranes. In the machine shop there is a row of arcs down the middle of each bay, an arc being placed in every other space between roof trusses. Alternate spaces are used in the two bays. In the boiler shop arcs are placed every 55 ft. along the side walls and in the centre of the shop. The lights in the row down the centre are staggered with those in the side rows.

Each machine tool is furnished with an extension cord and an incandescent light. The cord is a twin-wire conductor, built up round about ½-in. diameter and armored with light steel braid. Each light socket is fitted with a clamp, which is a modified form of "electrogrip," made of specially heavy material.

At the centre of each work bench between the pits in the erecting shop is a lamp post, a general outline of which post is shown in the accompanying cut. About 7 ft. above the floor is provided a cluster of five lights and a snap switch. Below this is a 4-point outlet box for extension cords, and at the top of the post, 8 ft. 6 ins. above the floor, are four arms, over which the extension cord can be thrown, so that if a man is using the light about the locomotive the cord will be held up out of the way of passers-by. The cluster of lights are protected from this cord by the wrought-iron ring just above them. The details of construction of this special post are clearly shown in the drawing. Portable lamp posts have also been fitted up for use in the various shops.

Progress in Passenger Cars.—Thirty-five years ago the average coach would carry from thirty to forty-five passengers and weighed about fourteen tons; the cars were equipped with link and pin couplers; were carried on 4-wheel trucks with journals 3½x6 ins.; were lighted with oil lamps; had small windows; in some cases were without a clear story, and were heated with wood-burning stoves. The cost of a coach such as I have described was about $3,500. To-day our standard coach is 72 feet long over end sills; weighs from 52 to 55 tons; has a seating capacity of 86 passengers; is carried on 6-wheel trucks, with journals 5x9 inches; has steel platforms and wide vestibules; is heated with steam heat and lighted with gas and electricity. To-day a wide vestibule coach is worth in the neighborhood of $10,000.—F. W. Brazier, presidential address, M. C. B. Association.

In discussing the power required of a locomotive to move itself, figures were quoted from tests on the London & Northwestern Railway before the Institution of Mechanical Engineers, showing that in one case at 60 miles an hour a locomotive used 444 out of a total of 1,170 h.p. to move itself. This large proportion of unproductive work suggests a very important line of investigation in connection with high-speed locomotives.

A Traveling Railroad Machine Shop.—An 80,000-lb. box car has been fitted up as a traveling machine shop by the Morgan Construction Company, Worcester, Mass. According to the *American Machinist*, it is equipped with a 20-in. Reed lathe, an 18-in. Stockbridge shaper, a Norton emery grinder, a forge, anvil, bench and vise, and also a number of small tools. The car is used in connection with the erection of large buildings and such plants as rolling mills. An 8 h.p. gasoline engine furnishes the power.

THE POSSIBILITIES OF THE RAILWAY MOTIVE POWER OFFICER.

BY A RETIRED SUPERINTENDENT OF MOTIVE POWER.

What a flood of reflections are aroused by the above subject! The discussion of the possibilities and the probable final outcome as to operative and financial success for any official who may have selected the mechanical department as the field for the exercise of his talents is a fruitful theme at least for present consideration, even if the possibilities have only been realized to a very limited extent in the past. To present the subject in a clear and logical manner with only so much partisanship as may justly be allowed to one who has at heart the success of mechanical work, considered from a railway standpoint, and the well-being of those who are engaged therein—even this is a difficult task. To present the subject in most forceful terms and by really strong arguments would seem to call for a presentation from a somewhat too personal standpoint. For one to say "out loud" that the American mechanical worker has had a ban put upon him, either intentionally or on account of existing conditions, would possibly seem to some to suggest a defense of this proposition, involving a statement of personal experiences and pros and cons which in the end might engender hard feelings detrimental to the good results hoped for. Hence it is with some degree of circumspection that one would approach the subject, not on account of any innate fear as to the justice of the cause advocated, but on account of the uncertainty as to the effect on the minds of some who might unjustly suppose that the writer had in view some particular officials, unique and strange, whose peculiarities he was endeavoring to hold up to the light of day. Yet *personal* experience is to some extent the basis of knowledge and belief, and I trust that mine may justify any facts set forth without malice.

I violate no confidence when I say that among those with whom I have talked on the subject there has been a very strong evidence of discontent with railway mechanical work, both as to the relation of the mechanical to the other departments and as to the probable outcome of a life spent in that department. I would also further state that I have met almost as many higher officials who were dissatisfied with the results obtained by their mechanical departments, so the discontent is not all on one side. To bring about better results would certainly be a commendable object, and a free discussion of the subject will not hurt either the public or the mechanical department, though it might affect in the end other departments in so far as the offices, which on some lines have always been held by men from other branches of the service, might be thrown open to the deserving men who have had their training in the mechanical department.

In this busy world, with its struggle for existence, distinction and future monetary welfare, as a rule, neither man, union nor corporation voluntarily gives up any advantage which may be enjoyed over a competitor. It therefore cannot be expected that any man connected with other than the mechanical department, who is not obliged to do so, is going to give up any advantage which, given up, might mean the advancement of a competitor to his own detriment. Hence a recognition of the mechanical worker as a candidate for still higher positions must come from those who have gotten past the point in their official career where they need fear mechanical department competition. I make no charge of any incompetency or unfitness on the one hand, against those who have had the advantage thus far, nor do I argue any special fitness for the man with mechanical training over his successful rival in the other departments. I would only ask consideration for the mechanical department unfortunate in so far as his ability gives evidence of his desirability as a candidate for something better, instead of the almost general custom of the past, which has kept a man in the mechanical department so long as he remained in service, and practically never has admitted that a mechanical department man could be good enough for anything else. While I am free to admit that long service in the mechanical department may put a man beyond the time when his mind is alert and grasping as to new ideas and present progress, yet it would seem that at a certain time in his career he might be as desirable as some whom custom has marked for preference.

A certain amount of mechanical training ought not to be adverse to the highest success in railway work; yet a search of the records of the higher officials reveals the fact that there are about thirty men who have enjoyed the title of master mechanic and succeeded in getting beyond the mechanical department confines. A further search will show that there are about eleven hundred positions on American railroads which might be opened to the deserving mechanical man. I say these positions might be opened on the ground that those fortunates who have escaped are holding such positions as I have included at present—successfully, for aught I know to the contrary. There are at least 750 men who hold the title of master mechanic, or better, in railway mechanical work at present. From these figures I think one can obtain some idea without further comment as to the probabilities of the mechanical officer obtaining further recognition as things are at present constituted.

It may not be amiss to add that one railway system forms quite a prominent exception to the prevailing custom of promotion, and a considerable percentage of those who have been favored are from this one system. I do not believe there is any ground save appearance for the old story of the sectionman who desired to get his boy Johnny into the mechanical department in preference to the other departments, giving as a reason for his preference, "Johnny is not very bright."

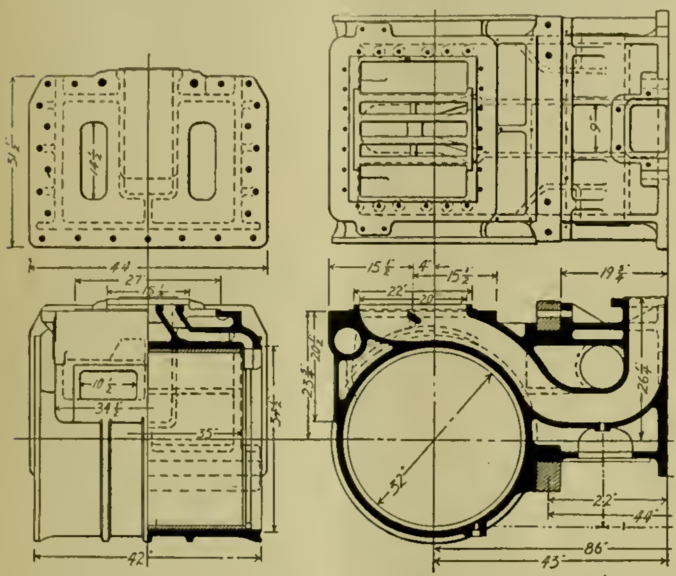
The general success of the mechanical department is intimately connected with the welfare of the railroad, and a failure of this department from any cause whatsoever is generally keenly felt. Theories are much easier to change than material facts. The mechanical department deals with material matters, and the failure of the machine to do the work required is often so much more apparent than any other that the proper handling of the machine and the failure to anticipate mechanical department needs are quite often lost sight of in the haste of those affected to "get under cover."

A little more mechanical knowledge in the operating department would aid the mechanical department and a great many failures which do not primarily belong to the mechanical department, but which in the end lodge at its feet, due to the final result being looked at and the causes which led up to it being overlooked, would be thoroughly understood and much unnecessary friction avoided. A little more interest of the mechanical department taken in the operating problems will tend to do away with the ancient worship of the machine and the consequent forgetting of what the machine was primarily designed for. This will help the other departments. It is complained that mechanical men cannot put themselves in the place of the other departments. Possibly a lack of opportunity to look the other side of the fence has made them self-centered.

It would seem that there is going to be as great a demand for mechanical talent in the future as in the past. The development of large railway shops and modern methods will certainly call for the best that is to be had and the best will be none too good to meet the problems before them. I think I do not misjudge the present conditions when I say that there are none too many good mechanical men in the field at present. It would seem to me that some outlet near the top of the mechanical department system would have to be provided in order to get the needed new blood in at the bottom and thus avoid stagnation at the top. Helping the mechanical department and at the same time getting mechanical knowledge more generally throughout the working system of the railway are not the only points to be gained by a more general recognition of the mechanical department in the higher field of railway work. Greater rewards will naturally call more men into the mechanical field, which is to be desired.

At present it is quite difficult in some cases for railroads to fill their special apprentice lists with satisfactory men, the time is so long and the compensation so slight at starting that many do not wish or cannot afford to bind themselves for a period of three years for what the mechanical department of an average railroad has to offer as compared with other lines of business. It would seem to a certain extent, as far as final results are concerned, time wasted for a man to undertake to fit himself for a railway mechanical position and to go through the necessary apprenticeship lasting until he is in some cases from 28 to 30 years of age before he holds anything but student positions. The same amount of energy and endurance applied to other than the railway mechanical field ought to bring greater returns. Something should be done to make railway mechanical work a more attractive proposition, either by a more general recognition of the mechanical department in selecting the higher operating officials or by raising the compensation of the mechanical officer to a figure which is commensurate with that paid by manufacturing enterprises of the same magnitude. The latter plan would contemplate the mechanical man staying in that department, which he would be willing to do if the dignity of the department were increased by proper compensation. I would think the former method would be conducive to better results.

Only by some such changes as above suggested will mechanical *possibilities* become mechanical *probabilities*. Many will agree that the field for railway mechanical work is not an attractive one at present.



MALLET COMPOUND LOCOMOTIVE—LOW PRESSURE CYLINDER.

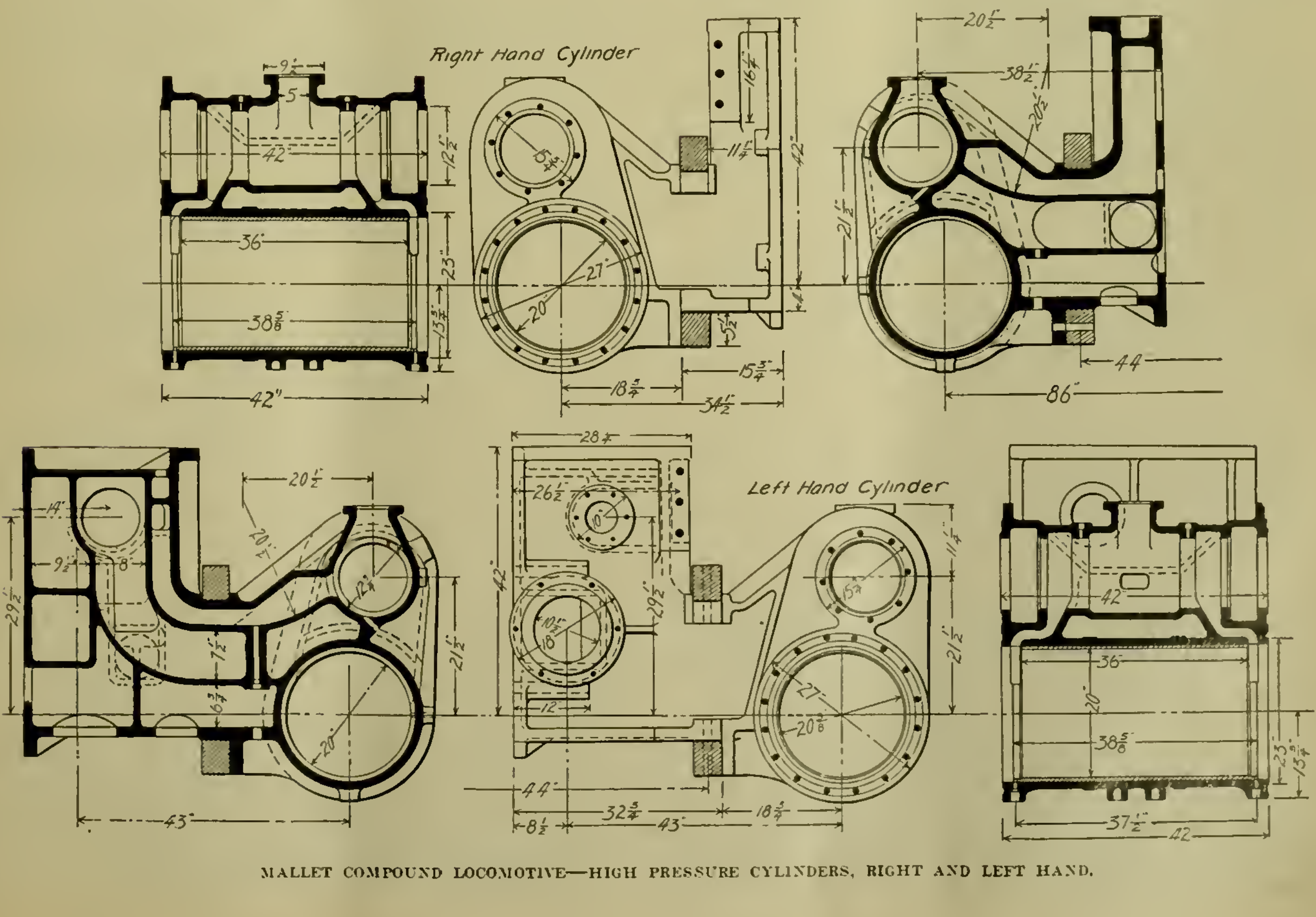
MALLET COMPOUND LOCOMOTIVE—0-6-6-0 TYPE.

Baltimore & Ohio Railroad.

ADDITIONAL DETAILS.

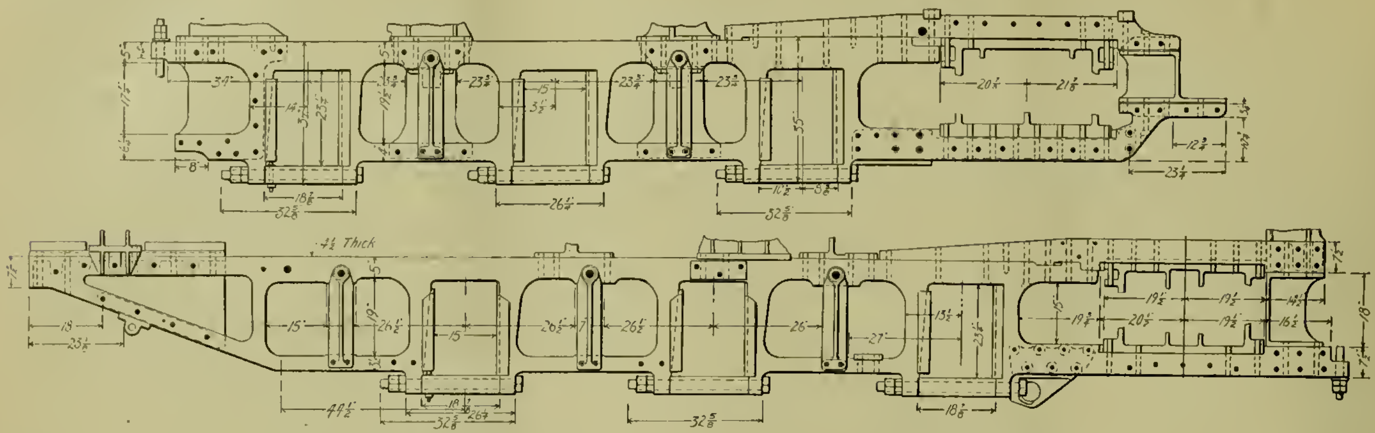
Supplementing the description of this locomotive (American Engineer, current volume, pages 167, 237 and 262) some of the most important details are now presented. These include the cylinders, frames and the long receiver pipe connecting the high and low pressure cylinders. While the power of this locomotive is very great, the individual parts, except the boiler, are not excessively large. This is indicated in the drawings of the cylinders and frames. This fact is one of the important features of this form of locomotive development for large and powerful units. It involves the principle of dividing the work among a large number of parts as distinguished from obtaining the increased capacity by a mere increase in size of the parts. If no improvement in economical operation was to be expected this principle of dividing the work would constitute a sufficient advantage to justify the Mallet type for large freight locomotives.

Several problems were encountered in the cylinder and re-

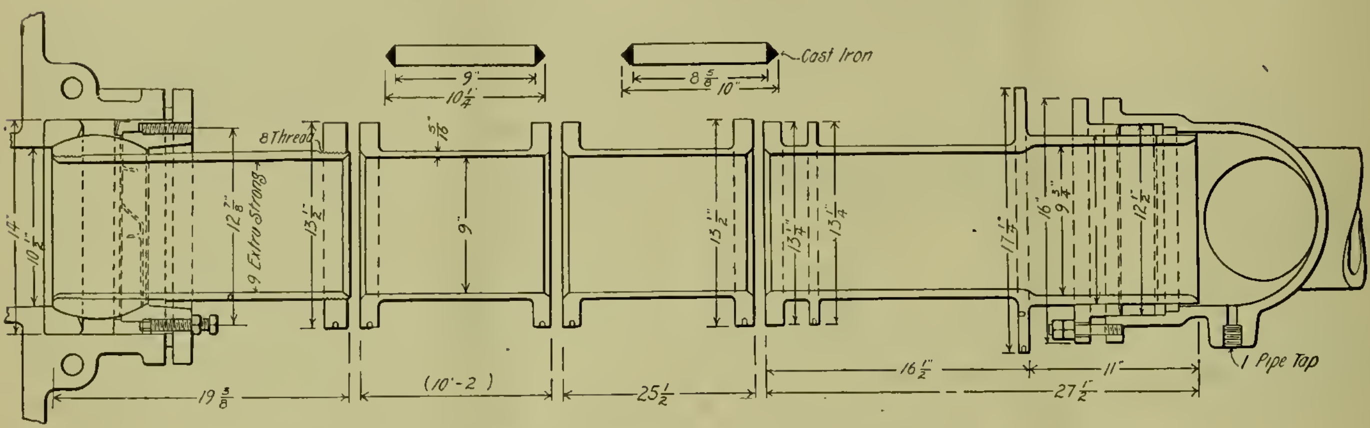


MALLET COMPOUND LOCOMOTIVE—HIGH PRESSURE CYLINDERS, RIGHT AND LEFT HAND.

ceiver construction. Because of the necessity for providing a tight joint for the receiver pipe, the high pressure cylinders do not part midway between the frames, and are therefore not alike, the pipe joint being at one side of the centre. Bushings are provided for all cylinders. The receiver pipe is of steel, lap welded, with welded flanges. It has a ball joint, with cast iron rings at the back and a slip joint at the front end. Thus far these joints have remained perfectly tight.



MALLET COMPOUND LOCOMOTIVE—DETAIL OF MAIN FRAMES, FRONT AND BACK.



MALLET COMPOUND LOCOMOTIVE—RECEIVER PIPE, WITH SLIP AND BALL JOINTS.

PERSONALS.

Mr. Frank N. Hibbits has resigned as consulting mechanical engineer of the Southern Railway to accept the position of mechanical superintendent of the New York, New Haven & Hartford Railroad, with headquarters at New Haven, Conn., to succeed Mr. John Henney, superintendent of motive power, resigned.

Mr. F. T. Hyndman has been appointed superintendent of motive power of the Buffalo, Rochester & Pittsburg Railroad, to succeed Mr. Charles E. Turner, who has resigned. Mr. Hyndman's headquarters will be at Du Bois, Pa.

Mr. John Henney, who has for many years held the position of superintendent of motive power of the New York, New Haven & Hartford Railroad, has resigned to take a well-earned rest, and he will probably take an extended trip to Europe.

Mr. Charles E. Turner has resigned as superintendent of motive power of the Buffalo, Rochester & Pittsburg Railroad. He has held that position for nearly 10 years, and during this time has brought the condition of the motive power and car equipment of this road up to the highest standard.

Mr. C. W. Osborn has been appointed foreman of shops of the Chicago & North Western Railway at Fond du Lac, Wis. Mr. Osborn began service with this road as a special apprentice, and his advance to this position is a result of ability combined with hard and faithful work.

Mr. R. F. Hoffman has been appointed assistant to the general superintendent of motive power of the Frisco system, with headquarters at St. Louis, Mo.

Mr. B. D. Lockwood has been appointed mechanical engineer of the Cleveland, Cincinnati, Chicago & St. Louis Railway, to succeed Mr. R. L. Ettinger.

Mr. J. H. Wynne has been appointed mechanical engineer of the Illinois Central Railroad to succeed Mr. C. A. Strom.

Mr. R. L. Ettinger has resigned as mechanical engineer of the Cleveland, Cincinnati, Chicago & St. Louis, to succeed Mr. F. N. Hibbits as consulting mechanical engineer of the Southern Railway, with headquarters in Washington.

Mr. Theo. N. Ely, chief of motive power of the Pennsylvania Railroad, has been honored by receiving from Hamilton College the degree of Doctor of Science. He was graduated from Rensselaer Polytechnic Institute with the degree of Civil Engineer, and was honored by Yale University with the degree of Master of Arts.

Mr. George Westinghouse—"He has made a chain of world-encircling industries. Presumably he is proud of it, and he has a right to be. No other man has done this thing. It is an achievement imperial in its scope. It may be asked from what special achievement he derives most satisfaction. It is a natural question, and one night he made a remark which may be taken as the answer to it: 'If some day they say of me that with the air brake I contributed something to civilization, something to the safety of human life, it will be sufficient.'"—*Arthur Warren, in the New York Times.*

SHOP EQUIPMENT.

BY WILLIAM S. COZAD, NORFOLK & WESTERN RAILWAY.

In a certain shop repairing several hundred engines per year it requires four men an hour each to get a pair of driving-wheels into the lathe, which is no fault of the men, but a lack of proper facilities for doing the work. This shop has a very large air compressor, but no air jack is provided to handle these wheels.

In another small shop wheels are rolled in on the main track, picked up by an air hoist, dropped into the machine and chucked in twenty-five minutes. The machine man and one helper do the work after the wheels are rolled into the shop.

A certain new car shop, just completed, has a transfer table operated by an air engine. This apparatus has eccentrics, cranks, handles, link motion, and about everything else except the necessary machinery to stop it at the precise point. It contains a storage drum which must be charged at the end of each transfer every time the table is used. This is a great improvement over the old method of handling the table by hand, but an electric motor would cut the present time in two. No time would be lost in charging the tank nor in stopping at the right place, but the table would always be ready to put in motion.

A very large number of the turntables used at present are still operated by hand, and no one not in actual touch with the work can form much idea how expensive and unsatisfactory this method is. At the Norfolk & Western shops in Roanoke, Va., which handle 70 to 80 engines per month, the turntable was, until a year ago, operated by hand. This required three to four laborers to turn a heavy engine, and in winter we would often have to call out as many as a dozen men. This not only cost the company the time of the men directly engaged, but usually caused delay to a large force in the shop. The table is now equipped with an electric motor and will transfer an engine in two minutes.

Another shop, not far away, handles a large number of engines on an old-fashioned transfer table operated by gear wheels and cranks. Suppose that four men can operate this table under all conditions. To get an engine out, transfer and "pinch" it in on another pit or onto the main track will require at least one hour, or a total of four hours for the men operating the table. Every man working on that engine will lose, as a rule, the time which it takes to transfer it. At least two mechanics and two helpers work on the same engine at the same time. Now figure transfer men at 15 cents per hour, machinists at 30 cents, machinist helpers at 20 cents, and the total cost per transfer is $1.60. If the shop overhauls 30 engines per month each engine must be handled at least twice, making a total of $96 per month for transfers, or $1,152 per year, not counting a great deal of other work handled in this way.

Shop machinery in many of the old shops is not located with reference to the work to be done. I visited a shop lately where crossheads are fitted in one end of the shop and pistons in the other, with the result that crossheads go first to one place to be taken apart, then to another to have the piston rods fitted, and to another to have wrist pins tried, and still to another point to have shoe bolts fitted, then back to be put together. Rods are overhauled in one end of the machine shop, and about as far away from the erecting shop as it is possible to get, and rod brasses are bored and shaped in the other end, which requires unnecessary handling of material, a great loss of time by both mechanics and foremen, and usually a general misunderstanding among all concerned. Driving box brasses are turned at one end of the shop, shaped at another point, put into boxes in another place and bored at another point, and for want of a press, helpers drive out all old brasses with a sledge.

In the blacksmith department of a certain shop two forges were occupied in dressing and tempering tools for machine shop use. One smith was forging heavy tools. He put one tool into the fire, got it hot, then ran 20 yards to the nearest hammer to forge it. Occasionally some one a little closer would step in ahead of him, he would lose the heat, and the same performance would be gone over again. The helper was also in evidence, standing idle both at the fire and at the hammer. In this shop there is no doubt tool work enough to keep one hammer constantly employed, which, in connection with good heating facilities, would effect a saving sufficient to pay for the hammer in a year or less.

The same department of another shop capable of turning out 10 engines per week has but one hammer. Some roundhouse work, road work and extra car work must be done in addition to the 10 engines. Another hammer in this shop would pay for itself in six months. A Bradley cushion hammer, or one of similar construction, has a capacity equal to at least four forges on properly classified work, but it is seldom that one is seen in a railroad shop.

Many of the old shops are still lifting engines off their wheels with hydraulic jacks. This requires three or four men from two or three hours to a day or two, depending entirely on the condition of the jacks. Usually when a heavy engine is about half way up, one or more of the jacks fail and repairs must be made. Four pneumatic telescope jacks would accomplish this same work in about 30 minutes with proper air pressure. Engines lifted off the wheels with jacks are often left high in the air, thus requiring men to work on them with the bottom of the frame as high as their heads. This destroys about one-half the capacity of the workman. If he works on a scaffald one-half his energy will be required to maintain his position while the other half is applied to his work.

In a shop employing two or three hundred men I found no tool room. There was no space for a tool room inside the shop. At another place I found what was called a tool room in which were a few old, antiquated machines used to keep up the tools, but entirely unfit for the work assigned to them. The men were very intelligent and courteous and apologized for the condition by saying it was the best they were able to get.

I saw recently an old truck wheel lathe with a bed twice as long and large as necessary to support its other parts in use in a shop maintaining the repairs on 700 engines. The capacity of that machine was one pair of wheels per day. Much of this work, therefore, had to be done on driving-wheel lathes, where, on account of difficulty in chucking, two or three pairs of wheels were a day's work. A modern lathe would turn out seven pairs of wheels per day. Suppose five pairs the average per day. On the old machine this work would require five days at a cost of $10 for labor, allowing 20 cents per hour. The same work on a new machine would require one day, a net saving to the company of $8 per day, besides the use of the machine for the extra four days. A new machine here would pay for itself in 12 months and also pay the operator.

Knuckle joint pins cost for forging about 20 cents and for turning on an ordinary lathe 35 cents each, a total of 55 cents. On the modern turret lathe these pins can be made from the rough bar for 16 cents each, excluding fitting. Wrist pins forged and turned complete in the old way cost about 75 cents each; on a modern turret lathe they would cost about 20 cents each, fitting excluded. Knuckle joint pins, lift shaft and all similar bushings cost 15 to 20 cents each when forged in the blacksmith shop, yet on a modern lathe they can be cut from steel tubing at a cost of about one cent each and bored and turned for much less than if forged. These differences will hold good on all work for which these lathes are adapted, and any repair shop having work of this kind in sufficient quantity to keep one or more of these machines occupied will find they will pay for themselves every 12 months in the saving effected.

Every railroad shop has a labor or roustabout gang, and in this department there is usually the greatest leak compared to the amount of money invested to be found in any part of the plant. For instance, in a shop on one of the largest roads in the country many hundred pairs of car wheels are loaded every year. A car is placed at the end of a long straight track and two timbers are laid, one end on the car and the other on the ground at end of track from which wheels are to be taken. Then with two men on the car and two or three at points along the line, a pair of wheels are started and delivered from man to man until they are landed on the car at a speed of about 20 miles per hour. This requires from two or three hours to half a day, depending on the time required to place and remove this apparatus and the number of wheels that get away. A pneumatic hoist placed in the center of the track would lift the wheels and place them on two short pieces of rail, whence they could be rolled onto the car in the shortest possible time. This would require two men 30 or 40 minutes to load a car at a cost depending on the day rate of the men involved.

I was connected with a plant some time ago where it cost 11 cents each to unload pressed steel car bolsters and about four cents more to reload and get them into the erecting shop, total 15 cents. This company used several hundred of these bolsters every year, and a few dollars invested in crane facilities would have reduced the cost of handling to about two cents each; the crane would also have been very useful for other work.

A great many blacksmith shops are still heading bolts on old, antiquated machinery in connection with coke furnaces (and I suppose a coke furnace is good enough for that kind of a machine) at a cost of from 25 cents to 40 cents per 100 for ¾ to 1-in. bolts, while a few other shops have put in up-to-date machines and oil furnaces and reduced the cost of this work to about $1 per 1,000 bolts.

Conclusions.

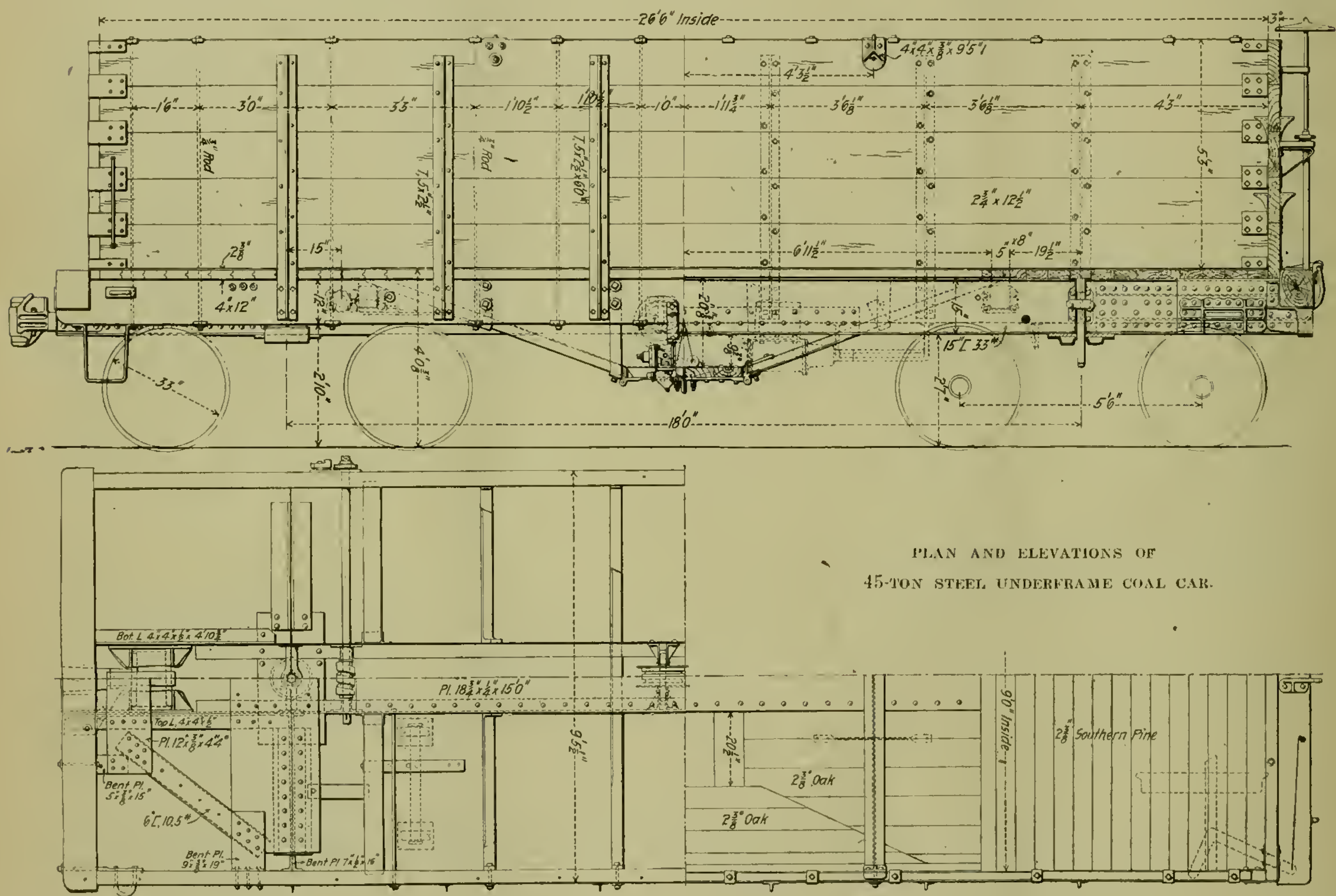
1. The average railroad shop is at the rear of the procession so far as modern facilities for turning out work are concerned.

2. If motive power is in demand and it is necessary to reduce the time of engines in the shop to the minimum and utilize shop space to the best advantage, such machinery must be put into the shop as will perform the work in a reasonable length of time.

3. It is sheer nonsense to expect a foreman to turn out any definite amount of work on worn-out machinery; to utilize high-speed steel to best advantage on machines that have been in use 25 or 30 years.

4. A repair shop can not be put on a commercial basis unless modern machinery and modern methods are used, and until this is done it must be remembered that where little is given little should be required. It is always possible to improve shop methods, but there is a point beyond which we can not go, and if few of the shops at present pay a dividend on the money invested it is not particularly on account of poor methods, but surely on account of the large number of old machines in use.

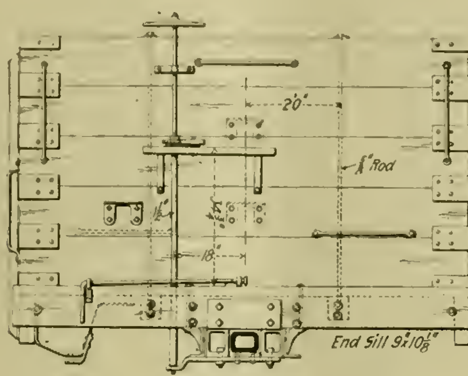
Let the superintendent of motive power who may read this article ask for a statement of the number of lathes, planers, drill presses, boring mills, etc., that have been in constant use in his shops for the last 15 or 20 years and note the result. I saw such a list recently which had been compiled by the foreman of a large shop and over 60 per cent. of the machinery in that shop had been in constant use 15 to 20 years, some of it much longer. If these machines were not affected by wear they would still be run at a loss because of the great improvement in construction of shop machinery in the past five or six years. We formerly used chilled cast iron cutting tools for many classes of work, but since the self-hardening steels came out we do not use these tools, but we do try to use the same old machines. There is nothing that seems to get quite so close to the heart of a railroad company as an old machine. When one of these relics become so worn that it is entirely unfit for service in one shop, it is repaired and sent to some outlying point to take up valuable room for another 10 or 20 years. Another important point to be considered is the marked effect such tools have on the workmen in the shop. Men make shop conditions, and in time these same conditions make other men to a greater or less degree; and as long as a lot of old, antiquated machinery is kept running in the shop and other conditions correspond, we shall not get the benefit of the best efforts of the men employed. As a general proposition men do not rise above their surroundings. Like begets like; and as the conditions and facilities for doing work are improved, the interest of the men in the general welfare of the company will grow accordingly.

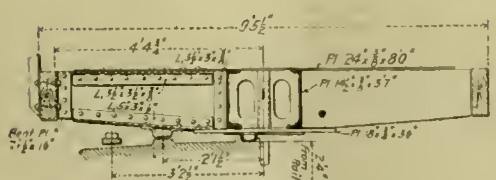


PLAN AND ELEVATIONS OF 45-TON STEEL UNDERFRAME COAL CAR.

45-TON STEEL UNDERFRAME COAL CAR.

Through the courtesy of Mr. George I. King, drawings and a photograph of a 45 ton coal car with structural steel underframe have been received. This design was prepared for the Bulah Coal Company, and the cars were built by the Middletown Car Works. The car is similar to the Class G x cars of the Pennsylvania Railroad. It is mounted on Pennsylvania Railroad standard 50-ton arch bar trucks and is fitted with the new centre construction designed by Mr. King. Its light weight is 35,700 lbs. with these heavy trucks, which were selected in order to avoid excessive wheel failures, which have become troublesome in connection with large capacity cars. At the same time the trucks will be invaluable for cars of larger capacity should they be needed for this purpose. For the 4 by 10 in. side sills of the Pennsylvania cars, Mr. King substituted





4 by 12 in. sills, and for the pressed steel stakes rolled steel tees.

Mr. King has developed the end construction of the steel underframes, which is indicated in the drawings. The centre sills are of 15-in. channels and terminate 2 ft. beyond the bolsters. From these points riveted extensions are provided, to continue the centre sills, carry the draft gear and support the end sills, which are of wood. The connections to the end sills are made with large steel castings, giving ample bearing surface and including the coupler carry iron. This construction facilitates repairs in case of damage to the end of the sills without taking down the entire sill. A cover plate is placed over the centre sills between the bolsters, and the bolsters are of diaphragm form, riveted to the center sills. The drawing gives the sizes of the angles and thicknesses of plate used. At the corners of the car are substantial channel braces extending between the top cover plate of the bolsters, enlarged for this purpose, and a 2-in. plate riveted across the ends of the extensions of the centre sills. This plate is 44 ins. long. The form of the hopper and its construction are shown in the drawing.

LOCOMOTIVE TESTING PLANT AT ST. LOUIS.

PENNSYLVANIA RAILROAD TESTING PLANT.

The Pennsylvania Railroad has issued Bulletin No. 3 concerning the tests to be made on the locomotive testing plant at St. Louis, from which the following is reproduced:

DESCRIPTION, DIMENSIONS AND PROPORTIONS.

DRIVING WHEELS.

1. Number of pair.........................
2. Approximate diameter, inches.........................
3. Measured circumference, feet, Right No. 1 ....
4. " " " " " 2.........................
5. " " " " " 3.........................
6. " " " " " 4.........................
7. " " " " " 5.........................
8. " " " Left " 1.........................
9. " " " " " 2.........................
10. " " " " " 3.........................
11. " " " " " 4.........................
12. " " " " " 5.........................
13. Average " "

ENGINE TRUCK WHEELS.

14. Number ....
15. Diameter, inches.........................

TRAILING WHEELS.

16. Diameter, inches.........................

WHEEL BASE.

17. Driving wheel base, in feet.........................
18. Total wheel base, in feet.........................
19. Gage of wheels, in inches.........................

WEIGHT OF ENGINE, POUNDS.

(With water at second gage cock and normal fire.)

20. On truck ....
21. On first drivers.........................
22. On second drivers.........................
23. On third drivers.........................
24. On fourth drivers.........................
25. On fifth drivers.........................
26. On trailers.........................
27. Total ....
28. Total on drivers.........................

45-TON STEEL UNDERFRAME COAL CAR.

CYLINDERS.

29. High pressure, number.........................
30. Low pressure, number.........................
31. Arrangement ....
32. Diameter, inches, high pressure, right.........................
33. Diameter, inches, high pressure, left.........................
34. Diameter, inches, low pressure, right.........................
35. Diameter, inches, low pressure, left.........................

STROKE OF PISTON, FEET.

36. High pressure, right.........................
37. High pressure, left.........................
38. Low pressure, right.........................
39. Low pressure, left.........................

CLEARANCE, PER CENT. OF PISTON DISPLACEMENT.

40. High pressure, right, head end.........................
41. High pressure, right, crank end.........................
42. High pressure, left, head end.........................
43. High pressure, left, crank end.........................
44. Low pressure, right, head end.........................
45. Low pressure, right, crank end.........................
46. Low pressure, left, head end.........................
47. Low pressure, left, crank end.........................

RECEIVER, CUBIC FEET.

48. Volume, right side.........................
49. Volume, left side.........................

STEAM PORTS, INCHES.

(For piston valves the length equals the circumference of inside of bushing, minus the sum of the widths of bridges.)

50. High pressure admission, right, head end, length.........................
51. High pressure admission, right, head end, width.........................
52. High pressure admission, right, crank end, length.........................
53. High pressure admission, right, crank end, width.........................
54. High pressure admission, left, head end, length.........................
55. High pressure admission, left, head end, width.........................
56. High pressure admission, left, crank end, length.........................
57. High pressure admission, left, crank end, width.........................
58. Low pressure admission, right, head end, width.........................
59. Low pressure admission, right, head end, width.........................
60. Low pressure admission, right, crank end, length.........................
61. Low pressure admission, right, crank end, width.........................
62. Low pressure admission, left, head end, length.........................
63. Low pressure admission, left, head end, width.........................
64. Low pressure admission, left, crank end, length.........................
65. Low pressure admission, left, crank end, width.........................
66. High pressure exhaust, right, length.........................

67. High pressure exhaust, right, width........................
68. High pressure exhaust, left, length........................
69. High pressure exhaust, left, width........................
70. Low pressure exhaust, right, length........................
71. Low pressure exhaust, right, width........................
72. Low pressure exhaust, left, length........................
73. Low pressure exhaust, left, width........................

PISTON RODS, DIAMETER, INCHES.

74. High pressure, right........................
75. High pressure, left........................
76. Low pressure, right........................
77. Low pressure, left........................

TAIL RODS, DIAMETER, INCHES.

78. High pressure, right........................
79. High pressure, left........................
80. Low pressure, right........................
81. Low pressure, left........................

VALVES.

82. Type ....
83. Design ....
84. Balanced area in per cent of total........................
85. Type of link motion........................

GREATEST VALVE TRAVEL, INCHES.

86. High pressure, right........................
87. High pressure, left........................
88. Low pressure, right........................
89. Low pressure, left........................

OUTSIDE LAP OF VALVE, INCHES.

90. High pressure, right, head end........................
91. High pressure, right, crank end........................
92. High pressure, left, head end........................
93. High pressure, left, crank end........................
94. Low pressure, right, head end........................
95. Low pressure, right, crank end........................
96. Low pressure, left, head end........................
97. Low pressure, left, crank end........................

INSIDE LAP OF VALVE, INCHES.

98. High pressure, right, head end........................
99. High pressure, right, crank end........................
100. High pressure, left, head end........................
101. High pressure, left, crank end........................
102. Low pressure, right, head end........................
103. Low pressure, right, crank end........................
104. Low pressure, left, head end........................
105. Low pressure, left, crank end........................

MISCELLANEOUS.

106. Cylinder lagging, material........................
107. Cylinder jacket, material........................

BOILER.

113. Type ....
114. Outside diameter, first ring, inches........................

TUBES.

115. Number ....
116. Outside diameter, inches........................
117. Thickness, inches........................
118. Length between tube sheets, inches........................
119. Total fire area, square feet........................
120. Serve tubes, number of ribs........................
121. Serve tubes, square inches of inside surface in one inch of length..

SUPERHEATER.

125. Number of tubes........................
126. Outside diameter, inches........................
127. Thickness, inches........................
128. Length of tubes, inches........................

FIREBOX, INSIDE.

132. Length ....inches........................
133. Width ....inches........................
134. Depth, front end........................inches........................
135. Depth, back end........................inches........................
136. Volume ....cubic feet........................

FIRE DOORS.

141. Number ....
142. Area, square feet........................

GRATES.

144. Style ....
145. Total area, square feet........................
146. Total area, dead grates, square feet........................
147. Width of air spaces, inches........................

AIR INLETS.

148. Through firebox sides........................Square feet
149. Through grates........................Square feet
150. Through fire doors........................Square feet
151. Total air inlets, No. 148, No. 149 and No. 150..........Square feet
152. Ratio air inlets (No. 149) to grate area (No. 145)..............
153. Ratio air inlets (No. 151) to grate area (No. 145)..............

HEATING SURFACE, SQUARE FEET.

154. Of the tubes, water side........................
155. Of the tubes, fire side........................
156. Of the firebox, fire side........................
157. Of the superheater, fire side........................
158. Total, based on inside of firebox and inside of tubes..............
159. Total, based on inside of firebox and outside of tubes..............

BOILER VOLUMES.

(With water surface at level of second gage cock.)

160. Water space, cubic feet........................
161. Steam space, cubic feet........................

EXHAUST NOZZLE.

162. Double or single........................
163. Dimensions of right side, inches........................
164. Dimensions of left side, inches........................
165. Area of right side, square inches........................
166. Area of left side, square inches........................
167. Total area, left side........................

REVERSE LEVER.

168. High pressure cylinder, notches forward of center..............
169. Low pressure cylinder, notches forward of center..............

RATIOS.

171. Heating surface (No. 158) to grate area (No. 145)..............
172. Fire area through tubes (No. 119) to grate area (No. 145)......
173. Firebox heating surface (No. 156) to grate area (No. 145).......
174. Tube surface (No. 155) to firebox heating surface (No. 156).....
175. Firebox volume (No. 136) to grate area (No. 145)..............

CONSTANTS.

179. For dynamometer horse-power (power developed when the speed is one r.p.m. and the pull is one pound)........................
For indicated horse-power (power developed at one r.p.m. and one pound m.e.p.)........................
180. High pressure cylinder, right, head end........................
181. High pressure cylinder, right, crank end........................
182. High pressure cylinder, left, head end........................
183. High pressure cylinder, left, crank end........................
184. Low pressure cylinder, right, head end........................
185. Low pressure cylinder, left, crank end........................
186. Low pressure cylinder, left, head end........................
187. Low pressure cylinder, left, crank end........................

FOR PISTON DISPLACEMENT, CUBIC FEET.

188. High pressure cylinder, right, head end........................
189. High pressure cylinder, right, crank end........................
190. High pressure cylinder, left, head end........................
191. High pressure cylinder, left, crank end........................
192. Low pressure cylinder, right, head end........................
193. Low pressure cylinder right, crank end........................
194. Low pressure cylinder, left, head end........................
195. Low pressure cylinder, left, crank end........................

The numbered blank spaces are provided so that information concerning unusual features of the locomotive under test may be inserted. The dimensions and constants will be given for each locomotive tested, the observed data and calculated results for each test. There will be from 14 to 20 tests on each locomotive.

The method for obtaining the dimensions and data given is in most cases self-evident; but that these may be clearly understood, and also to show the precautions taken to insure accuracy, the following are deemed sufficiently important to require special mention:

DESCRIPTION, DIMENSIONS AND PROPORTIONS.

Items Nos. 3 to 13. The circumference of the driving wheels will be measured with a flexible steel tape, divided in feet and hundredths of a foot. The circumference will be taken at the point where the driver would rest on the rail. The gage of track being 4 ft. 8½ ins. and the width of the rail head being 2¼ ins., the distance between the circumferences to be measured is 4 ft. 10¾ ins.

Items Nos. 20 to 28. As there is no scale at St. Louis with sufficient capacity to weigh many of the locomotives which are to be tested, the locomotives will be weighed at the most convenient point by a member of the testing force, although in some cases it may be necessary to take the builders' weights of the engine in working order.

Items Nos. 32 to 35. The diameters of cylinders will be taken with an inside micrometer caliper, at the head end, crank end and middle of the bore of the cylinder. These three locations in the cylinder will be measured with the calipers in a vertical position, and also in a horizontal position; the diameter given being an average of the six measurements obtained in this manner.

Items Nos. 36 to 39. The locomotive being set on one of its dead centres, the distance from some convenient point on the guides or cylinder to some point horizontally in line on the crosshead or piston rod will be measured. A similar measurement will then be taken between the same two points with the locomotive on the other dead centre. The difference between these two measurements in feet will give the stroke.

Items Nos. 40 to 47. The volume of clearance will be obtained by placing the locomotive on the dead center and filling the clearance space with water from a vessel holding a known weight of water. The water remaining in the vessel will be weighed and the rate of leakage from the clearance space observed. From these data the volume of the clearance space can be readily calculated, and 100 times this volume, divided by the volume of piston displacement, will be the result desired. As a check, the clearances will be calculated from measured dimensions and working drawings, but preference will be given to the results obtained by the use of water.

With piston valve engines it will be necessary to place the valve so that it will block the steam port; a tell-tale hole being provided to allow the escape of air and to show the height of the water. By removing a cylinder cock, and using a hand pump, the water may be forced in from below, and the amount ascertained.

Items Nos. 48 to 49. The receiver volumes will be ascertained if practicable in the same manner as the volume of clearances.

Items Nos. 50 to 73. The length of the steam and exhaust ports given will not be the actual length, but will be such a dimension that, multiplied by the actual width, will give the actual area of the port. The measurements are given in this way to allow for the rounded corners usually found in cylinder ports.

Items Nos. 74 to 81. The piston rods and tail rods will be measured at several points by a micrometer caliper. The diameter given for each rod will be the average of all measurements.

Item No. 84. The balanced area of the valve will be the product of the dimensions to inside edges of balance strips or rings; the total area that of the entire face of valve.

Items Nos. 86 to 89. The greatest valve travel will be obtained with the reverse lever in full gear forward, by scribing the valve rod and measuring with a tram.

Items Nos. 90 to 105. The outside and inside laps will be calculated from measurements of valve and valve seat taken while hot, and their relative positions at centre of valve travel.

As a set of working drawings will be furnished, the chief purpose of these measurements will be to check the drawings.

Item No. 114. The outside diameter of the first or smallest ring of the boiler will be calculated from the circumference as measured with a flexible steel tape.

Items Nos. 116 and 117. As the thickness and outside diameter of tubes vary considerably after they have been in service, for nominal diameter and specified thickness will be taken.

Item No. 118. The length of tubes, between tube sheets, will be obtained by measuring the length over beads of a number of tubes well distributed and deducting the thickness of tube sheets and beads.

Item No. 119. The total fire area of tubes will be obtained by multiplying the area of cross section of inside of tube by the number of tubes.

Item No. 121. As a factor in obtaining the surface contour of the Serve tubes, a strip of adhesive tape will be pressed into the form of the ribs of the tube or a cast of the same. The length of this tape in inches will equal the square inches of surface in 1 in. of length.

Items Nos. 126 and 127. The dimensions of superheater tubes will be found in the same way as already described for boiler tubes.

Items Nos. 132 and 133. The length of the firebox will be measured at the level of the bottom of fire door, and parallel to line of rail, the width being the horizontal distance between side sheets at mid-length.

Items Nos. 134 and 135. The depth of firebox will be the measured distance (perpendicular to the rail) from grate surface to crown sheet at front and at back of firebox.

Item No. 136. The volume of firebox will be calculated from dimensions of the firebox above the surface of the grates, and checked from the drawings.

Item No. 147. The width of the air spaces in grates will be, with bar grates, the actual width of the openings; with finger grates, the maximum opening.

Item No. 149. The area of the air inlets through the grates will be calculated from drawings known to correctly show the grates.

Item No. 150. The air inlet area through fire doors will be the area of dampers or holes in fire door, when dampers are open as far as possible.

Item No. 154. The heating surface of the water side of the tubes will be obtained by multiplying the circumference of the outside of tube, in feet, by the length between tube sheets, in feet, and by the number of tubes.

Item No. 155. The heating surface of the fire side of the tube is to be obtained in a similar manner to Item No. 154, except that the internal diameter of the tube will be used. In the case of Serve tubes the length over the ribs (No. 121) divided by 12 is the circumference in feet.

Item No. 156. The heating surface of the firebox is the area calculated from measurements of the firebox sheets, above the level of the grates, less the total fire area of the tubes (No. 119), the area of fire doors (No. 142), and the area of air inlets through sides of firebox (No. 148).

Item No. 157. In the heating surface of superheater will be included any headers, etc., which may form a part of the true superheating surface.

Items Nos. 158 and 159. The heating surface of the superheater, for a locomotive so equipped, is included in these items; using the fire sides of tubes and headers. The heating surface, based on the fire side, will be used in all calculations in these tests.

(To be continued.)

THE APPLICATION OF INDIVIDUAL MOTOR DRIVES TO OLD MACHINE TOOLS.

BY R. V. WRIGHT.

McKees Rocks Shops.—Pittsburg & Lake Erie Railroad.

XIII.

MISCELLANEOUS TOOLS.

This article presents some interesting but very simple motor applications which were made to a large punch and shear, a small punch and a slab milling machine.

Fig. 60 shows a motor application made to an old Hilles & Jones No. 3 punch and shears, which will punch a 1⅜-in. hole in 1-in. plate and will shear 1-in plate. The motor is, in this case, supported by a simple cast-iron bracket, which was designed to correspond to the contour of the frame and is firmly bolted to the frame of the tool. The speed cone which was used with the belt drive was removed and replaced by the larger Morse silent-chain sprocket. The motor is a Crocker-Wheeler 10I.-L.S.-C.C.M., which is capable of developing 10 h.p. at 240 volts. It is operated at a constant speed, and the tool runs at a rate of 25½ strokes per minute. The starting box is located on the panel board, which is placed close to the base of the tool just below the motor.

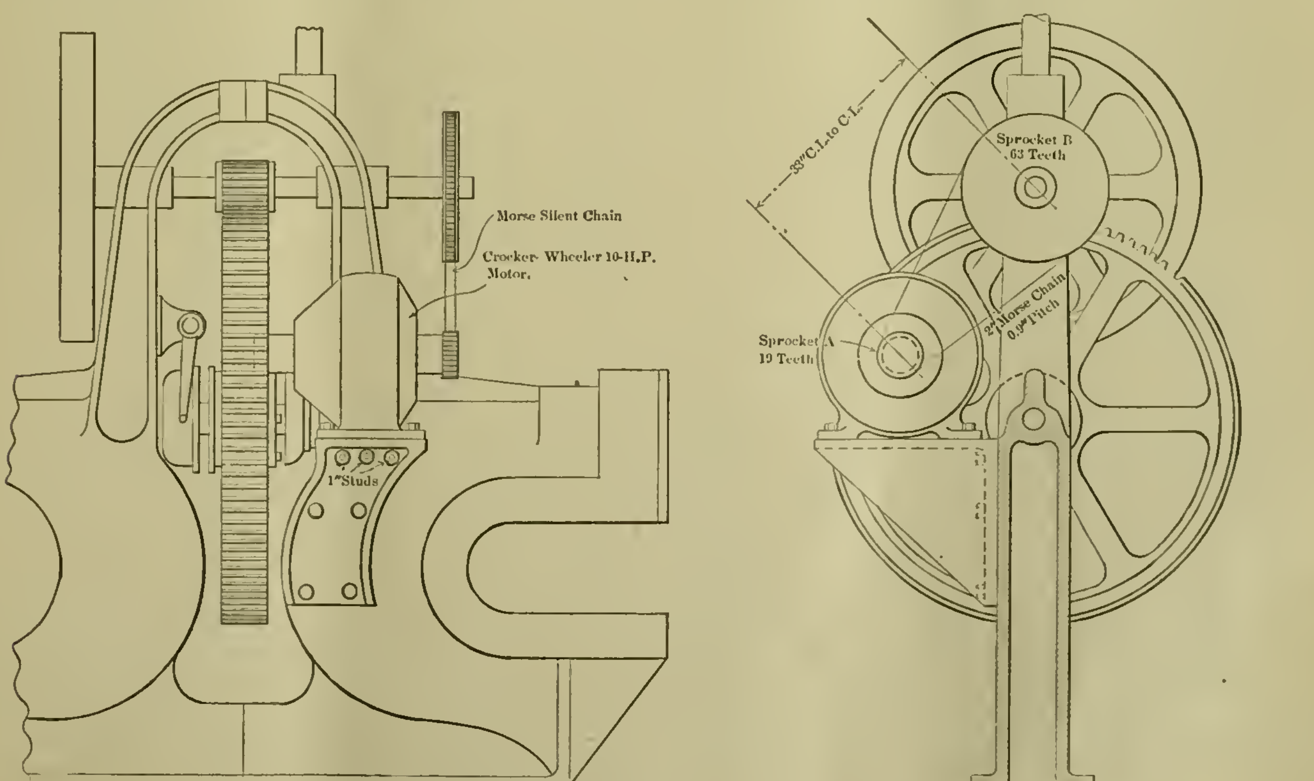


FIG. 60.—APPLICATION OF MOTOR DRIVE TO HILLES & JONES PUNCH AND SHEARS.

Fig. 61 illustrates the application of a motor to a small punch made by the Excelsior Machine and Cleveland Punch and Shear Company, which will punch a 13-16-in. hole in ⅜-in. plate. The motor is supported by two brackets of 1¼-in. x 4-in. wrought-iron bar; one end of each bracket is fastened to the floor by ⅝-in. lag screws, and the other end is bolted to the frame of the tool as shown. The belt speed cone was replaced by the large Morse silent-chain sprocket. The motor is a 5 h.p. type I.-L.S.-C.C.M. machine, which develops 5 h.p. at 240 volts. The tool runs at a speed of 39 strokes per minute. The starter is on the panel board, which is placed near the motor and close to the tool.

An application of a motor to a Sellers slab milling machine is shown in Fig. 62. With the belt drive a cone on shaft A was driven from a countershaft. Pulley C was merely an idler, and run loose on shaft B. The feeds were operated by a pulley, which was keyed to shaft B where the Morse silent-chain sprocket now is, and which was driven from a countershaft.

When the motor was applied the speed cone was removed from shaft A, and pulley C was keyed to shaft B. The pulley which operated the feed shaft B was replaced by the Morse silent-chain sprocket D and was driven from the motor by the Morse silent-chain as shown. The motor is a Crocker-Wheeler M.S.-C.M., which will develop 6½ h.p. at 240 volts. It is operated by a 40-M.F.21 controller, and the maximum speed of the tool is 75 revolutions per minute. The controller is bolted to the side of the housing on the side opposite the motor.

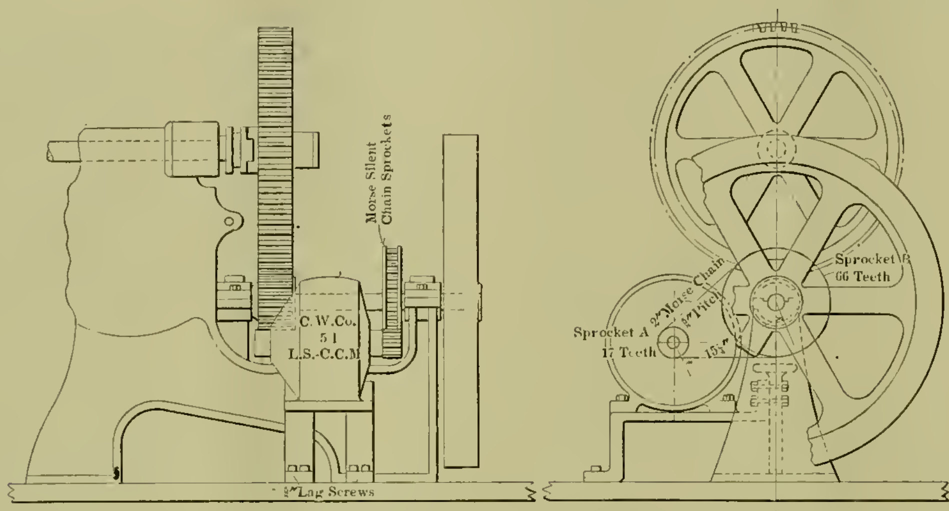


FIG. 61.—MOTOR DRIVE ON SMALL PUNCH.

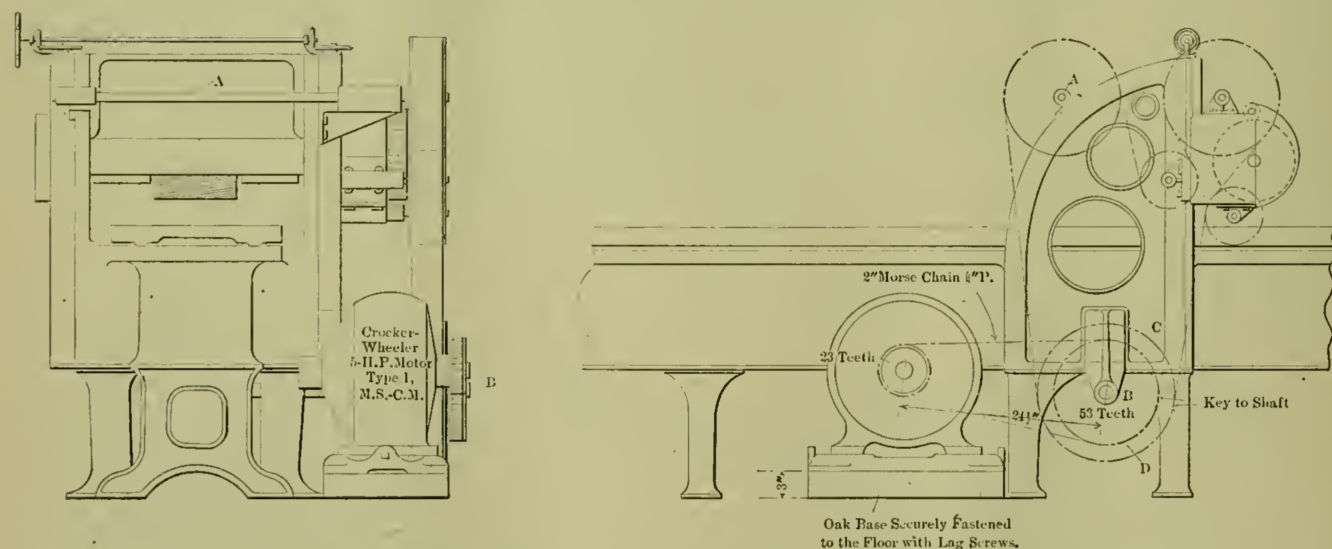


FIG. 62.—MOTOR DRIVE APPLIED TO SELLERS SLAB MILLER.

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

EDITORIAL CORRESPONDENCE.

(*Continued from page 265.*)

Crank axles are very common here because the prevailing types of locomotives for years have employed inside connected cylinders. The older and smaller engines do not work their axles severely enough to cause any anxiety because of cracks, but the heavier and more recent locomotives require very careful watching. Crank axles run from 200,000 to 300,000 miles without trouble, and then they are usually removed because of cracks which generally develop in the region of the junction of the crank pins and webs. When the rods are down the cracks are easily discovered and are closely watched for developments. Circular cracks around the crank pins or the body of the axle are not allowed to grow, and the axles are scrapped, but the other, or corner, cracks are sometimes allowed to advance as far as 1½ in. from the edge, providing the advance is not at a greater rate than about one-sixteenth inch per month. Twice this rate of advance is considered excessive and dangerous. These observations cover in a general way the practice of a number of roads. No one here seems to be in the least degree anxious about crank axles, but it is evident that they are most carefully inspected and conscientiously cared for. The older and smaller types of engines almost invariably have solid axles, with the cranks cut out of solid forged steel, but the advances in speed and power have compelled the construction of built up cranks. The limits to the solid crank axle have been reached. In the recent types of fast passenger engines built up construction is used. The webs and crank pins are pressed on, and this method is not only cheaper but it does not torture the material as does the bending in forged cranks. It also avoids the expensive cutting away of material of solid cranks. The built up axles, furthermore, provide some elasticity at the joints, which appears to relieve the structure from the local bending and tends to prevent localized flexures and consequent cracking. Some of the roads make their crank webs, pins and bodies of axles of different steels, having a touch of highly scientific metallurgy, which is guarded as a secret. There seems to be little in this, however. This subject is important to Americans just now because, whether they like them or not, crank axles are sure to be used in future American locomotive practice. It will be necessary for us to go into greater refinements in design of locomotives, and no one can study the locomotive in England, France and Germany without seeing the unquestionable advantages of the application to American practice of the principles which accompany the latest developments involving crank axles. We must get more power from the weights we use, and to do this we must inaugurate scientific designing. That this can not be avoided in justice to the locomotive, to the American traveling public and the owners of our railroads is one of the apparently important conclusions in this tour of study. This will be mentioned again. It is made prominent just at this point because so much centers in the crank axle.

In the frame construction of English engines an important feature of bracing stands out prominently. The deep and thin plate frames, usually ⅞ or 1 in. thick, tend to cover up the valve motion and render the vital parts of the running gear inaccessible. This does not appear attractive in any way. With the deep plate frame, however, very great vertical strength is secured, and the frames as a whole are not rigid against side stresses. It is customary to brace these frames admirably, and in exactly the way in which American frames are weakest. At the cylinders a deep brace is secured by the cylinder bolts. The motion plate which crosses between the frames and holds up the rear ends of the guides, is generally of cast steel, and is a girder as deep as the frames. A third deep brace or cast steel diaphragm crosses the frames back of the leading driving axle of a 2—6—0 engine, and under the front end of the firebox is another one, not quite as deep. These braces tie the frames together across the engine, but they do much more than that. Because of their depth they act as the diagonal braces of bridge trusses and prevent twisting of the frames. This is believed to be an important matter, and is just now receiving careful attention in the new freight engines of the Lake Shore, which have been illustrated in this journal. A rather close questioning of English officials did not discover any serious difficulties with frames on the larger types of engines which have gone into service during the past five or six years. We might advantageously apply this method of preventing twisting, due to heavy side stresses in entering and leaving curves, against which our frames are not in the least protected.

Trains in England are always light, relatively, to ours. A 500-ton passenger train is unknown, and a 1,000-ton freight train is unheard of on most roads. In fact, but one road was found having any trains of this weight. As a rule the track and bridges are not sufficient for engines capable of handling 1,000-ton freight trains. Freight service, therefore, except as to speed, offers little of interest. It is not so, however, with passenger service here, with 300 to 375 ton trains, running on schedules of 50 miles and over per hour. These trains carry many passengers, and more than ours of equal weight. This fact is commented upon elsewhere in this review. Foreign railroads are not "blessed" with passenger agents and the Pullman Company, with their influences in the direction of great weights of passenger equipments. Sleeping cars here are not in extensive use, and are not required on most runs. Those which are used are much lighter per passenger than ours. As a general statement, it is safe to say that the number of passengers carried by an American train of 600 tons would travel in an English train of about 200 tons. Of course this bears an important relation to the weight and capacity of locomotives. The delicate screw thread couplings of English "carriages" tell a story with respect to the locomotives, but these engines do wonderful work considering their weight and size.

The severest service in Great Britain is the London-Scotch traffic on the east and west coasts. On both sides of the island material advances were made in the capacity of locomotives about eight years ago. This was immediately met by an increase in the weights of cars and trains, and a recent advance in the locomotive has been again accompanied by increasing the requirements.

The severest service in Great Britain is on the Caledonian Railway. The train leaving Glasgow for Carlisle at 2 p. m. weighs 360 tons, back of the tender, not including passengers and baggage, and the corresponding train from Carlisle to Glasgow usually weighs 300 tons, the speeds ranging about 56 miles per hour. With lighter trains, weighing 200 tons behind the tender, this road makes runs averaging 59 miles per hour from Sterling to Perth, 33 miles, and from Forbar to Perth, 32 miles. This is done by engines weighing 116,908 lbs. The grades on this section are 2 miles of 59 ft. per mile; 2 miles of 65 ft. per mile, and 6 miles of 70 ft. An example of good work by a light engine is a recent performance of a 110,660-lb. engine in starting a train from Stonehaven to Dubton, with 6½ miles of an average grade of 170, this distance being made in 11½ minutes, with a minimum speed of 35 miles per hour, the train weighing 198 tons. This grade begins at the Stonehaven station. I could not secure figures for coal consumption for individual runs, except in terms of rough weights, which are not satisfactory. The firemen, however, are not overworked, though they must use great skill and must co-operate very carefully with the engineers in order to keep up steam pressures. The reversing quadrants on these engines are very finely divided, and the engines are carefully and scientifically handled. In the United States the advent of a new locomotive of increased power sometimes has the effect of discouraging the men who still run the lighter engines, and they fall back in their efforts to make time with the smaller engines. It is not so in Great Britain. I never have seen small and light engines worked as skillfully as these are. The men are expected to get the utmost out of the small and old engines. They certainly do it.

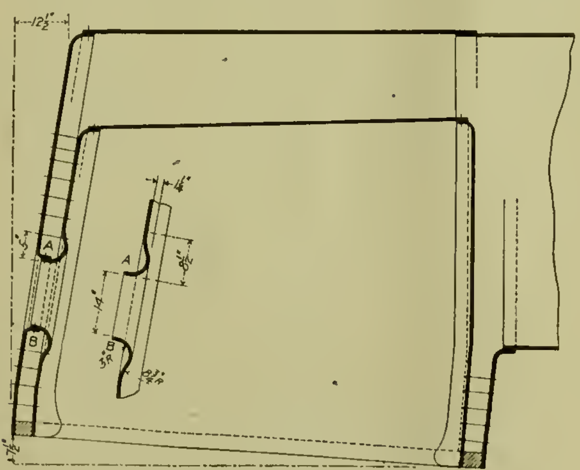
In England as in the United States the combination of technical education and practical experience is sought in providing succession in the office of locomotive superintendents, and it is becoming increasingly difficult for a man to rise from the ranks. This appears to many people as an unimportant matter, but it surely is important. In England in the early development of railroads, locomotives were always designed and built by locomotive building concerns. The responsibilities of locomotive superintendents began in operation and repairs. Occasionally a locomotive engineer was promoted to have charge of shops, and afterward advanced to the head of the department. This developed a type of strong, practical men, now represented by a few veterans whose standing as railroad officials and locomotive experts is very high. Naturally they became educated, though they are not necessarily classed as engineers. Some of these men stand for the most progressive methods in Great Britain to-day, although it can not be said that they are the only progressive ones.

About 35 years ago the roads began to build their own locomotives, and most of them supply their own wants to-day, both as to design and construction. This brought the drawing office into prominence, which is now a very important branch of the service. This change opened the way for the educated engineer. Occasionally one of these was appointed to take general charge of the department, and "practical" men were depended upon to look after operation. Now it is quite difficult, if not impossible, for the practical men to rise to the top, not for lack of ability, but of opportunity to show what they can do. Of course a single instance does not prove anything, but it is worth noting that in one case two roads were found running in conjunction and hauling through traffic. The road under the educated engineer has continued the use of light engines, which have been habitually double-headed, while the same trains were hauled over the connecting line by single engines of much greater power, which were designed under the direction of a "practical" man. The latter operated at an advantage because of the thorough understanding of the operating side of the department by the chief. The writer is confirmed in the opinion that it is very desirable to establish a plan of promotion with respect to the chief motive power officer, which will accomplish two things: First, develop the talent of the rank and file by opening the way for promotion of all alike who possess ability. Second, to establish a method whereby educated men will prepare for their responsibilities slowly and thoroughly. G. M. B.

(To be Continued.)

IMPROVED FIRE DOOR FLANGE.

Very good reports are received with respect to this fire-door flange on locomotives on the Chicago & Northwestern Railway. Door joints, with abrupt flanges, have always been troublesome, because the flanges are alternately heated very hot when the door is closed and cooled when it is open. Usual construction produces stiffness in the sheets and a rigidity around the door which causes the expansion and contraction to localize and develop cracks which are difficult to repair. The joint illustrated has been developed and patented by Mr. M. O'Connor, foreman boilermaker of the Chicago &



IMPROVED FIRE DOOR FLANGE.

Northwestern, at Missouri Valley, Ia. He states that it is being applied to all locomotives requiring heavy boiler work at that point and that of twenty-eight locomotives fitted with it in the past three years, no failures have been found. This form of door flange provides a rounded surface of the sheets, and a particularly full curve of the inside sheet. This gives the sheet an opportunity to bend without cracking, and it also increases the space for water circulation around the door opening. This construction avoids sharp bends, prevents lodgment of scale and mud, and it costs no more than other forms of door flanging.

BARDONS & OLIVER TURRET LATHE—Bardons & Oliver of Cleveland, O., have just shipped to the Canadian Pacific Railway at Montreal a 5-in. turret lathe with an automatic chuck and wire feed, whose net weight is over 20,000 lbs. It will turn 42 ins. in length and will make a 4¾-in. crosshead pin from bar steel at the rate of 3 per hour. It is the heaviest machine of this type that has ever been built.

THE OPPORTUNITY OF THE ENGINEER.

The official estimates of the Government make the present population of the United States 80,000,000. Reasoning from the past it seems probable that twenty-five years from now our population will be 125,000,000. That is, by the time that the young engineers now starting their life work have reached a ripe and active middle age the population of the United States will be as great as the present population of the United Kingdom, the German Empire and two-thirds of France added together. It will be a homogeneous population, of high average education, and averaging higher in courage, enterprise and self-reliance than the people of any other great country, for reasons which we need not now go into. That population will be planted in a temperate climate, in a country of unequalled natural resources, intersected by great natural waterways, covered with a network of railroads, and with vast coast lines on two great oceans. The wealth, the power, the physical and intellectual influence of such a nation may be guessed at; they cannot be measured.

Such is the inheritance of the American youth who stands to-day in the gateway of life. To the young engineer all this has an especial meaning. Heretofore we have been relatively an agricultural people. Soon we shall be relatively a manufacturing people. Doubtless we shall long continue to be the greatest food producing nation; but we shall come to be also the greatest manufacturing nation. The opportunities we offered to courage and enterprise plus highly trained intelligence. That means that the great prizes of the next quarter of a century will be for the engineer. But if he will grasp them he must not only be an engineer; he must be a man.—*H. G. Prout in Electric Club Journal.*

RAILROAD PROGRESS AS SHOWN BY INTERSTATE COMMERCE COMMISSION STATISTICS.

The total single track railway mileage in the United States on June 30, 1903, was 207,977.22 miles, having increased 5,505.37 miles in the year ending on that date. This increase exceeds that of any previous year since 1890.

On June 30, 1903, there were in the service of the railways 43,871 locomotives, the increase being 2,646. As classified, these locomotives were: Passenger, 10,570; freight, 25,444; switching, 7,058. There were also 799 not assigned to any class.

The total number of cars of all classes was 1,753,389, this total having increased 113,204 during the year. The assignment of this rolling stock was, to the passenger service, 38,140 cars; to the freight service, 1,653,782 cars; the remaining 61,467 cars being those employed directly by the railways in their own service. Cars used by the railways that were owned by private companies and firms are not included in this statement. The average number of locomotives per 1,000 miles of line was 214, showing an increase of 8. The average number of cars per 1,000 miles of line was 8,540, showing an increase of 345 as compared with the previous year. The number of passenger-miles per passenger locomotive was 1,978,786, showing an increase of 70,476 miles. The number of ton-miles per freight locomotive was 6,807,981, showing an increase of 141,482 miles as compared with June 30, 1902.

Practically all locomotives and cars in passenger service had train brakes, and of the 10,570 locomotives in that service, 10,110 were fitted with automatic couplers. Most of the freight locomotives had train brakes and 98 per cent. of them automatic couplers. Of 1,653,782 cars in freight service on June 30, 1903, 1,352,123 had train brakes and 1,623,330 automatic couplers.

The number of persons on the pay rolls of the railways in the United States, as returned for June 30, 1903, was 1,312,537, or 639 per 100 miles of line. These figures, when compared with corresponding ones for the year 1902, show an increase of 123,222 in the number of employes, or 45 per 100 miles of line. The classification of employes includes, enginemen, 52,993; firemen, 56,041; conductors, 39,741, and other trainmen, 104,885. There were 49,961 switch tenders, crossing tenders and watchmen. With regard to the four general divisions of railway employment it appears that general administration required the services of 45,222 employes; maintenance of way and structures, 433,648 employes; maintenance of equipment, 253,889 employes; and conducting transportation, 576,881 employes.

REGULATING AND REVERSING CONTROLLERS FOR MACHINE-TOOL MOTOR DRIVING.

A new type of controller, particularly adapted for use with independently-driven machine tools, has recently been designed by the Westinghouse Electric & Manufacturing Company, manufactured as types V and W, which cover a wide range of sizes and capacities to fulfill all the requirements of service.

The type V controllers are used upon 2-wire single voltage circuits, eight forward speeds and four reverse speeds being obtained by resistance in the shunt field circuit of the motor. In the type W, which is designed for use in connection with 3-wire 2-voltage circuits, the speed variations are obtained by means of the two voltages, as well as the shunt field-resistance, provision being made for 6 forward speeds on the lower and 9 on the higher voltage, and 6 reverse speeds on the lower voltage. Experience has proven that this number of speed variations is the best possible for general use, and affords all the differences in speed which are required in service.

The type V controllers are ordinarily adopted when a speed variation of 2 to 1 is required, and the type W for variations of 4 to 1, although other variations may be obtained as desired, each installation being separately considered and the controller used which is best adapted to the motor with which it is to be used. The successive intermediate speeds are arranged in practically geometrical progression, but extra leads are provided by the use of which the owner may make such changes as he desires.

In general structure, these controllers are based upon the most modern and improved types of controller design, insuring reliability and long life, regardless of hard usage. The drum is made of metal and secured to an insulated shaft. The contact strips and the fingers are of hard rolled copper, and the fingers are provided with lock nuts and adjusting screws. All parts are liberally proportioned and are made easy of access. The cover can easily be removed by withdrawing the pins which hold it in place, and access to the leads is quickly obtained by removing the strips screwed to the back of the controller.

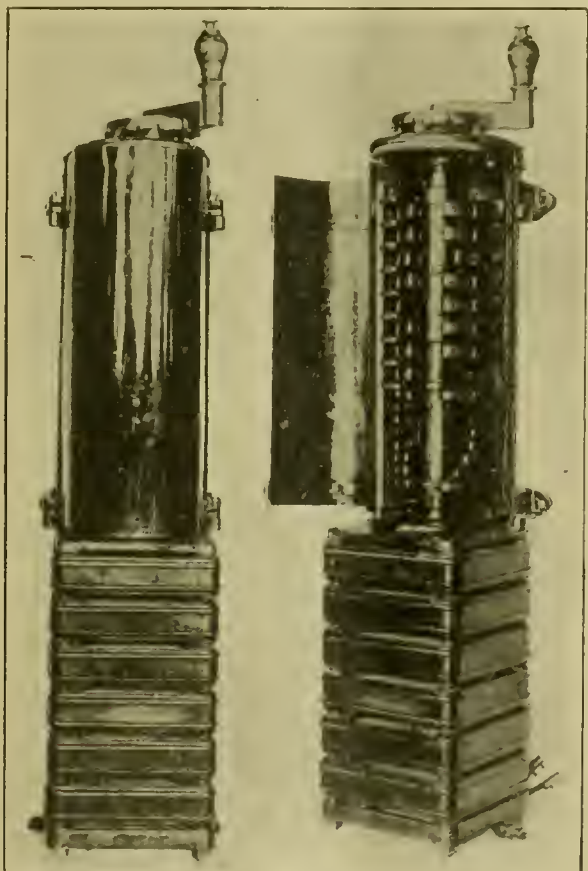
Another important feature which assures the adaptability of these controllers to various conditions is the fact that the handle and ratchet are so designed that they may be removed from the controller and placed at any point which is convenient, permitting connection to the controller by means of bevel gears and shafting. This not only adapts the apparatus for distant control, but it enables the operator to use the same handle, ratchet and indicator dial which are furnished with the controller; this saves the expense of making a new handle and ratchet, as is necessary in some cases.

The notches in the ratchet are positive, and the design is such that as each step is reached a key drops into a notch and stops the handle, holding it firmly in place until released by a pressure upon the thumb stop in the end of the handle. The operator is thus able to watch his work uninterruptedly while applying power or changing the speed—a fact of distinct advantage. The handle and ratchet are simple in construction and each step is plainly indicated and numbered.

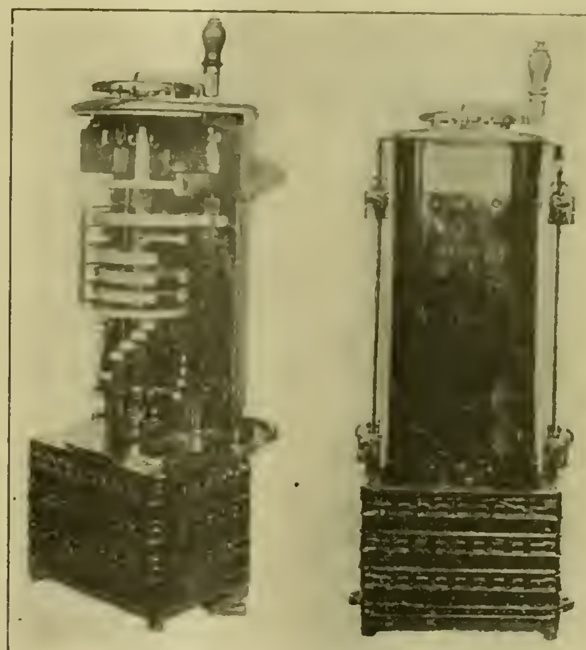
In the type V controller the starting resistance is inserted when the first contact is made, being cut out when the handle is moved to the second position. In the type W a cam lifts from the contact the finger whose function is to cut out the starting resistance, and thus leaves the resistance in circuit when starting or when changing to a higher or a lower voltage. By means of a dash pot, the return of the finger is delayed for a predetermined interval of time, the speed of the return being regulated by means of a screw; the checking medium is a non-freezing liquid, greatly superior to air as a means of even and close regulation and not affected by atmospheric conditions. If desired, the dash pot can be removed without disturbing any other portions of the controller.

Arc shields are placed between all contacts which carry the main current, and in addition all sizes above 10 h.p. have a powerful magnetic blow-out coil.

In capacities to and including 10 h.p. the resistance, which is of the imbedded type, is regularly mounted directly beneath the controller, as shown in the accompanying illustrations. In larger sizes it is mounted separately. The leads are conveniently located and have screw connectors. These controllers are designed in every particular to give superior service under even the least favorable conditions.



TYPE V CONTROLLER.



TYPE W CONTROLLER.

CONTROLLERS FOR MACHINE TOOLS.

A TEST OF A MOTOR DRIVEN PLANER.

BY J. C. STEEN.

Following closely after the series of articles recently published in these columns upon the motor driving of planers, it is believed that an account of an interesting test upon a motor-driven planer recently made will be appreciated. The planer is one built by the Pond Machine Tool Company, 66 ins. in width and having a platen 12 ft. long. The motor which is used to drive this machine is one built by the Northern Electric Company, of Madison, Wis. It is a 15 h.p. compound-wound motor running at 400 r.p.m. with the normal line voltage of 220. An extended armature shaft carries the driving pulleys direct, and upon the extended shaft is also carried a heavy balance wheel, the utility of which will be seen upon examination of the following diagram and data given.

These data were obtained by means of a recording ammeter, the accompanying diagrams being traced directly from the record strip. The use of this instrument enables a graphical showing to be made of the power consumed during any period of time, or cycle of operations, of the machine being tested. Its use also makes possible the calculation of the actual total power consumed for a given time.

The work done upon the planer during the test required a platen traverse of about 8 ft. The two surfaces cut were about 26½ ins. long each, with a space between, so that the cut was not continuous. Both tool heads were used, each one carrying a cut of ⅝ in. in depth with a feed of ⅛ in. The material was of cast iron, of medium hardness. While the cuts taken are not nearly up to the capacity of the machine, the work represents average practice fairly well.

The results of the test are given as follows, the voltage being 215 as an average throughout the test:

Power required to drive the motor, driving shaft, the pulleys on the machine, and the platen in forward direction, no cut being taken; average gross power of	10.3 h.p.
Power required for return of platen, including reverse	16.9 h.p.
Power required at time of heaviest cut (maximum)	14.4 h.p.
Power required at moment of reverse from return to cut (max.)	16.3 h.p.
Power required at moment of reverse from cut to return (max.)	22.4 h.p.
Power required as average throughout entire cycle of platen movement	13.6 h.p.
The time required for one cycle of platen movement	.48 min. or 29.0 secs.
The time required for cutting movement of platen	.34 min. or 20.5 secs.
The time required for return movement of platen	.14 min. or 8.5 secs.

From the above it will be seen that the ratio between the time of reverse and cutting movement is 1 to 2.43.

By the application of a Warner cut-meter to the moving platen it was found that the cutting speed was at the rate of 25 ft. per minute, with a return speed of 75 ft. per minute, a ratio of 1 to 3. The difference between these two ratios may be taken to represent the time loss at reversals. The action of the motor was all that could be desired.

It will be seen that the power required to reverse the direction of platen movement from cut to return was only 22.4 h.p., an increase of but 55 per cent. over the power necessary at maximum cut, and an increase of 64 per cent. over the average amount required during the whole cycle of movement. This maximum power is much less than might be expected from a machine of this size, and the very favorable result shown is undoubtedly very largely due to the balance wheel on the motor shaft. It will be understood of course that a balance wheel requires some expenditure of power to keep it in motion, but as this is a relatively small amount it is more than compensated for by the advantages obtained by its use. Another result of the balance wheel action will be seen upon reference to the diagram. The depth of the cut was quite uniform throughout its

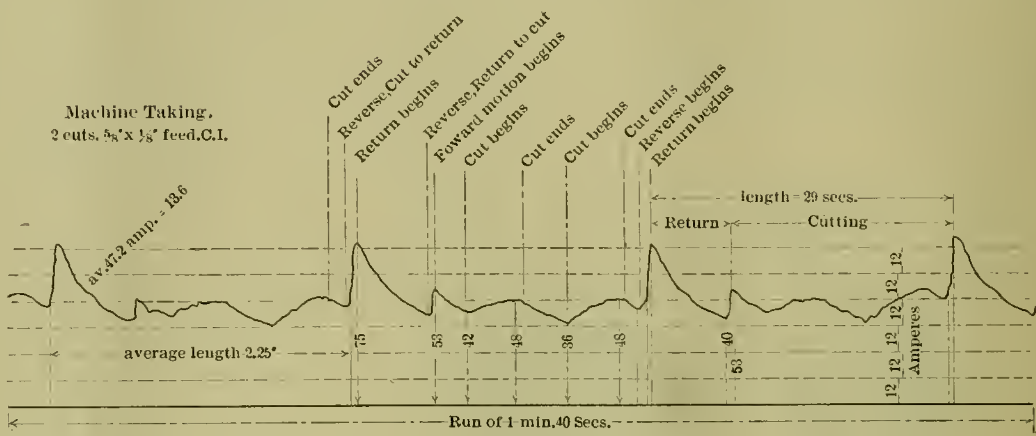


FIG. 1.

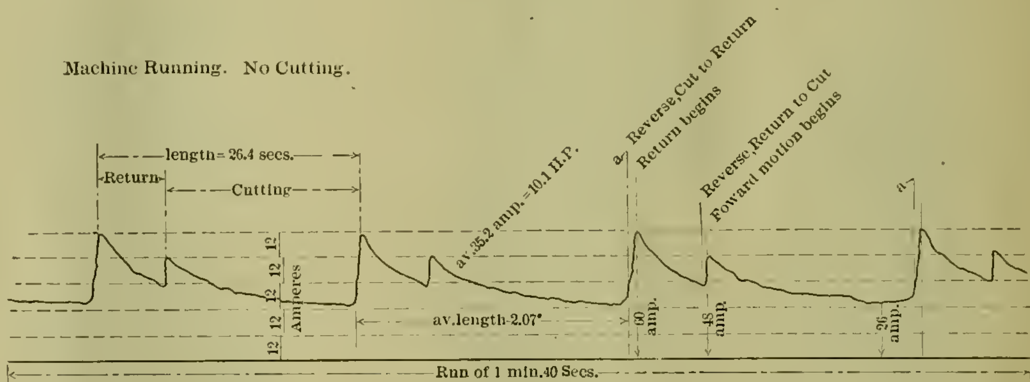


FIG. 2.

length, yet there is no sudden rise in the power line at the point where cut begins, the rise being gradual up to the point of maximum power. This feature will be noticed at the beginning point of each cut.

From the data given above, certain information is obtain-

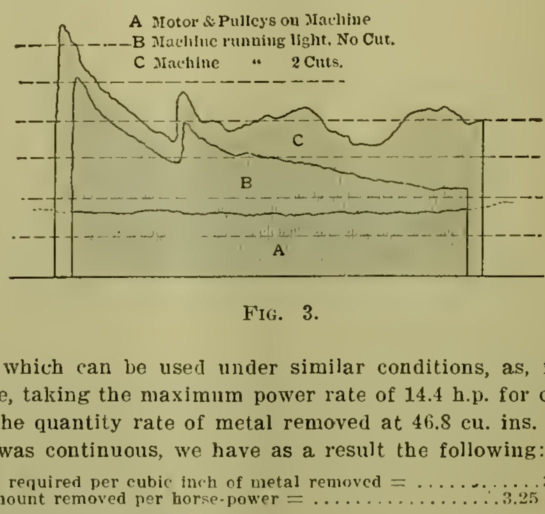


FIG. 3.

able which can be used under similar conditions, as, for instance, taking the maximum power rate of 14.4 h.p. for cutting and the quantity rate of metal removed at 46.8 cu. ins. if cutting was continuous, we have as a result the following:

Power required per cubic inch of metal removed =	.308 h.p.
Or, amount removed per horse-power =	3.25 cu. ins.

While the above item gives the rate as to capacity of motor required it does not give the power cost rate. This can be obtained by taking the power consumed during the complete cycle of movements and the actual amount of metal removed during the cycle. Thus it is seen that the average power used through the cycle was 13.6 h.p. and the quantity of metal removed was 8.26 cu. ins.; hence, the following:

Amount of metal removed per horse-power expended = ...607 cu. ins.
Amount of power used per cubic inch of metal removed = ...1.64 h.p.

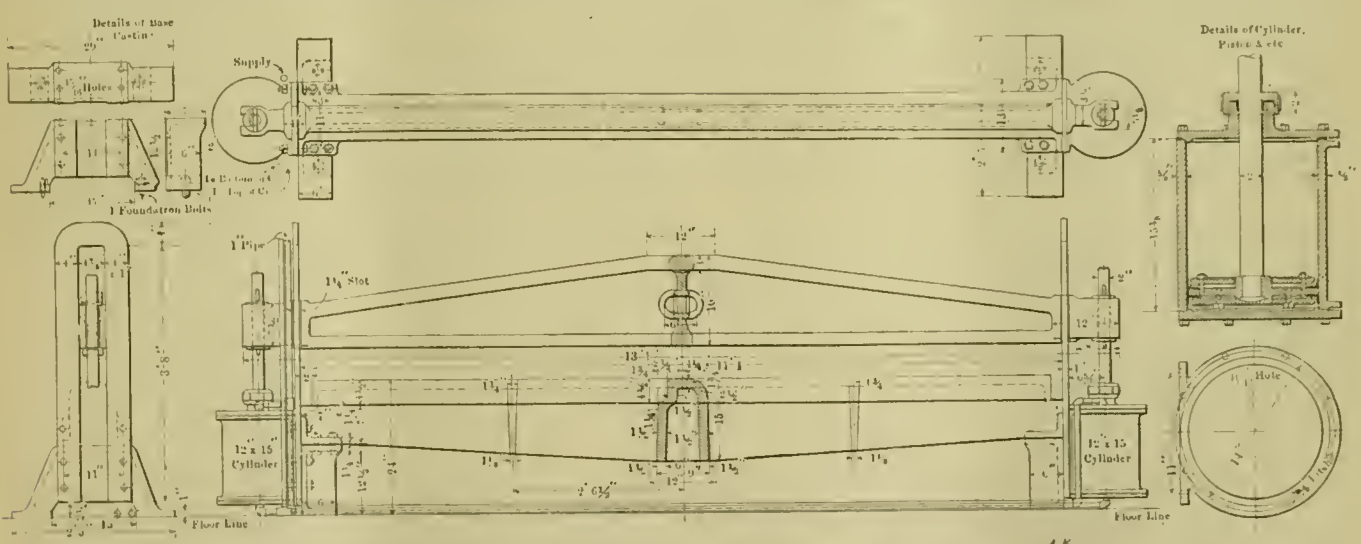
From the data given the total amount of power could be very closely arrived at by making proper observations and timing the various periods of running under cut, running light, etc.

By taking the power used throughout the cycle under cut, and while running with no cut, the difference represents the actual power used in removing the metal. Referring to the accompanying diagram, Fig. 1 shows something over three consecutive cycles, taken while machine was cutting. Fig. 2 shows the same length of time with machine running but no cut being taken. Fig. 3 shows three sections of record strip superimposed for purpose of ready comparison. Comparison of the figures and the diagram will show also that the time required per cycle differed somewhat between running light and running under cut. In other words, as the load decreased the speed of motor increased somewhat, and consequently the time of cycle was shortened. These diagrams form quite an interesting exhibit of the power variation required for planer driving.

COMPRESSED AIR FLANGING CLAMP.

Buffalo, Rochester & Pittsburg Railway.

Machines of this description usually require holes in the floor to accommodate the cylinders. These are objectionable. The design shown here is by Mr. W. R. Maurer, of the Buffalo, Rochester & Pittsburg Railway, the machine being in use at the Du Bois shops of that road (see American Engineer, April and May, 1902). These machines often depend upon screws to adjust the stroke to the work. This one depends entirely upon air. Everything about the clamp is accessible and from the cross-sections of the beams it appears to be sufficiently stiff for satisfactory work. In other respects the engraving speaks for itself. We are indebted to Mr. Charles E. Turner, formerly superintendent of motive power, for the drawing.



DETAILS OF THE COMPRESSED AIR FLANGING CLAMPS IN USE AT THE DUBOIS SHOPS.—BUFFALO, ROCHESTER & PITTSBURG RAILWAY.

A School for Telegraphy and Stenography has been established by the Canadian Pacific Railway at Montreal, for the benefit of employees of the company. It is understood that promotions in the operating department will depend upon a knowledge of telegraphy. A tuition charge of $2 per month is required, and this is refunded to pupils whose attendance at the classes is 80 per cent.

Educate Your Successors.—Organization demands that we have somebody to succeed us, to follow us. Have you in your shop men working for you who are competent to take your place if you are called away, if you should be transferred to some other place? Possibly this has occurred to you; possibly not. I want to urge upon you very strongly the educating of the men under you—the men who are doing the work for you—the men who are making you a success. It is coming to be more and more recognized every day by those in charge of the education of children that it must begin when the child is young. The same thing applies to the men working in the shops. We must not only select those who appear to be bright and sharp, but we must make especial effort to increase the efficiency of our brothers by educating them in every possible way. In olden times, the foreman would not give up to anybody what he called his trade secrets. It was a mistaken policy—very mistaken. The man who makes a success does it not by doing himself all the work, but by having those who are subordinates do the work for him.—*S. W. Miller, before International Railway Master Boiler Makers.*

Porosity Test for Paints for Metallic Surfaces.—On a slip of glass put a thin coating of dextrine (20 grams dextrine, 40 c. c. water, 30 c. c. alcohol) on a spot about 1½ ins. diameter. When thoroughly dry paint the surface of the slip, including the spot of dextrine, with the paint to be tested, one or several coats, as may be desired, to correspond to the conditions of use. When the paint is dry and hard, in service condition, the slip is immersed in water. If the film is porous, water soaking through will dissolve the dextrine, giving it a whitish color and causing the overlying paint to peel off.—*Dr. C. B. Dudley, before American Society for Testing Materials.*

Railroad Mileage of the World.—According to statistics prepared by the *Archiv fur Eisenbahnwesen*, and translated in the *Railroad Gazette*, the railroad mileage of the world at the end of the year 1902 was 520,955 miles. Of this amount North America has 233,186, or 44.75 per cent.; North and South America and Australia, 53.33 per cent.; Europe has 183,997 miles; Asia, 44,358; Africa, 14,554; North America, 233,186; South America, 28,822; and Australia, 16,038 miles.

Remarkable Fuel Economy in Locomotives.—A record of 1.97 lbs. of coal per indicated horse-power hour in a locomotive on the Adriatic Railway, Italy, is given by Mr. Charles R. King in an interesting article in the *Railway Engineer*, April, 1904. This was done by one of the new 0—6—4 type, passenger locomotives, arranged with the cab and firebox in front. They are four-cylinder compounds.

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

THE AGE OF THE AMERICAN ENGINEER AND RAILROAD JOURNAL.

A correspondent recently inquired concerning the statement printed on the editorial page of this journal to the effect that it was established in 1832, and asked whether it has been published continuously since that date. In answer to this the following statement was transmitted, which may also interest other readers of this journal:

The *American Railroad Journal* was first published January 2, 1832. It was the first railroad paper published anywhere in the world, and was issued weekly in New York City. The *Mechanic's Magazine* was united with it July 1, 1838, the combined title being the *American Railroad Journal and Mechanic's Magazine*. In November, 1846, the office of publication was in Philadelphia, and in January, 1849, again in New York. This publication was bought by Mr. M. N. Forney October 1, 1886, and in January, 1887, was consolidated with *Van Nostrand's Engineering Magazine*. This latter publication was established in 1869 by Mr. H. L. Holley. The combination title was the *Railroad and Engineering Journal*, and in January, 1893, it was changed to the AMERICAN ENGINEER AND RAILROAD JOURNAL. January 1, 1896, the AMERICAN ENGINEER AND RAILROAD JOURNAL was bought by Mr. R. M. Van Arsdale and consolidated with the *National Car and Locomotive Builder*, being published with the title of the *American Engineer, Car Builder and Railroad Journal*. January 1, 1899, the title was shortened to the AMERICAN ENGINEER AND RAILROAD JOURNAL, under which the publication has continued.

This journal has been published continuously since the year 1832, and it is the oldest railroad paper in the world.

THE POSSIBILITIES OF THE RAILWAY MOTIVE POWER OFFICER.

The words of a retired superintendent of motive power in his argument for a better standing of the motive power department given in his article in this issue should be pondered by all who have to do with the management of railroads. This article is a statement of facts and also a warning which should be heeded and acted upon. No one who knows railroad mechanical methods at the present time and is in a position to compare them with the methods which have brought great commercial success to large industrial enterprises, need be told the importance of the arguments of this gentleman. Transportation by railroads presents some of the greatest problems of the time, and some of its most vital factors are mechanical. It is also true that some of the greatest possibilities in cost reducing methods are also mechanical. Real economies in locomotive operation and maintenance have only begun, and the need of the best equipped mechanical officers was never so great as now. The field for railway mechanical work is not as attractive as it ought to be and so important a matter should receive the thought of owners and managements without delay.

APPRENTICESHIP—WILL IT TAKE CARE OF ITSELF?

This journal has been taken mildly to task for giving so much attention to the apprentice problem. This is done by an officer who is high in the councils of a large railroad system and who believes that "the apprentice problem is settling itself very nicely." With this view all who have studied apprenticeship and present methods of recruiting railroad service must positively take issue. Apprenticeship is certainly not taking care of itself, and the neglect of it by the railroads is a very serious matter. Pension plans, improved methods of management, and the most correct dealing with employees can never permanently improve the labor conditions in railroad shops unless the method whereby youths enter the shops and learn the work are put right. Of all present-day problems there is none more vital or important in possibilities for influencing the future than that of recruiting the ranks of the workmen, whether in the shops, on locomotives, on trains, and at the telegraph key. The railroad officer who establishes a proper apprentice system and follows it up with its logical accompaniments will go down into history as a great man as well as a public benefactor. It can and must be done. Who will do it?

THE LOCOMOTIVE HAS GROWN IN 37 YEARS—HAVE OPERATION AND MAINTENANCE KEPT PACE?

Nothing could be done at this time to better point out the way to improve American railroad operation than to direct attention to progress in size and capacity of locomotives, as was done by Mr. W. H. Lewis in his presidential address before the Master Mechanics' Association.

Everyone who reads this comparison, thoughtfully, must necessarily be led to think of the progress in the work done by the locomotives and in methods of operation and maintenance. This suggests several questions which the president and general manager should answer: 1. Is the locomotive department as a whole advancing in scope and authority to correspond with the increased responsibilities of running and maintaining and loading big locomotives? 2. Is the roundhouse and locomotive terminal, except in a few isolated cases, properly equipped to meet the needs of big locomotives, worked as they are, to-day? 3. Has the locomotive repair shop, considered generally, advanced to a degree adequate for best commercial results with these big engines? 4. Is any railroad taking proper precautions to prepare enginemen for their important work in running and firing the big locomotive of to-day? 5. Is any railroad following up its use of fuel as carefully as the stupendous proportions of the fuel bills renders absolutely necessary to the owners of the properties? 6. What better way is there to put these things right than to put the motive power department on a rational basis; giving necessary encouragement, authority, scope and responsibility; putting the control in the hands of those who best understand the requirements?

It is desirable that the owners of the properties should realize that their interests depend upon the answers which their managements can give to the question: "What are your locomotives doing?" One of the greatest, and perhaps the greatest, of the problems before railroads to-day, and the one with the greatest possibilities for improvement, is the locomotive problem.

Because of their significance and because of the other comparisons which they suggest, the remarks of Mr. Lewis in regard to progress in size and in performance are reproduced as follows:

In 1868 we had locomotives with cylinders 16x24, with 60-in. driving wheels, with tractive power of 8,000 lbs.; boilers 46 ins. in diameter, with 15 sq. ft. of grate area and 900 sq. ft. of heating surface, and weighing approximately 60,000 lbs., with 38,000 lbs. on the drivers. Engines of these dimensions were considered large. In comparison with this take our passenger locomotives, with cylinders 22x28 ins., 80-in. driving wheels, developing tractive power of 32,000 lbs., with boilers 70 ins. in diameter, carrying 220 lbs. of steam, with 54 sq. ft. of grate area and 4,000 sq. ft. of heating surface, weighing 219,000 lbs. with 141,000 lbs. on the driving wheels; or the latest freight locomotive of the Mallett articulated type, with cylinders 20 ins. and 32 ins. diameter by 32-in. stroke, with 12 driving wheels 56 ins. in diameter, boiler 84 ins., carrying 235 lbs. of steam, with 72.2 sq. ft. of grate surface and 5,585.7 sq. ft. heating surface, developing a tractive power of 70,000 lbs. when working compound, or 80,000 lbs. while working simple; the weight of such an engine in working order being 334,500 lbs.

Comparing the engines of 1868 with standard modern freight engines, we find that the boiler pressure has increased 120 per cent., tractive power has increased 296 per cent., boiler diameter 52 per cent., grate area 260 per cent., weight on drivers 272 per cent., total weight 259 per cent. As an example of the increase during the past seven years I take the liberty of quoting the increase of the engines on the Norfolk & Western Railway Company, which, I believe, will serve to indicate the general increase on most of the roads of this country. The increase in the number of locomotives during the past seven years has been 37 per cent., total increase in tractive power 79 per cent. Increase in tractive power per engine, 30.7 per cent. During this time freight ton mileage has increased 86.7 per cent. and freight ton miles per engine has increased 35.2 per cent. The freight ton miles per pound of tractive force has increased 4.23 per cent., and freight engine mileage has increased 55 per cent., the increase in average miles per engine being 13.18 per cent. The total tons of coal per 1,000 ton miles, 4.09 per cent. The average cost of repairs, expressed in terms of "freight engine miles," has increased but 2.03 per cent. and repairs, in terms of "tons one mile of freight," has decreased 14.96 per cent. Freight train mileage has increased 23.6 per cent., the average weight per train has increased 50.9 per cent., and average number of tons hauled per engine has increased 21 per cent. From these figures you will see that while the average tons per train has increased 50.9 per cent., the cost of repairs to locomotives, expressed in terms of "ton mile of freight hauled," has decreased 14.96 per cent. The great significance of these comparisons justifies the presentation of these statistics, which will not be easily comprehended unless one has an opportunity to analyze them at his leisure. These figures will be found in detail in the committee's report on coal consumption in locomotives, a duplicate of which appears in the June issue of the American Engineer and Railroad Journal, in comparison with some data other than that of our own.

The Grafstrom Memorial.—Friends of the late Edward Grafstrom, who lost his life in saving the lives of others in the Kansas floods last year, will be glad to know that the memorial fund has reached the amount of $5,500. Messrs. S. P. Bush, W. H. Miner and B. C. Sammons, trustees of the fund, will purchase an annuity for Mrs. Grafstrom. They have also engaged Mr. Lorado Taft, the sculptor, to prepare a bronze tablet, to be set up at Topeka.

LONG STAYBOLTS, LEAKY FLUES AND WIDE FIREBOXES.

The following supplements the report of the discussions before the Master Mechanics' Association, printed last month on page 273:

Advisability of Reducing the Diameter of Staybolts and Reducing the Distance Between Them.—Mr. G. R. Henderson presented a table showing the pitch necessary in using bolts of from 1 in. down to ⅝ in. in diameter. Increasing the width of water spaces would help the staybolts. Few bolts broke within 2 ft. of the mud ring. Taking everything into consideration, increase of length was believed to be preferable to a reduction in diameter of bolts. Prof. Hibbard had found that reducing the diameter of staybolts between the sheets did not increase the life of staybolts. Mr. Mord Roberts gave testimony from experience which was very favorable to "flexible" staybolts. Mr. McIntosh also had had excellent results with such staybolts, which had practically eliminated breakage, not one of these bolts having been found broken in two years of service.

Leaky Flues in Wide Firebox Locomotives.—Mr. M. K. Barnum believed the trouble to be due to faulty firing, bad water and short distances between the grates and the bottom flues. Brick arches would probably help the flues. With good water, good firing and tubes of the same length there should be no more trouble with wide than with narrow fireboxes. Mr. Vaughan thought flue difficulties to be due to two causes, the first being overheating of the flue ends. Wide firebox engines were doing more work than narrow ones, which led to overheating. The other cause was sudden contraction from cold air passing suddenly through a portion of the flues. When newly fixed the tubes were strongly secured in the sheets, but after a while they became loose and the change of length caused leaks. Wide grates were difficult to keep covered, and holes for cold air were much more likely to occur in the fire and cause sudden contraction of the flues. Mr. Bentley (Chicago & North Western) had practically overcome flue failures by the use of water-treating plants. Relay engines, engine failures and delays in turning engines had become practically things of the past with him. With bad water nothing would improve the situation, but with good water very little care was required. He gave strong testimony in favor of water purification. In fact, all of the speakers emphasized the importance of good water.

Limit of Width of Soft Coal Burning Fireboxes.—Mr. Lawford H. Fry opened this discussion in place of Mr. Vauclain. Excess air through large grates and excessive high rates of combustion were both to be avoided. Mr. Fry quoted experiments illustrating the losses due to excessive air admission, which carried off a great deal of heat and reduced the temperature of the firebox. The limiting width of grates depended upon the quality of coal. It was desirable to use vertical inside sheets of fireboxes in order to facilitate circulation. Dr. Goss gave a word of caution against loss of efficiency due to excess air. With wide fireboxes we were bound to be concerned with this question.

The Heating Surface of Serve Tubes.—The usual rule for measuring the heating surface of Serve tubes, which are now commonly used in foreign locomotive practice, is to take the whole internal surface which is in contact with the hot gases and reckon this as the heating surface. This was brought out in a recent discussion before the Institution of Mechanical Engineers, England.

A Good Report of Piston Valves.—"On the Eastern Railway of France piston valves have been used with great advantage; they have larger ports and experience shows that an economy of nearly 10 per cent. was secured by piston valves as against flat valves."—*Engineering.*

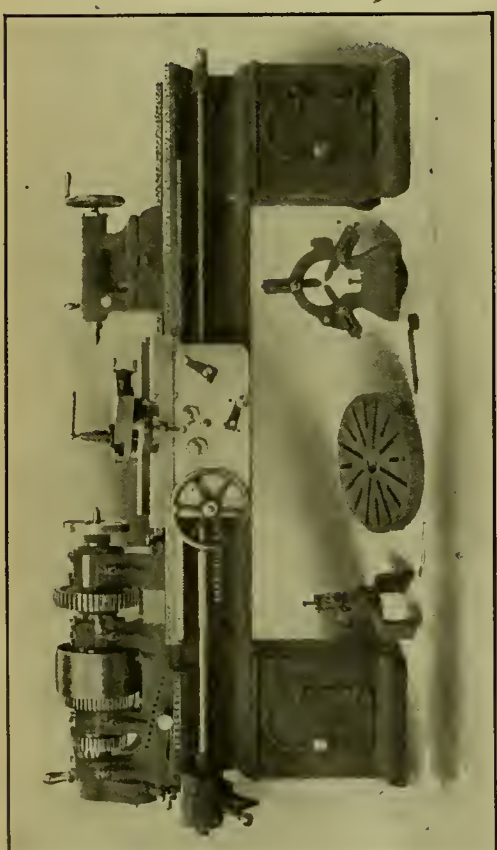


FIG. 1.—LATHE COMPLETE.

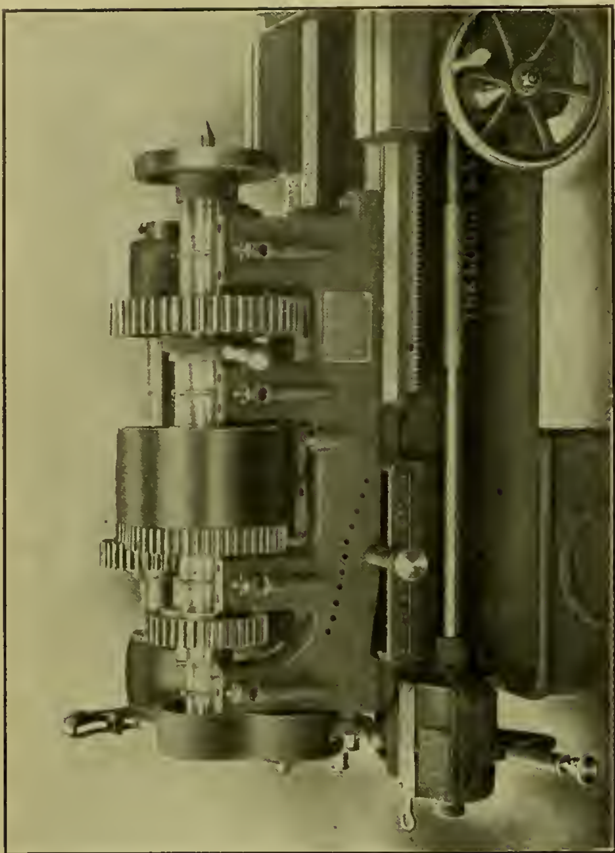


FIG. 2.—HEADSTOCK WITH BEARING CAPS REMOVED.

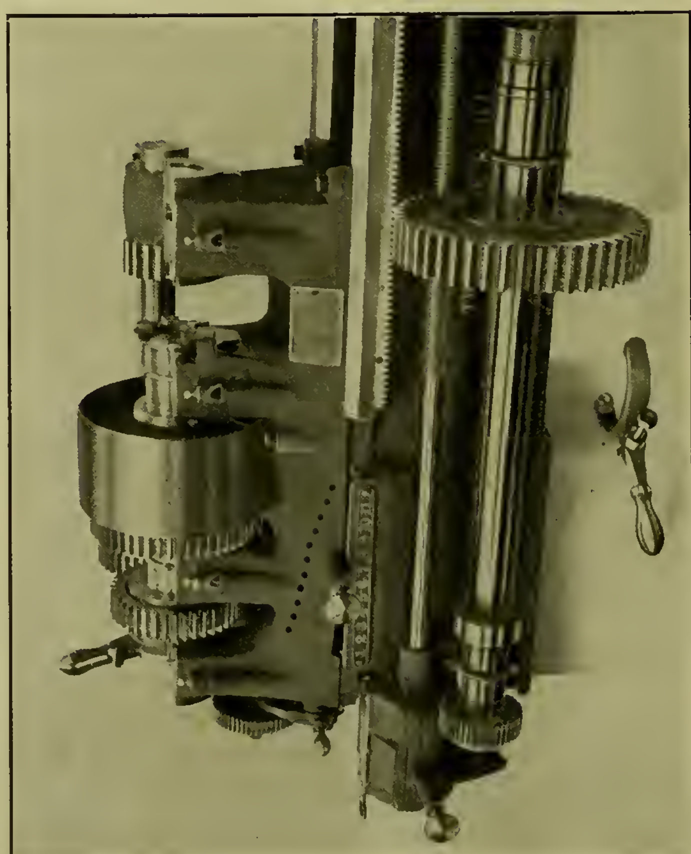


FIG. 3.—HEADSTOCK WITH SPINDLE REMOVED.

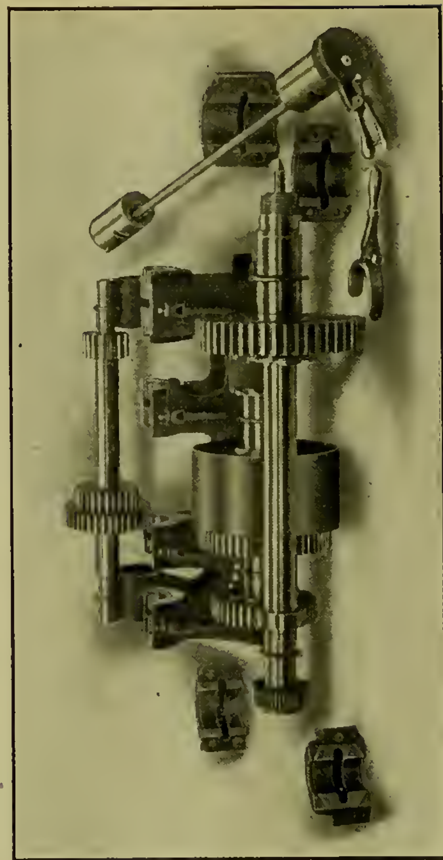


FIG. 4.—DETAILS OF HEADSTOCK.

LODGE & SHIPLEY 20 INCH LATHE WITH IMPROVED HEADSTOCK.

A NEW DESIGN OF ENGINE LATHE HEADSTOCK.

A new and very interesting design of engine lathe headstock, which is radically different from that ordinarily used on belt-driven lathes, has recently been put on the market by the Lodge & Shipley Machine Tool Company, of Cincinnati, O. This headstock was designed especially to stand the severe service caused by the use of high speed tool steels and maintain its life and durability. To accomplish this arrangements were made to use a much wider driving belt than usual, and also to relieve the main spindle and its bearings of all the strain due to the pull on the belt, and to provide an improved device for oiling the bearings.

A 20-in. lathe, which is exactly the same as the standard Lodge & Shipley quick change gear lathe, except for the improved headstock, is shown in Fig. 1. Attention is at once attracted to the fact that the familiar cone pulley is missing and in its place is a single pulley with a very wide face and large diameter, and also that the main spindle is apparently supported by four bearings in place of two, as ordinarily used. Fig. 2 shows the headstock with the bearing caps removed. As a matter of fact, the two inner bearings are for the sleeve which carries the belt pulley, and the two outer ones for the main spindle, which passes through the pulley sleeve but does not touch it, as the sleeve is bored out to a ⅛-in. larger diameter than the diameter of the spindle. The belt pull, therefore, all comes on the pulley sleeve and its bearings, and the main spindle will preserve its alignment much longer and the life of its bearings will be much greater than with the old construction.

Fig. 3 shows the headstock with the main spindle removed. The pulley sleeve has a substantial jaw clutch on one end, as is clearly shown, and this engages with one which slides on the inside hub of the face of the larger gear. When the clutch is engaged, the main spindle of course revolves at the same speed as the belt pulley. At the other end of the pulley sleeve are keyed two gears of different sizes, one on each side of the bearing. On the back shaft are two sliding gears, either one of which can be thrown into mesh with the corresponding gear on the pulley sleeve, depending on the speed required. When not in use these sliding gears on the back shaft are located between the gears on the pulley sleeve. The ratios of the back gears are 3 to 1 and 9 to 1. The lathe with the direct run and the two runs of gearing has three speeds, and these, in connection with a countershaft with three speeds, give a total of nine spindle speeds. If the backing belt is not required on the countershaft it can be arranged to give six forward speeds which, in connection with the three speeds in the lathe, will make a total of 18 forward speeds.

The details of the headstock are shown in Fig. 4. The back shaft runs in self-oiling bearings, which are eccentric, and which are connected by a rod, as shown. The back shaft is hollowed out to take this rod.

Deep oil wells, which hold at least a pint of oil, are cast into the main spindle and pulley sleeve bearings. Brass rings, which have outside projections, are mounted on the spindles and arranged to turn with them. Holes are drilled into the projections on the rings, and these dip up the oil from the wells and, as they pass over the centre, drop it on the spindles. The construction of the bearings is such that the oil cannot get out of them, and the oiling device will run at least three months at one oiling. On the front of each of the bearings will be noticed a lug. These lugs are bored out and connected to the oil wells. The front part of each lug is then partially cut away, so that when a glass tube is inserted in the lug the level of the oil in the well can be seen.

POOLING OF LOCOMOTIVES—DISADVANTAGES.

In a report on the subject of coal consumption of locomotives a committee of the Master Mechanics' Association made the following observations with respect to pooling:

Theoretically, the pooling of locomotives is advantageous, but there are many conditions which detract from the theoretical benefit of such method of handling when applied in practice. It may happen that engines pooled at different terminals will run over not only one division but a number of divisions and come in contact with various conditions affecting their economical operation, and the interest manifested by the men who operate the engines and those who care for them at terminals is diminished, resulting in a decreased efficiency in their performance. The pooling system has a demoralizing effect on the interest which is taken in the maintenance of the engines and their operation by the enginemen and firemen, resulting ultimately in less loyalty to the company which they serve. However, in numerous instances pooling is necessary, and where such is the case it cannot reasonably be expected that motive power can be maintained with as little expense as can be done with regularly assigned engines. The attention to detail of maintenance in keeping the motive power in serviceable condition without continual shop repairs is the keynote to good operation and economy, and is more likely to be obtained under a regular assignment where each man runs one particular engine than where one man runs forty engines. With a regular assignment each engineman becomes not only an inspector but an educator for the particular fireman who may be assigned to him, and a certain pride attaches to both men to maintain and have maintained that part of the property of the company which is entrusted to their care.

The result of pooling engines is further shown by the inability of firemen to cope with the differences in designs of engines as well as can be done when they are regularly assigned to one engine, especially where conditions warrant the use of both wide and narrow firebox engines. The care with which wide firebox engines should be fired is not generally appreciated by the men. This is perhaps largely the cause of the numerous troubles due to leaking which are experienced with this type of engine. It is much easier to maintain an even fire on a small grate than a large one, and the tendency with the large grate to allow different temperatures at different parts of the fire is considerably more than obtains with the small grate, hence the necessity of additional care on the part of the men operating an engine with a wide firebox and relatively large grate area.

ROLLER BEARINGS FOR LINE SHAFTS.

In the course of a paper on "Electric Power in Workshops," by Mr. J. T. Irwin, before the Rugby Engineering Society, the author gives the following results of a test regarding the relative powers absorbed by the friction of journal and roller bearings. The figures given show the power taken on a line of shaftings, first, when fitted with cast-iron swiveling bearings 14¼ ins. long; and, secondly, when fitted with patent roller bearings 16¾ ins. long, so constructed as to allow of a certain amount of elasticity. The shafting was 124 ft. long by 3½ ins. diameter, and was supported by 13 bearings in each case. The shafting drove 26 machines, 6 lathes and boring mill gearing:

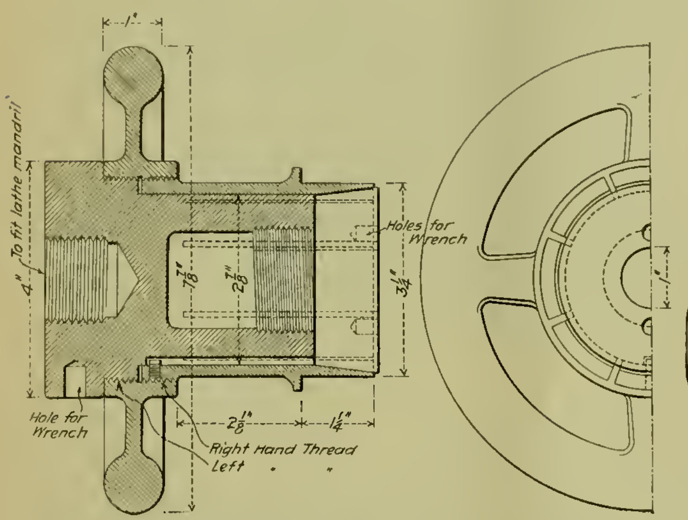
Plain Bearing.		Roller Bearing.		
Starting. b. h.p.	Running. b. h. p.	Starting. b. h. p.	Running. b.h.p.	Remarks.
14	1.9	10	1.2	Running shafting alone.
20	6.8	15	5.5	Shafting and countershafts.

From the above it will be seen that when using roller bearings the starting current required was much less, and also the friction load, which is more important, the advantage in favor of the roller bearings being about 37 per cent. with the shaft running light, and about 20 per cent. when loaded.—*The Mechanical Engineer.*

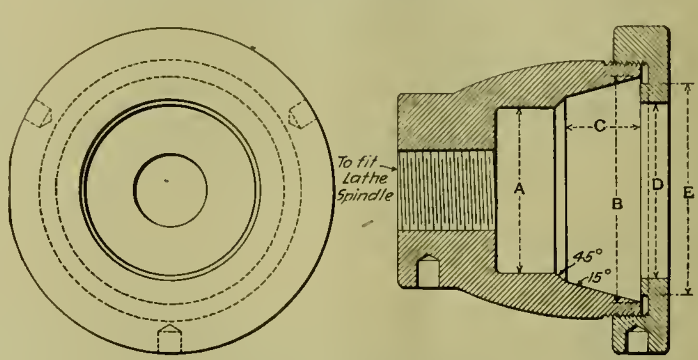
CHUCKS FOR TURNING AND BORING METALLIC ROD PACKING.

A correspondent asks us to illustrate the chucks used by the United States Metallic Packing Company for turning and boring the packing manufactured by them. This company has courteously responded to a request for information with the accompanying drawings. Because of the great importance of proper fitting of rod packing, special attention should be given to these chucks.

One of the chucks is used to turn up the outside of the rings. It is made to fit the spindle of the lathe and is adapted to rapid work. The proper way for railroads to manufacture their own packing rings is to cast the rings separately and on a cone the size of the turning chucks. After facing the rings off separately, all three of them should be placed on this expanding chuck and the outside turned to conform to the interior of the vibrating cup. After this is done the rings should be put into the boring chuck and bored to the desired size.



EXPANDING CHUCK FOR TURNING OUTSIDE OF PACKING.



CHUCK FOR BORING PACKING.

SIZES OF CHUCKS (INCHES) FOR BORING MULTIANGULAR PACKING-RINGS.

Diameter of Rod.	A.	B.	C.	D.	E.	Diameter of Rod.	A.	B.	C.	D.	E.
4½	4⅝	6	1¼	4¾	5¾	2⅝	2¾	3¾	1 3-16	2⅞	3½
4¼	4⅜	5¾	1 3-16	4½	5½	2½	2⅝	3⅝	1 3-16	2¾	3⅜
4	4⅛	5½	1 3-16	4¼	5¼	2⅜	2½	3 7-16	1 3-16	2⅝	3 3-16
3¾	3⅞	5 3-16	1 3-16	4	4 15-16	2¼	2⅜	3¼	1	2½	3
3⅝	3¾	5	1 3-16	3⅞	4 25-32	2⅛	2¼	3⅛	13-16	2 5-16	2⅞
3½	3⅝	4 13-16	1 3-16	3¾	4 9-16	2	2⅛	2 15-16	13-16	2 3-16	2 11-16
3⅜	3½	4 11-16	1 3-16	3⅝	4 15-32	1⅞	2	2 13-16	¾	2 1-16	2⅝
3¼	3⅜	4 7-16	1 3-16	3½	4 3-16	1¾	1⅞	2¾	23-32	1 15-16	2½
3⅛	3¼	4¼	1 3-16	3⅜	4	1⅝	1¾	2½	11-16	1 13-16	2 5-16
3	3⅛	4⅛	1 3-16	3¼	3⅞	1½	1⅝	2⅜	11-16	1 11-16	2⅛
2⅞	3	4 1-32	1 3-16	3⅛	3 13-16	1⅜	1½	2⅛	⅝	1 9-16	1 15-16
2¾	2⅞	3 15-16	1 3-16	3	3 11-16	1¼	1⅜	1 15-16	⅝	1 7-16	1 11-16

The interior of the boring chuck is bored to correspond exactly with the inside of the vibrating cup, so that when the metal rings are in position to be bored they are in the same position with reference to the cup as they occupy on the engine. This insures accuracy and the rings must necessarily be bored concentric with their exterior surfaces.

There has been a tendency among railroad men toward the belief that metallic packing need not be fitted at all carefully and that it will take care of itself when put into service. Everything is satisfactory if piston rods are always smooth and crossheads travel in line, provided the packing is properly fitted when applied. It is necessary to follow systematic methods with respect to packing and it is hoped that the description of these chucks will contribute toward an improvement. The accompanying table gives the various dimensions of the boring chuck for different diameter of rods.

LOCOMOTIVE TERMINALS.

In a paper read before the Master Mechanics' Association Mr. Robert Quayle outlined the elements of a successful and adequate round house establishment, and among other things enumerated week spots usually found, as follows:

"Insufficient tracks for storing engines; poor coaling facilities or coalhouse too far from roundhouse; sandhouse badly located or inefficient; water supply improperly located or inadequate; cinder pits not long enough or so located that engines have to run a long distance after fire is dumped; cinder car track not depressed enough, causing unnecessary shoveling; lack of a wideawake man outside, who should, while working as a hostler or in some other capacity, have supervision over clinker pit, sandhouse, coal shed and other men working in the vicinity; turntable too small or weak and not power driven, causing more time to be spent spotting engines and turning them than is absolutely necessary; a roundhouse too small to get engines inside and close the doors, or one that is improperly lighted and ventilated; a poor roundhouse foreman; a poor engine inspector; washout facilities not arranged to wash out with hot water, or to have at least a pressure of 100 lbs. per sq. in.; drop jacks that won't drop; cinder floors; poor method of giving out work and checking it up; poor discipline among shopmen; a machine shop stocked with obsolete tools, or so located that men waste time running back and forth; a storehouse minus necessary material; a heating system that won't heat properly."

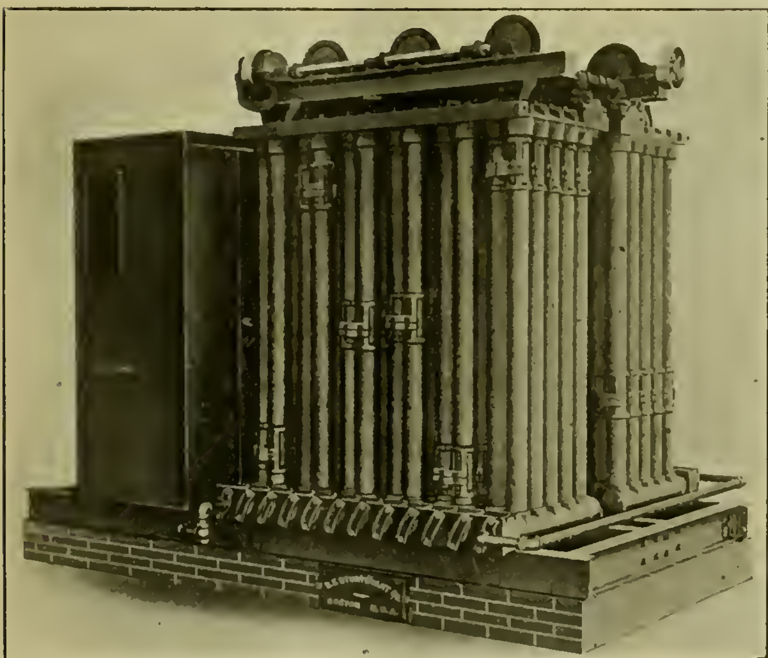
Under the head of roundhouse organization Mr. Quayle said:

"There should be a good, live foreman in charge, who is responsible to the master mechanic. All of the men working inside and out should be amenable to his orders; such a man, if a firm disciplinarian, and one who has the good will of the men and is quick to think and act, is invaluable. Under him should be an assistant who is familiar with the engines, enginemen and workmen; it should be his duty to give out the work and see that it is properly done, keeping check of the men who have done the work, so that in case it becomes necessary at some future time to locate them there would be no difficulty in doing so. A good staff of machinists, boilermakers, truckmen, helpers, boiler washers, wipers, engine inspectors, etc., is indispensable, all having their duties outlined so that there will be no friction in promptly doing the work. Fair and straightforward treatment of the men will in return get, in most cases, cheerful service. Proper records must be kept of the numerous periodical inspections that are called for. The enginehouse in and out register should be entered up daily, and a check of engineers and firemen who are laying off or sick is useful to locate and round up men in case of a shortage."

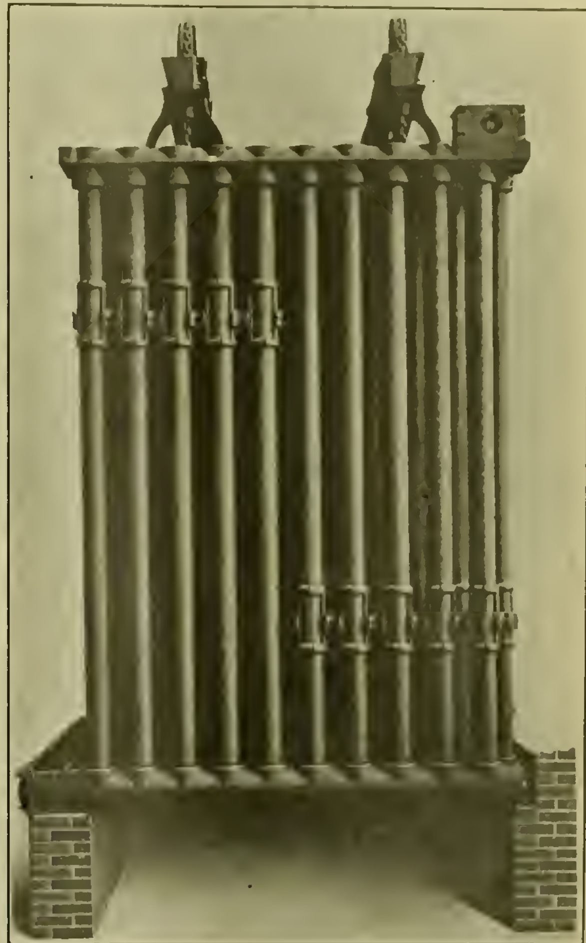
THE STURTEVANT ECONOMIZER.

The economizer developed and installed in a number of successful power plants by the B. F. Sturtevant Company will interest the readers of this journal in connection with the important question of power plant economy. This economizer is a logical adjunct to the well known mechanical draft apparatus of this company, and is simple, strong and accessible. Its object is to utilize nearly all of the heat of the waste gases, which is accomplished by means of staggered pipes. This feature, by the way, constitutes a strong point of this economizer.

This is not an experimental construction. It is a development which has an established place through a number of commercial applications. It is adapted to new installations and also to application to old power plants, and by the use of two groups of sizes, the "Standard" and the "Pony," it covers all ranges of capacity down to about 50 h.p. The former size is generally used for boiler capacities of 350 h.p. and over, while the latter ranges from 50 to 500 h.p. It has been generally believed that only large plants offer suitable opportunities for the application of economizers, but this system provides equally convenient apparatus for relatively small plants, the saving being in the same proportion in small as in large plants.



THE STURTEVANT PONY ECONOMIZER, SHOWING FAN.



THE STURTEVANT STANDARD ECONOMIZER.

The effectiveness of economizers is usually measured from the increased temperature of the feed water, whereas it should be measured by the saving in fuel and also in boiler repairs. An economizer renders a large quantity of very hot water always available, and this insures hot feed water at a nearly uniform temperature, which greatly prolongs the life of boilers. Much of the scale-forming impurities of the feed water are deposited in the tubes of the economizer instead of in the boiler. These tubes are straight, and easily cleaned.

By a careful design the Sturtevant construction is such as to appeal to the engineer, who always has in mind the important question of maintenance. The tubes are of cast-iron, fitted into the headers with tapered iron to iron joints, made perfectly tight by hydraulic pressure. These tubes may be easily removed and replaced for repairs, and every tube is accessible for interior cleaning. The staggered arrangement of tubes is urged as a strong point of this economizer, as it breaks up the streams of gases and forces them into contact with the tubes. The bolts which hold the outside caps in place are not in the water in the tubes, and are not subject to deterioration by rust. Instead of pipe manifold headers, cast-iron wall boxes are used, which avoid many troublesome pipe joints and provide structural strength to the economizer for the proper support of its weight, distributing it uniformly along the foundations. Scrapers for cleaning the smoke surfaces of the pipes, safety relief valves to guard against excessive pressure, sediment blow-off valves and cast-iron soot-pit doors are provided.

These economizers are used with and without mechanical draft, which does what an ordinary chimney is incapable of doing. Its cost is from 20 to 40 per cent. of that of a chimney; its intensity permits of using finely divided or low grade fuel; it makes possible the utilization of flue gases which a chimney wastes in producing draft; it is independent of the weather; is automatically regulated to maintain constant steam pressure; decreases smoke; increases the capacity of an existing plant; serves as an auxiliary to a chimney already overburdened, and saves space. In conjunction with mechanical draft an economizer provides an ideal arrangement. Further information concerning this economizer may be obtained from The B. F. Sturtevant Company, Hyde Park, Mass.

OVERLOADED FREIGHT CARS.—In a paper before the St. Louis Railway Club, Mr. Waughop cites cases of cars with a marked capacity of 80,000 lbs. which are regularly overloaded with 122,000 lbs. of coal. These cars were billed at their marked capacity, therefore the road received nothing for hauling the excess. The author of the paper said: "Railway companies should, in my opinion, mark all cars with but one capacity stencil, and that should be the limit capacity. When a shipper goes beyond that marked limit, all excess should be confiscated by the railways and sold for the benefit of the car department."

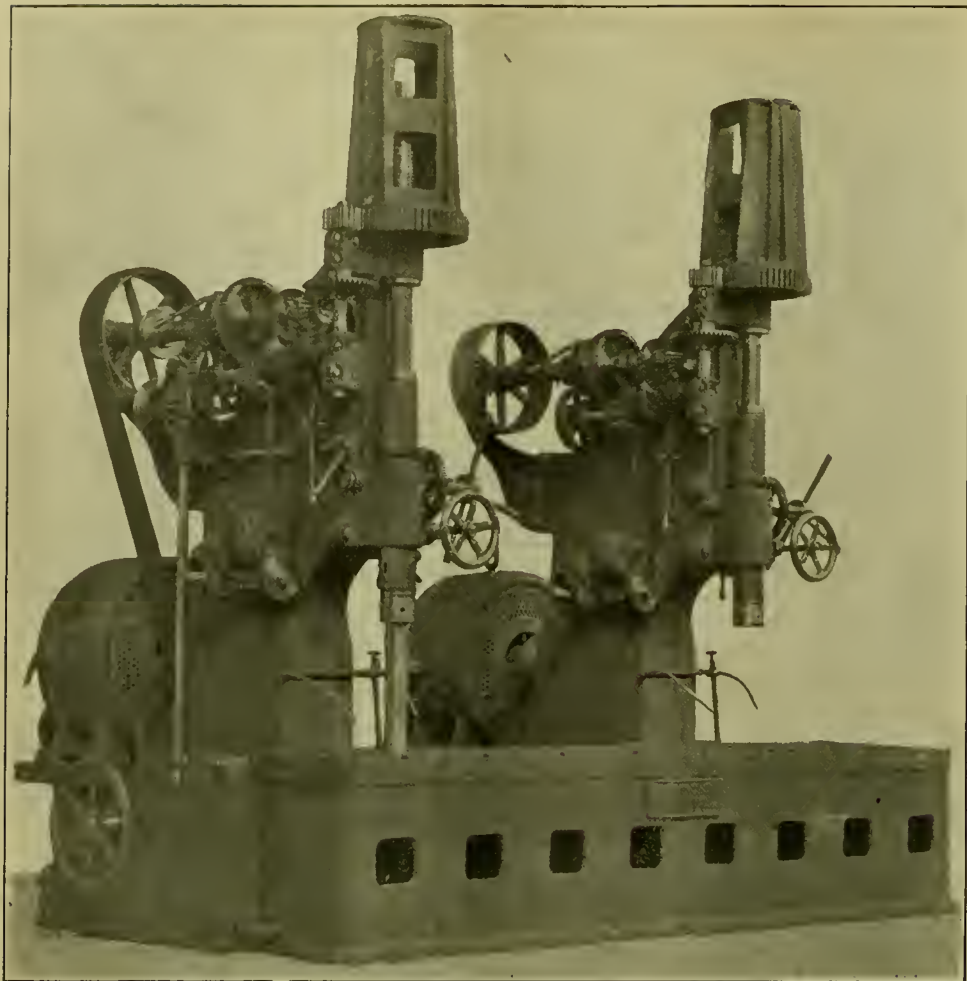


FIG. 1.—DOUBLE SPINDLE BORING MACHINE.—BAKER BROS.

SOME NEW DESIGNS OF MACHINE TOOLS FOR RAILROAD SHOPS.

These tools, which are manufactured by Baker Bros., of Toledo, O., were designed especially for use in locomotive, railroad and engine works, and were made unusually heavy, substantial and complete in order to successfully meet the severe demands caused by the use of the most modern methods in machine shop practice.

The heavy double spindle boring mill, shown in Fig. 1, was designed for such work as boring out connecting rods and for heavy facing and counter-boring operations. The two spindles with their frames and driving mechanism are entirely independent, but are mounted on the same base. The frames are adjustable along this base so that the distance between their centres can be regulated to suit conditions. The left hand frame can be adjusted by power. The maximum distance, centre to centre of spindles, is 9 ft. 6 ins., and the minimum is 3 ft. 4 ins. The distance from the centre of the spindles to the frame is 20 ins., and each spindle has 24 ins. travel.

The bed plate, which is very massive, has a working table 11 ft. 2 ins. long and 24 ins. wide between the oil grooves, and the interior of this table forms an oil tank. Each spindle is provided with an oil pump for forcing the oil from this tank to the cutting tool. The spindles are triple back geared, and are each driven by a 220-v., 13-h.p., Westinghouse type S motor, which has a speed variation of 4 to 1. The motors are connected to the driving mechanism by belts and are supported by special brackets, which are cast on the frames. The motor controllers provide 15 forward and 6 reverse speeds. These, in connection with the triple back gears, give a total of 45 forward and 18 reverse speeds. The total range of spindle speed is from 3 to 90 r.p.m. Each spindle is provided with 20 rates of feed, varying from 0.005 to .125 in., and these feeds are all geared, and change from one to another can quickly be made by means of the change gear box on the side of the frame. The tool weighs 32,000 lbs.

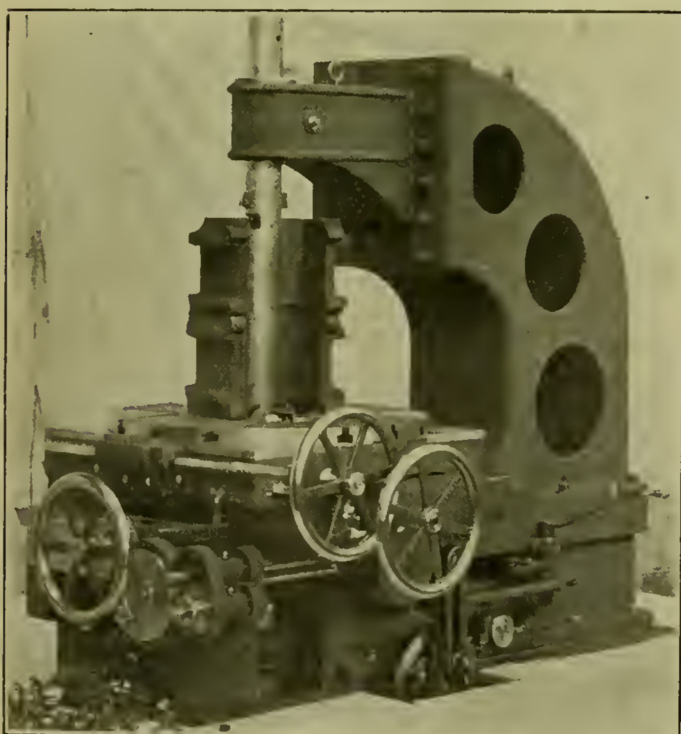


FIG. 2.—30-INCH DRAW-STROKE SLOTTER.—BAKER BROS.

Fig. 2 illustrates a very heavy design of 30-in. draw-stroke slotter, which was primarily designed for machining cast-steel locomotive driving boxes, but which is of course suitable for a great variety of other work, and will be found especially useful in machining long deep holes which the ordinary slotter cannot reach, and for key seating. Full automatic feeds are provided in all directions, and these and the hand feeds can readily be engaged by the operator standing in front of the machine. The length of feed is adjusted at the right side of the machine. The working table is 38½ ins. in diameter, with a 20-in. hole, and is only 32 ins. above the floor level, so that it is very convenient for the operator.

The ram is rack and pinion driven through a heavy train of gearing, and is counterbalanced. The reverse is accomplished by means of wide, shifting belts, which shift freely, and which have been found very satisfactory under heavy duty. The bar which carries the cutting tool can be made any shape or size up to and including 4½ ins. in diameter, and its size or shape

A well designed gas producer and gas engine should develop an indicated horse-power per hour for a carbon consumption of 0.75 lb.—*B. H. Thwaite.*

can readily be changed by changing the bearings. The boring bar is so supported that it is very rigid. The lower end is clamped into a long bearing in the ram and the bar is securely supported by a bearing in the table just under the work and also by a bearing in the upper arm. The machine has a wide range of feeds, and weighs about 16,000 lbs.

The following tests, which were made on one of these slotters, will give some idea of its strength and capacity: A steel driving box was slotted out in a circle 11¾ ins. in diameter and with a cut 11½ ins. long. A roughing and a finishing cut were taken off all surfaces, including the corners, in 28 minutes. The roughing cut was ⅜-in. deep with a ¼-in. feed, and the machine made 15 cutting strokes per minute. After the test 15 chips were picked up at random and were found to weigh 4 lbs. Another cut ¾-in. deep with ⅛-in. feed was taken on the same box. The cut was 11½ ins. long, and in 15 minutes the metal was removed for 22 ins. around the circle.

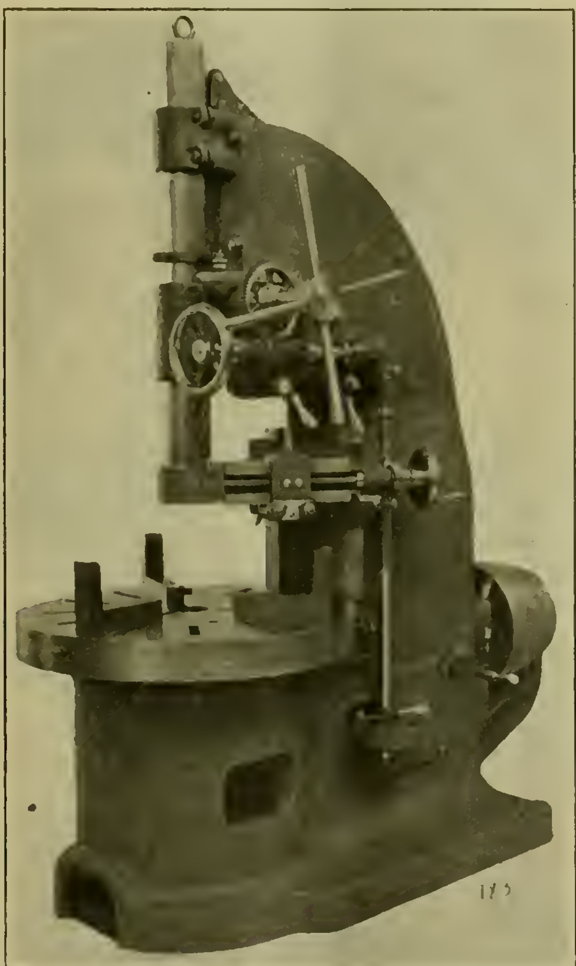


FIG. 3.—CAR WHEEL BORER.—BAKER BROS.

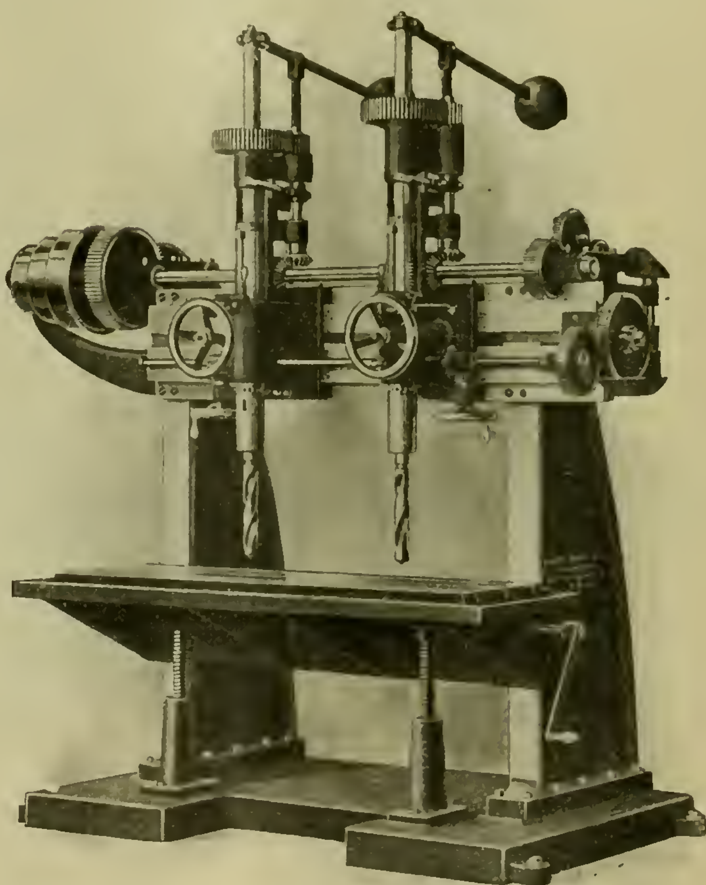
The car wheel boring machine, which is illustrated in Fig. 3, is fitted with a facing attachment that is of a rather novel and interesting design and is very rigid. The outer end is fitted with a bushing which guides the boring bar. The cross feed is geared and the vertical feed is operated by hand. The boring bar is 4¼ ins. in diameter, is fitted with a Morse taper socket, and is provided with long bearings, which are adjustable for wear.

The spindle is 4½ ins. in diameter and has a 2¾-in. hole running its full length for chips or for the boring bar. It is provided with a larger roller thrust bearing, and is fitted with taper adjustable bearings for taking up the wear. The frictional resistance is therefore small and the spindle is entirely free from vibration. The back gears can be thrown in by the lever, which is shown on the right hand side to the rear. The chuck is secured directly to the large driving gear. This machine is made in two sizes, 28-in. and 30-in., and weighs about 3,800 lbs.

INDEPENDENT MULTIPLE DRILL.

This drill, shown in the half-tone, is manufactured by Foote, Burt & Co., of Cleveland, O., and is known as their No. 17. It is entirely new, and the design embodies some very interesting features.

The spindles are independent in both feed and motion, and either spindle can be instantly started or stopped without interfering with the other. The heads can be adjusted along the crossrail by means of a rack and pinion without stopping the machine. The minimum distance between spindle centres is 8 ins. and the maximum is 48 ins. The hand feed is provided for through worm gearing, and can instantly be thrown either in or out regardless of whether the machine is in motion or not. A positive automatic knock-off has also been provided which can knock off the feed at any point. This works very easily and smoothly, whether the tool is running light or under very heavy duty. The table adjusts vertically on uprights by



INDEPENDENT MULTIPLE DRILL.—FOOTE, BURT & CO.

means of jack screws and worm gearing. The miter gears are made of drop forged steel.

The machine has three positive gear feeds and six spindle feeds. It has a capacity up to 2¼-in. drills in solid metal, and weighs, complete, about 7,000 lbs. It can be used to very good advantage on work where two holes occur in the same piece, by operating both spindles simultaneously, or it can be used to equally good advantage on single hole work, one operator tending to both spindles and thus reducing the cost of the work.

Metallic Packings.—Under this title the United States Metallic Packing Company, 427 North Thirteenth street, Philadelphia, have issued a little pamphlet illustrating and describing their packings for marine and stationary engines. It comes from a firm having had an experience of 25 years in this line of manufacture. This pamphlet will interest railroad officials in connection with shop engines and engines of their floating equipment.

McCANNA FORCE FEED LOCOMOTIVE LUBRICATOR.

The lubricator proper is placed on the regular standard for steam lubricators over the boiler in the cab. The actuating valve is placed at any convenient point on the engine where reciprocating motion can be obtained. The lever of the actuating valve is connected usually to the valve stem or rocker arm. This actuating valve is practically a rotary slide valve and is operated by a ratchet drive. It is connected to the main air drum on the engine by a pipe connecting with the air inlet shown in Fig. 3. The air ports are then connected to each side of the operating piston of the lubricator reservoir similar to that shown on top of the lubricator, Fig. 3, which prevents the siphoning of the oil from the pipes and also prevents the back pressure blowing the oil out of the pipes. The gravity check valve is one of the principal features of the device. It consists of a cylindrical brass shell enclosing a hexagonal weight with a needle valve on its lower end closing the oil outlet. The oil to get to the point of lubrication has to raise this weight and needle valve from its seat, necessitating a pressure of about 25 lbs. It then flows through the outlet to the bearing. The weight being hexagonal and having space above and below it, and on account of its hexagonal form, all around it also, any back pressure from cylinder or air pump is exerted equally in all directions and there is no tendency to lift the valve from its seat, it being held down by gravity. One of these valves is located at each pump outlet at the oil reservoir and another at each lubrication point. The one over the reservoir serves two purposes, being provided with an additional outlet, by which the amount of oil being pumped can be tested at any moment, the oil thus showing dropping back into the oil reservoir.

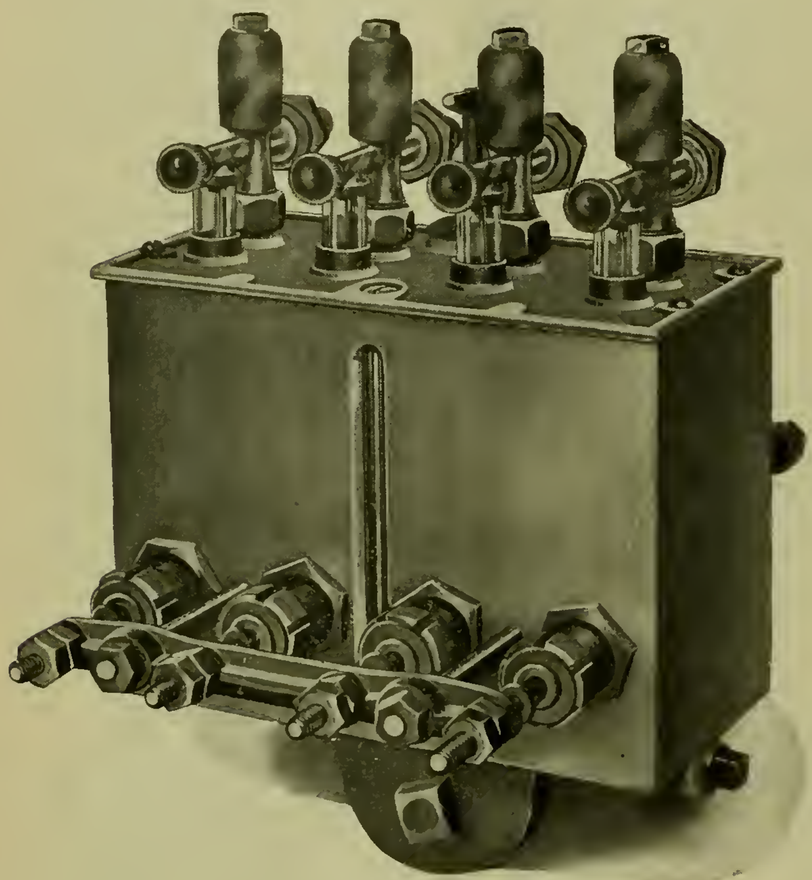


FIG. 1.—THE LUBRICATOR.

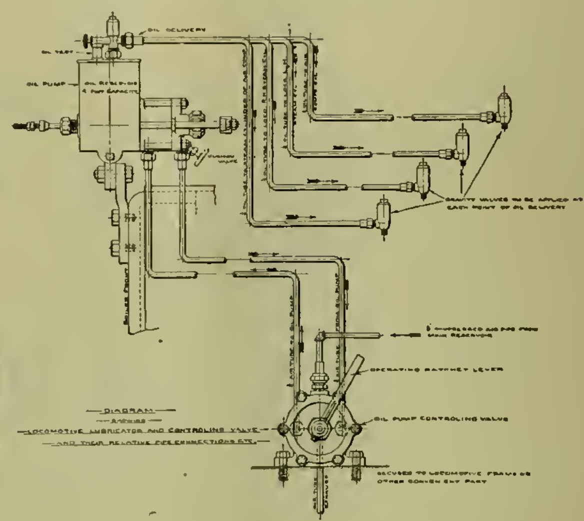


FIG. 3.—PIPING AND INSTALLATION.

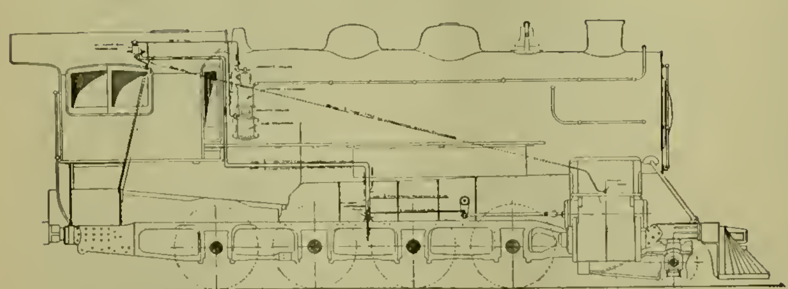


FIG. 2.—THE APPARATUS AS APPLIED TO A LOCOMOTIVE.

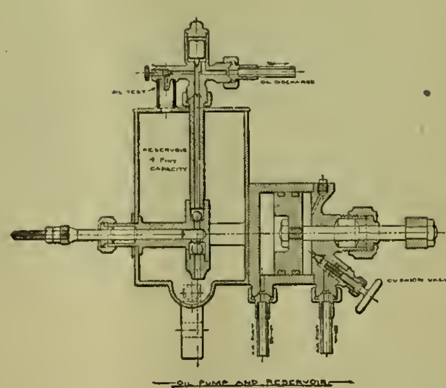


FIG. 4.—OIL PUMP AND RESERVOIR.

shown in Fig. 4. This piston is connected to a crosshead carrying two rods extending clear through the lubricator reservoir to another crosshead which operates the four pump plungers. These pump plungers have adjustable nuts, so that while the stroke of the operating piston is constant, the stroke of the pump plungers may be adjusted separately.

When the engine starts the reciprocating part communicates its motion to the arm of the actuating valve. This revolves the circular valve, admitting the air to one side or the other of the piston of the lubricator proper. This piston operates the pump, as explained above, and the oil is pumped to the point of lubrication by positive hydraulic pressure. At the point of lubrication is a check valve, shown in Fig. 4,

This method of "bleeder" test has been adopted instead of the ordinary liquid sight feed, as glycerine or water through which the oil passes in the ordinary sight feed becomes clouded after a time and requires renewal.

It will be noted that this method of lubrication absolutely eliminates any chance of broken sight feed glasses and the injury which may result from such an accident.

Lubrication, therefore, is in direct proportion to the speed, as the faster the engine travels the faster the actuating valve is revolved and the faster, therefore, the pumps are operated.

The stroke of each pump being independently adjustable, as much or as little oil can be fed to the point to be lubricated as is desired.

When the engine stops the oiling stops.

If an excess of oil is wanted at any particular moment on any of the bearings for any purpose, it can be obtained by operating that particular pump plunger by hand. Further information may be had from McCord & Co., Old Colony Building, Chicago, Ill.

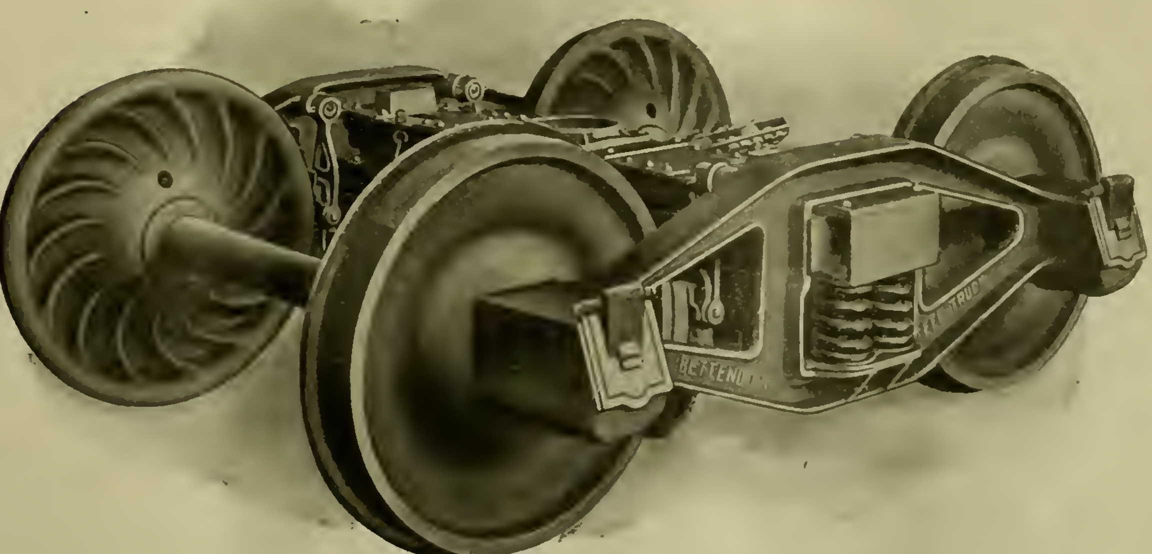
BETTENDORF CAST STEEL TRUCKS.

The new Bettendorf cast steel trucks exhibited at the recent conventions at Saratoga attracted attention because of the interest in the design and also because of the remarkably fine appearance of the steel castings. A one-piece truck side frame, including the journal boxes, in a single casting is of itself an interesting suggestion. A saving of about 1,000 lbs. per car is a distinct advantage, and to these are added a convenient construction, which avoids the use of bolts and nuts on the bottom of the frame. The quality of the material is broadly guaranteed, but should a journal box fail, the entire frame will be replaced at the cost of malleable journal boxes. This design may be made to interchange with the ordinary types of arch bar construction, and it also provides for top and bottom rollers.

As to repairs, this truck has been removed from under a car and completely dismantled in 9 minutes. It has been reassembled and replaced under the car in 8 minutes, a total of 17 minutes. The freight car trucks have coil springs under the bolsters, and the side frames finish at the ends in the journal boxes as shown in these engravings. For tenders an arrangement is provided for combining elliptic springs under the bolsters and coil springs in barrels over the journal boxes. These springs acting together are designed to produce the easy riding qualities of equalized swing-motion pedestal trucks. The coil and elliptic springs are given an initial load sufficient to support the light tender at the desired height.

The engravings of the separate parts indicate the manner of erecting this truck without bolts or rivets. The space between the columns is wide enough at the bottom to admit the end of the bolster, and when raised the guides enclose the columns. The form of the ends of the sand plank is such as to hold the truck together when put in place.

This is a bold step in truck construction, and is worthy of thoughtful attention. Additional information may be obtained from the Bettendorf Axle Company, Davenport, Iowa, who have developed the various "Bettendorf" car equipment improvements.

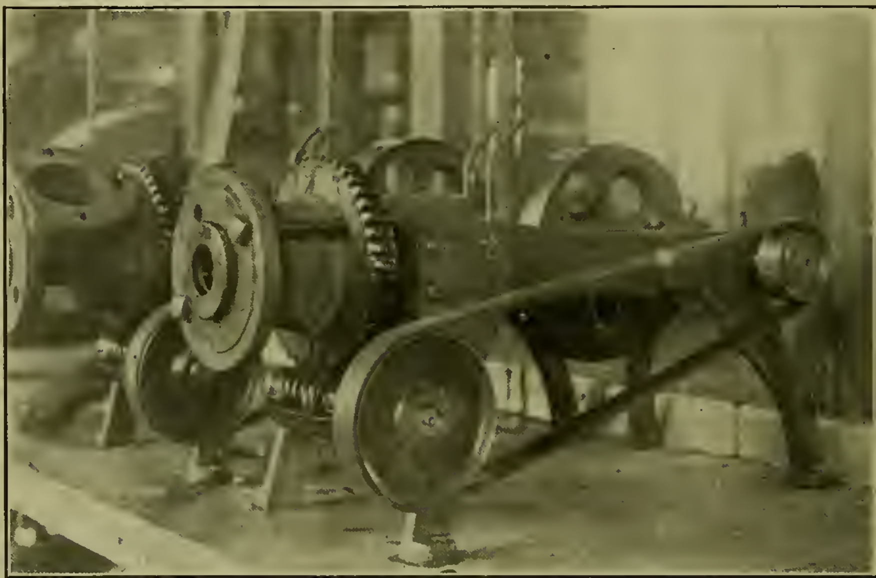


THE BETTENDORF CAST STEEL TRUCK.

GRINDING MACHINE FOR TRIPLE VALVE PISTON RINGS.

Four of these machines are in use at the San Bernardino shops of the Santa Fe—and with them a boy, who tends all four machines—and grinds in from 65 to 70 triples in 10 hours. Each triple requires from 20 to 30 minutes, whereas a man at the vise cannot do the work in less than from one to three hours per triple, and cannot do it well at that.

The triple is bolted to the face of a worm wear, which is slowly rotated by a worm below. This worm is belt driven from the horizontal shaft at the right. On this shaft is a small eccentric and a driving pulley. The eccentric gives a reciprocating motion to the triple valve piston by means of a connecting rod and bar crosshead. By the combined motions the piston is reciprocated while the triple valve chamber is slowly rotated and a different portion of the bushing is presented to any given portion of the ring at every stroke of the piston. When the operator has secured the parts in position, he starts the machine and it needs no attention until the work is done; therefore the attendant may be given other duties. It is not to be supposed that this machine can take the place of an accurate bushing grinding machine, such as is employed at the works of the air brake manufacturers. This piston ring grinder was devised by Mr. J. P. Phillips, foreman of the machine shop at San Bernardino, who has applied for a patnet upon it.



SPECIAL GRINDING MACHINE FOR TRIPLE-VALVE PISTON RINGS.

A Lesson from Expositions.—When we think of the marvels of engineering skill at the Chicago Exposition (1893) which learned scientific gentlemen decorated with blue ribbons and which were said to represent perfection in the art, and remember that the aforesaid "marvels" have, for the most part, been relegated to the scrap pile, and that in many cases the companies which produced them have vanished or been absorbed by more successful competitors, we realize that although "Time is short and art is long," eleven years is a long time in the art of electrical engineering. We should all note well the novelties in engineering at the St. Louis Fair. They will indicate the possibilities of the next decade and foreshadow the passing of most of what will there be displayed as the perfection of the art.—*R. H. Pierce in Western Electrician.*

Hollow Staybolts.—The following is abstracted from a paper by Mr. John Livingstone on the advantages of the Falls hollow staybolt. Hollowing the staybolt increases its flexibility, and the current of air passing through it cools it and thus reduces the expansion and also protects it from burning. Reducing the expansion of the staybolt lessens the liability of cracking the side sheets, and the molecular strains in the bolt itself are also reduced. When the solid staybolt vibrates or bends at the outer sheet the metal at its centre is crushed, thus causing internal expansion. Hollow staybolts are relieved of this. The 3/16-in. hole through the bolt furnishes a supply of oxygen to the firebox and gives sure warning if the bolt breaks. For these reasons the life of both the firebox and the staybolt is increased and the cost of repair reduced. Copies of this paper can be secured from C. M. Walsh, general manager, Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio.

The Standard Brazing Company of Boston have executed a license with the Erie Car Works of Erie, Pa., and also with the Portland Company of Portland, Maine. Both of these companies are now equipped to do brazing of cast iron for the general trade.

Universal Directory of Railway Officials, 1904. Published by the Directory Publishing Company, 3 Ludgate Circus Building, London, E. C., England. Representative for the United States, E. A. Simmons, 83 Fulton street, New York.

This is the tenth year of publication of this directory, and its value increases with the annual volumes. It is compiled from official sources by Mr. S. Richardson Blundstone, editor of the *Railway Engineer*, and is undoubtedly as accurate as it is possible to make a work of this character. This directory is invaluable to those who conduct correspondence with foreign railway officials.

ALLFREE-HUBBELL VALVE GEAR.

From a circular letter received from Mr. Ira C. Hubbell, in explanation of the Allfree-Hubbell valve gear, the following is taken:

"We increase the earning capacity of any class of locomotives converted to the Allfree-Hubbell type:

"First—By our system we greatly reduce cylinder condensation by reducing the radiating surfaces in clearance (ports) over 70 per cent., and by our valve-cylinder and saddle design protect the steam from loss of heat in its passage to the cylinder, and maintain continuously a hotter cylinder than is possible under any other design, insuring a high initial pressure of steam for each and every admission of steam to the cylinders.

"Second—Through our correction of the valve movement, by the simple, durable and economical addition we make to the existing link motion—we do not replace, displace nor change the links at all, nor in any way change their functions—we delay the opening of the exhaust port at all points of cut-off, and therefore hold the steam in the cylinder a greater portion of each stroke, and thereby necessarily increase the ratio of expansion, decrease the terminal pressure and get more work out of any given quantity of steam admitted to the cylinder.

"Third—By the addition made to the link motion, we also delay the closing of the exhaust port at all points of cut-off, thereby decreasing the volume in compression and thereby decrease the negative work of excessive back pressure in just that same proportion, and necessarily add just that much more to the positive work, the earning capacity of any given class of locomotives.

"Fourth—By decreasing the volume of compression, as we only can do, we reduce the cylinder clearance from 8 per cent. and over, to 2½ per cent., and less in cylinders, 20 x 26 ins., and never exceed 2¼ per cent., and which enables us to save considerably over 1 cubic foot of steam for each and every revolution of the drivers that the locomotive moves under steam.

"We can increase the earning capacity of any existing locomotive, and will guarantee to do so, and will further guarantee to do this with no increase in the total cost per 1,000 miles run.

"My attention has just been called to the prophetic statement made in a paper read before one of our leading technical societies twenty years ago, by one of the best known steam engineers of the world, as follows:

"'I contend that there is at our command in the present practice of generation of steam on railways the means of getting better results both in time and extent of load carried, by more economical application of steam, and that such results are attainable with a change of valve and construction of the engine so that more of the true force of the steam will pass into work on the pistons instead of being wasted in friction in passing through constricted openings between the valve and ports, and I am not inaccurate when I declare that this view of the case is deserving of most careful and serious consideration.'"

BOOKS AND PAMPHLETS.

Beveled Gear Tables, by D. A. Engstrom. Published by the Derry-Collard Company, 256 Broadway, New York, 1904.

This book presents a collection of tables and necessary explanations to enable any one to figure beveled gears without the use of trigonometry. It is not supposed to be an exhaustive treatise, but simply presents tables of dimensions of such gears as are generally found in practice, together with a few explanatory facts concerning the terms and diagrams. It is for beginners who have occasion to figure beveled gears, and is intended to entirely avoid the necessity for figuring. The author includes tables for every beveled gear from 12 to 47 teeth, inclusive. The various details of teeth elements and pitches, as well as construction and explanation of terms, are given in the earlier part of the work, together with explanation as to the use of the tables.

Electric Railways *(Les Chemins de Fer Electriques)*. By Henri Marechal. *Ingenieur des Ponts et Chaussees.* 600 pages, 8vo, profusely illustrated. Printed in French. Published by Ch. Beranger, 15 Rue des Saints-Peres, Paris, France. Price, 25f.

This is a very complete and strictly up-to-date work upon the general subject of electric railway construction. It treats the subject under the headings of Generation of the Electrical Current, the Right of Way and Track, Transmission of the Electric Current, Railway Motors, Motor Cars and Locomotives, and General Uses of Electric Traction. The treatment of the subject of generating the current is interestingly handled, special attention being given to the steam turbine. Particular attention is also devoted to the overhead-trolley and third-rail methods of collecting the current, as well as to the various multiple-unit systems of train control. It is of interest to note that numerous references are made to the standards of practice in use in this country, which are supplemented by well-selected illustrations. Considerable space is devoted, at the end of the volume, to a discussion of the various monorail and other similar systems of transaction, and also includes an interesting treatment of the moving-platform method of transportation.

Facts About Peat, Peat Fuel and Peat Coke. How to make it and how to use it. What it costs and what it is worth. By T. H. Leavitt. Illustrated. Boston, 1904. Lee & Shepard. Price, $1; postpaid, $1.10.

This little book of 115 pages states that peat is found in abundance in the United States, and that it may be cheaply and satisfactorily put into usable form as fuel by the use of machinery which bears the name of the author of this book, but the reader is not told enough about the process to convince him that peat will soon become a rival of coal as a fuel for use in large quantities. It is an interesting thing to know that peat is available in large quantities which are practically inexhaustible, and to be told that the process of preparation for the market is so cheap and simple; but the author of this book leaves much to the imagination of the reader, and does not present the right kind of facts to justify the conclusions which he evidently desires the reader to reach. It is not sufficient for him to state that condensed peat "made more steam than coal, and accomplished with ease the severest service required at the works."

Workshop Costs for Engineers and Manufacturers. By Sinclair Pearn and Frank Pearn, directors of Messrs. Frank Pearn & Co., Ltd., Manchester, England. Published by D. Van Nostrand Company, 27 Murray street, New York.

This work presents in complete detail a cost-keeping system as applied to the manufacturing of a line of steam pumps, and is presented in such a way as to be readily applied, without variation of principle or feature, to practically any operation involved in constructive work or manufacturing establishments. The book includes a complete set of blank forms, beginning with the pattern record and including material, time sheets and card-index records of the cost of the completed work, including labor and material. This system was developed and put into practice by the authors with a view of reducing to a minimum the routine work, also the number of blanks required in keeping the records. In this system chances of mistakes in ordering material are avoided by specifying in absolute detail on the cost sheet all of the material involved from a list of the component parts and quantities of the contract drawn up by the draftsman. Opposite each article is enumerated the cycle of operation through which it must pass, thus identifying the wages with the material. The work is divided into five parts, as follows: The nomenclature and registration of patterns and materials, the recording and analysis of labor, manufacturing the stores, and assembly work and contract or special work. While the book is specially intended for manufacturers, the principles involved are capable of adaptation to the keeping of costs in any shop involving repetitive operations, as in the manufacture of machinery of any kind.

Westinghouse Industries.—This is the title of a very attractive pamphlet which has just been issued in behalf of the Westinghouse interests for distribution at the Louisiana Purchase Exposition. It describes and illustrates the works and products of the various Westinghouse companies, both in America and foreign countries. These interests include the Westinghouse Air Brake Company; American Brake Company; Westinghouse Electric and Manufacturing Company; Westinghouse Machine Company; Union Switch and Signal Company; Westinghouse, Church, Kerr & Co.; Sawyer-Man Electric Company; Bryant Electric Company; Perkins Electric Switch Manufacturing Company; Pittsburg Meter Company; R. D. Nuttall Company; Westinghouse Automatic Air and Steam Coupler Company; Security Investment Company; Nernst Lamp Company; Westinghouse Traction Brake Company; Cooper-Hewitt Electric Company; and the foreign companies, which include the Westinghouse Air Brake Company, Limited, with works in England and Germany; the Westinghouse Company, Limited, with works at St. Petersburg, Russia; the British Westinghouse Electric and Manufacturing Company; Société Anonyme Westinghouse; Westinghouse Electricitats-Actiengesellschaft; the Traction and Power Securities Company, Limited, of London; and the Canadian Westinghouse Company, Limited.

Progress Reporter. The third number of this paper, which is issued by the Niles-Bement-Pond Company, is a special one, describing their exhibit at the St. Louis Exposition. The more important machine tools in the exhibit are described and illustrated.

The Development of the Brake Shoe.—The American Brake Shoe and Foundry Company of Mahwah, N. J., have just issued a very interesting pamphlet describing their exhibit at the St. Louis Exposition. The development of the brake shoe to secure durability, efficiency and strength and to wear the wheel tread where it is not acted upon by the rail is very carefully traced from the time that the first brake shoe was used to the present, and is nicely illustrated.

Axle Lighting.—In a small pamphlet the Consolidated Railway Electric Lighting and Equipment Company of New York City briefly describe their "Axle Light" system of operating fans in and lighting railway passenger coaches by electricity and also call attention to the advantages to be gained by the use of their system.

Air Compressors.—The Chicago Pneumatic Tool Company have issued a 72-page catalogue describing the air compressors built at their Franklin works. In addition to the illustrations and lists of sizes of the various compressors there is an interesting illustrated description of the constructive principles of the compressor. Several pages are devoted to information concerning the installation, adjustment and care of the compressors and there is also considerable information and several tables which will be useful to those interested in the use of compressed air.

Bowser Oil Cabinets.—The adjustable measure oil cabinets made by S. F. Bowser & Company, Fort Wayne, Ind., are described in a leaflet which directs attention to the features of these oil storage facilities which render them a necessity wherever oil is required for machinery or lamps.

Sketch Paper for Isometric Projection.—The Derry-Collard Company, 256 Broadway, New York, have gotten up pads of sketching paper for making drawings in isometric projection. This is the only practical perspective for machine drawings as it permits of making sketches to scale in any of the three isometric axes. The paper is very easy to use, and rapidity of sketching is quickly acquired. The paper is blocked in standard sizes, 6 x 9 ins.; 9 x 12 ins. and 12 x 18 ins., the prices being 25 cents, 50 cents and $1 each, respectively. This will be a great convenience for draughtsmen.

Valves.—The Crane Company of Chicago have just issued two pamphlets and a booklet describing and illustrating their valves. One of the pamphlets describes the renewable seat and disc globe, angle and straightway valves for high pressure service. The globe and angle valves are designed for 225 pounds and the straightway valves for 250 pounds working steam pressure and are particularly adapted for locomotive work. The other pamphlet describes their self-packing radiator valves and self-packing globe and angle valves with non-rising stem. The booklet, which is known as "Special Catalogue No. 101," describes the Crane patent improved safety valves for all kinds of boilers. The locomotive pop valve is fitted with two regulators, one for moderate changes and the other for extreme changes in the set pressure.

Air-Cooled Electric Drill.—The Chicago Pneumatic Tool Company in a special circular No. 48 calls attention to the Duntley Air-Cooled Electric Drill which they have just placed on the market. The drill which is described weighs only 12 pounds and is adapted for drilling holes up to ½ inch in diameter in iron and boring up to ¾ inch in diameter in wood. By cooling the motor with air the difficulties heretofore experienced with small electric motors are overcome and its use is made practical. The motor can be wound for either 110 or 220 volts and the drill has a speed of 850 rev. per min. The electric wires are fitted with a connection plug to fit an incandescent socket and this plug is equipped with a cartridge fuse plug which can easily be replaced if burned out.

New England Resorts.—The vacation custom is now a fixture, and the summer resorts of New England because of their unexcelled beauty and variety appeal to everybody. The beautiful lake resorts among the pinelands of Maine or in the northern portion of New Hampshire and Vermont; the verdant valleys watered by freshening streams such as the Merrimac, the Hoosac, the Connecticut and the Ammonoosuc; the long and famous stretch of seacoast from Portland and east to the rocky Nahant; the impressive grandeur and wonderful attractions of the White Mountains; the favorite haunts among the Hoosac Mountains and the Deerfield Valley; and the numerous towns and villages famed for their historic association as well as scenic and health resorts are delightfully pictured in the series of six books containing beautiful halftone reproductions of these various resorts, each book containing thirty or more views neatly bound with the title of the book embossed in gold letters on the cover. These books are entitled "Lakes," "Rivers," "Mountains," "Seashore," "The Charles River to the Hudson," and "Picturesque." The price of each book is six cents or thirty-six cents for the entire set. This includes the postage; issued by the General Passenger Department, Boston & Maine Railroad, Boston, Mass. This department has also just issued a remarkably fine and comprehensive folder entitled, "Resorts and Tours," which illustrates and describes a large number of inviting trips and side trips to the beautiful places with which New England abounds. For the special use of those attending the encampment of the Grand Army of the Republic in Boston in August a folder has been prepared illustrating the many points of historic interest in that city. These may all be obtained, upon request, from the passenger department.

NOTES.

The Warner & Swasey Company of Cleveland, Ohio, announces that Mr. H. L. Kinsley will represent them in the East. Mr. Kinsley has been with Manning, Maxwell & Moore for the last five and a half years, and previous to that time was with the Hopedal Screw Company.

Railway Appliances Company.—This company announces that they have been appointed exclusive agents for the United States for the railway trade of the Olds Motor Works of Detroit and Lansing, Mich.

Locomotive & Machine Company of Montreal.—The directors have elected the following officers: President, Mr. A. J. Pitkin; first vice-president, Mr. J. E. Sague; second vice-president, Mr. R. J. Gross; controller, Mr. C. E. Patterson. The expenditure of $300,000 for improvements was authorized.

The Broderick & Bascom Rope Company, of St. Louis, closed their works for the day June 25 and sent their entire force of 300 employes and their families to the World's Fair, with all expenses paid. They were taken to the handsome and impressive exhibit of the company, and had the day in the grounds. Such an instructive and enteresting treat has a good effect on all concerned.

Crocker-Wheeler Company.—This well known electrical company announces that in addition to the engineering advice upon design and installation of electrical apparatus for shop equipment which they have been accustomed to give their clients, they have retained the well known firm of Dodge & Day, Modernizing Engineers, of Philadelphia, Pa., who will furnish gratuitously advice upon the latest ideas and results in shop practice.

Northern Electric Motors.—The very attractive design and efficient application of these motors to machine tools have been frequently indicated in this journal but, inadvertently, the fact that the Gisholt Boring Mill, illustrated on page 277 of the July number, was driven by one of them was not mentioned. Because of the interest in the motor and also in the boring mill it is a pleasure to supply the omission now.

The American Nut & Bolt Fastener Company, Pittsburg, Pa., manufacturers of the Bartley Positive Fastener, shipped on July 6 an order from the Morden Frog & Crossing Company of Chicago, Ill., for 29,000 Bartley Fasteners to be applied on frogs and crossings of their manufacture. Large orders have been shipped recently to the Cleveland Frog Crossing Company of Cleveland, Ohio, Union Switch & Signal Company, Swissvale, Pa., and Lorain Steel Company, Johnstown, Pa.

The Crocker-Wheeler Company has made an arrangement with the celebrated engineers, Brown, Boveri & Company, of Baden, Switzerland, and secured their alternating current designs, patents and rights to manufacture in America, and have retained this firm as consulting engineers. The Crocker-Wheeler Company has put on the market alternating current generators, transformers and accessories, adapted to American practice, and opportunities to bid on this apparatus are invited. This company has contracted to furnish a 200-kw., 60-cycle, 440-volt alternating current generator for the Atlanta plant of the Procter & Gamble Company of Cincinnati and the field of alternating current works is entered with vigor.

The Walter A. Zelnicker Supply Company, St. Louis, report several recent sales of their "Zelnicker" portable wheel press. This company has an attractive exhibit in the Transportation Building at the fair, and are showing among other things this wheel press in operation, pressing wheels on and off axles. Blue prints and descriptive circulars will be furnished upon application. Many other of their specialties are exhibited, among them the celebrated "double clutch" car mover which this company manufactures. They report excellent sales of their car mover this year and that the factory is unable to turn them out fast enough. This company will send a sample of their lumber crayon for the asking, and guarantee it longer and better than any crayon on the market.

The St. Louis Transit Company, which operates the larger part of the street car system in St. Louis, has found itself short of power ever since the World's Fair began to attract large numbers of visitors. The traction plant was working at an almost constant 50 per cent. overload, and at rush hours the excess reached extreme proportions. The railway company have now applied to the World's Fair authorities for additional power, with the result that Governor Francis and the fair administration have, by contract, put at the service of the railway company during the day, from 2 p. m., until 7 p. m., when the loads are heaviest, the service of the huge Allis-Chalmers engine in the Machinery Building. This engine, which is coupled to a Bullock electric generator, and which, when operating at 75 revolutions per minute, at a steam pressure of 150 lbs., and operating non-condensing, is capable of developing 8,000 horse-power, is the central feature of the Machinery Building. From 8 p. m. until the fair grounds close this powerful unit supplies the current for the decorative lighting of the buildings and grounds, which forms the most conspicuous attraction of the exhibition. The lighting requires 200,000 incandescent lamps. The traction load which the engine and generator will now carry by contract between the railway company and the exhibition authorities will be at least 3,000 horse-power, to begin with, and may be much increased as the World's Fair crowds are augmented. It is this engine which has won at St. Louis the popular name of "The Big Reliable."

The capital stock of the Standard Roller Bearing Company, Philadelphia, Pa., has been increased from $1,000,000 to $2,000,000. There will be immediately erected a 250-ft. addition to the machine shop and factory as well as an office building two stories in height. This addition will be devoted exclusively to the manufacture of roller bearings, etc., while an addition 50x125 ft., three stories in height, will be made to the ball plant. Two hundred and fifty thousand dollars will be expended in the construction of the buildings and in equipping them with machinery. Contracts for the building and some of the machinery have already been given and it is expected that all of the building operations will have been finished by October 1. Two years ago the Standard Roller Bearing Company purchased in Philadelphia about three acres of ground on the main line of the Pennsylvania Railroad, about fifteen minutes' ride from the center of the city. Upon this property was erected a modern up-to-date machine shop, with power house, forging and hardening departments in separate buildings. Possession was taken of this property January 1, 1903, since which time the company has built and installed its own brass and iron foundries, and at the present time does not purchase anything whatever in the open market except the raw materials for its foundries and steel from which to make bearings, manufacturing all other devices themselves. The business continues to grow so rapidly that it has become necessary to build the extensions above noted. For about one year past the plant has been running twenty-four hours per day and for the past six months the ball plant has also been running day and night.

Manning, Maxwell & Moore report that they have just received a large order, amounting to between $150,000 and $160,000, from the Illinois Central R. R., for machine tools to be used in the various shops on the system. This order is the largest which has been placed for some time and includes a full line of railroad shop tools such as driving wheel lathes, steel tired wheel lathes, axle lathes, large and small engine lathes, brass lathes, car wheel borers, vertical and horizontal boring machines, radial drills, shakers, planers, slotters, bolt cutters, grinding machines, centering machines, punchers, shears, steam hammers, woodworking tools, and a full line of toolroom tools and milling machines. They have also secured an order for all the traveling cranes required in the shops of the system. They also announce that the Central Railroad of New Jersey has placed an order with them for a large number of radial drills, engine lathes, grinders and woodworking tools.

MASTER MECHANICS' ASSOCIATION.

Thirty-seventh Annual Convention.

Saratoga, N. Y., June 27 to 29.

ABSTRACTS OF REPORTS AND PAPERS (CONCLUDED).

LOCOMOTIVE FRAMES.

COMMITTEE—T. S. LLOYD, S. M. VAUCLAIN, J. E. SAGUE, REUBEN WELLS, S. HIGGINS, A. LOVELL.

Your committee endeavored to construct a composite drawing, in hope of illustrating in graphic form the combined experience as illustrated by the drawings furnished, but reluctantly had to abandon the idea after repeated ineffectual trials.

A careful scrutiny of the material conveys no information as to why the particular frames in question break; nothing to indicate *per se*, that the material from which the frames were made had anything to do with the fractures. The breakages reported are not confined to any particular locality; they show cracks in and about all pedestal jaws; in fact, as many fractures back of leading axle as in front of and about same; also that the fractures occur just as frequently in the solid parts as through the bolt-holes.

The total number of locomotives in the country is about 44,000. Percentage of total number of locomotives covered by the replies is 48 per cent.

The causes of fracture may be classified as follows: (*a*) Design. (*b*) Imperfect welds and faulty material. (*c*) Inertia of the boiler with reference to the frames, augmented by high cylinder saddles and accompanying high center of gravity of the boiler; the initial cause, the inertia of the boiler when front bumpers strike an obstruction or when brakes are suddenly applied. The fractures show mainly between the cylinders and front driver. All are not in agreement as to this, however, and attribute the class of breakage located between the cylinders and front driver to (*d*) Presence of water in cylinders, when accompanied by such arrangement of valves that prevents the water getting away quickly and freely.

A discussion, bearing mainly on point (c), furnished by one of the members, is as follows:

"There seems to be no question but that the fractures are usually located between the cylinder saddle and the rear of the first pedestal, but it should be further determined whether or not the cracks start from the bottom of the rail. If they do, then the bending moment due to the inertia of the boiler when the motion of the frame is suddenly arrested cannot be a cause of failure, because the bending moment induced by such force would put the top of the rail in tension and the bottom in compression, and the crack would therefore start from the top, as previously explained, except when coupling. If they start from the corner of the pedestal it is reasonably certain that the failure is caused by a loose bolt or light design of pedestal binder. It is very probable that the binder bolt will show a very much larger percentage of failures extending in the corner of the pedestal to the top of the rail than the clip pedestal brace, because of the difficulty of securing a bolt sufficiently large to prevent it stretching in service. Those failures which occur in the front of the pedestal cannot be assigned to this cause (unless the pound would strain the frame in a place of weaker section), and in failures of this nature the design of cylinder fastening and keys should be thoroughly examined. It might be well to point out that the bending moment induced by the pull of the drawbar would be at a maximum at a point between the front pedestal and the front cylinder. A stress from such a cause would start a crack from the bottom of the rail. If the frames break from a definite load or fiber stress, then a good grade of cast steel should give equal, if not better, results than wrought iron, and the steel should be of a moderately stiff grade. If, on the other hand, the frames break by a definite amount of distortion or bending, then wrought iron or soft steel would give better results, inasmuch as it would take a smaller force to bend this material a certain amount, and the fiber stress induced would therefore be considerably less in the case in which the stiff steel is used."

Professor Lanza has fully discussed the static loads and stresses on frames; these show that the frame is amply strong to resist any such stresses.

The inertia of the boiler in accelerating or retarding the train has also been given as a possible cause of breakage. Since frames never start to break from the top but always from the bottom of the rail, it is evident that the inertia of the boiler while the train is being retarded cannot be a cause of fracture, but the bottom of the rail is put in tension in overcoming the inertia of the boiler while the train is being accelerated.

From the calculations [Not reproduced.—Editor.] the following conclusions may be drawn:

1. The inertia of the boiler following the sudden application of brakes cannot produce a sufficient force to break the frame.

2. The inertia of the boiler due to the acceleration of the train, by acting with other forces, such as those produced by water in the cylinders, may bring about fracture.

3. The dynamic effect of the compression of water in the cylinders is the only force which, unaided, can cause failure of the frames by fatigue.

It may be well to point out that when the right side leads, the right side always pounds harder than the left. This is due to the fact that when the right crank passes the forward dead center the left cylinder is pulling forward, so that it aids the right cylinder in throwing the right box against the back jaw of the pedestal. The same is true on passing the back dead center, but when the left crank passes the forward center the right cylinder is pushing on the pin, thus subtracting from the left cylinder in pushing the left box against the back jaw of the pedestal. This should result in breaking more right than left frames when the right side leads, and vice versa when the left side leads.

The discussion of piston valves is not within the scope of this report, and the subject is alluded to only on account of the apparent difficulty of providing adequate relief from the presence of water. It is therefore thought pertinent to suggest that perhaps this side of the question should be given more care and attention than it has received heretofore.

The experience of two large roads, as reported to your committee, is quite significant. Each refers to a class of locomotives similar in every particular, except that a portion of each class have double front rails and slide valves, while the balance are equipped with single front rails and piston valves. The report states that all the frame failures with these locomotives are confined to the engines having single front rails and piston valves, the fractures located between the cylinder and front axle.

While it is true that no one cause for frame breakage can be given, it is safe to say that all the reasons assigned are at least contributory causes and should be taken into the account.

(As indicating what the committee considers good practice for reproduction in cast steel, a large number of frame drawings have been selected, and these are given in the report.)

The representatives of a number of steel makers examined and approved the frame designs accompanying this report, and also held independent meetings, agreeing on the following specifications:

SPECIFICATIONS FOR CAST-STEEL LOCOMOTIVE FRAMES.

Material:

Acid open-hearth steel .... { .28 carbon. .05 phosphorus. .05 sulphur. .60 manganese. }

Frames will be rejected that show less than .20 or over { .35 carbon. .06 phosphorus. 06 sulphur. 70 manganese. }

Tensile strength per square inch not less than 55,000 lbs.
Elongation in 2 ins. not less than 15 per cent.
All frames to be annealed.

Relating to the method of manufacture, a member contributes as follows:

"It may be well to determine whether or not the cast-steel manufacturers are all casting their frames in a manner to secure the best possible results. The method of casting, location of gates and headers, all have a very important part upon the life of the frame. It is the usual practice to cast the frame on an incline, the front end of the frame being at the top, the metal being poured into a riser at the back end of the frame, which is at the lowest point. This method results in washing the dirt and gases to the front end of the frame, and we have defective metal at the point at which the frames are most prone to break. It would therefore seem desirable to reverse this method and mold the frame so that the front end is at the lowest point and pour them through a gate leading into the two front rails. It would also seem inadvisable to place the riser at the point of the juncture of the pedestal leg to the top rail, so as to avoid any impurities separating at this point and prevent shrinkage cracks due to the different rates of cooling of the risers and of the frame section proper. It would no doubt be an improvement to locate the riser on the pedestal at a point between the tip and bottom rail.

"It seems that these points have as much bearing upon the life of the frame as the care that all the steel foundries exercise in using a high grade of material and in carefully annealing their castings.

"Relative cost of iron and steel frames: It may be advisable to state the relative cost of a finished iron or steel frame. In addition to the first cost, there is a certain amount of smith-shop work that must be done upon a steel frame before it can be bolted to the planer. By care in the steel foundries this can no doubt be reduced to a very low figure, but at present they do not exercise sufficient care to keep this expense within reasonable bounds.

"The cost of machining is also higher for steel frames, so that there is less difference between the final cost of the iron and the steel frame than the first cost would lead one to suspect."

Your committee considers cast steel a better material for locomotive frames than wrought iron.

The tensile strength of the steel suitable for frames is about 75,000 lbs. per square inch, as compared with 53,000 to 54,000 lbs. per square inch for the best hammered iron.

The cast-steel frame is practically homogeneous; that is to say, there are no welds, and it is of a uniform texture throughout its entire length.

The number of projections required for the reception of brake work, tumbling shafts, rocker pins, etc., seriously complicates the production of modern frames in hammered iron, whereas the reverse is true in the manufacture of cast-steel frames.

Generally speaking, steel is intrinsically superior to wrought iron, and all the difficulties experienced with cast steel are mainly chargeable to either design or method of manufacture, and not to the steel *per se*.

To abandon steel for such reasons is a reflection on our engineering skill and manufacturing abilities. Therefore we should devote our time and skill to the improvement of the art, and thereby approximate more nearly the possible theoretical advantages.

The following points are offered, the observation of which your committee hopes will go a great way toward mitigating the evil:

1. Sensible design.
2. Material, cast steel, made to a rational specification; careful foundry manipulation, adequate and suitable annealing.
3. Provide such form of bracing as will prevent "weaving." By weaving is meant a movement of one side independently of the other, or of the separate parts or joints with reference to each other locally, as *per contra* a movement of the frames as a whole, in unison. The bracing should be so designed that the bending, if any, should be synchronous as referred to the connected parts.
4. The clip form of pedestal binder preferred to the thimble and bolt type.
5. Provision for quickly and adequately draining cylinders. This point is just as important with slide as with piston valves.
6. Frames with single front rails should be made stronger and means provided to stiffen same back of cylinders or between cylinders and front driver.

It would seem from a study of the replies that, for the present at least, there is an intimation that the double front rail type is stronger, *per se*, and stiffer in a vertical direction, and yet as flexible longitudinally as the single front rail form; yet this conclusion is offered with hesitation, owing to the obscurity of the evidence. It is given, however, with the hope of provoking discussion or leading to special investigation.

The great success and satisfaction foreign roads are having with the so-called plate or girder form of frame, considered in the light of their conditions—and they have used both bar and plate frames—give us just a hint or suggestion that perhaps we may have something to gain by looking into this design a bit when scheming on future improvements.

VARIABLE-SPEED MOTORS.

A PAPER BY C. A. SELEY.

During the convention of 1903, in the discussion of the committee report of electrically-driven shops, the matter of varying speed of motors by field control was debated, but left in a somewhat uncertain state by reason of lack of data.

The writer promised, if given the opportunity, to present to this association the results of tests made on machines driven by individual motors on a two and three-wire direct-current system as developed at the East Moline shop of the Rock Island System. Very complete tests of all motors and controllers have been made at these shops and certain typical ones are selected for this report.

The tests were made by Mr. S. B. Seaman, of the G. E. Co., and Mr. C. H. True, assistant superintendent of shops, to whom I am indebted for the data. The variable-speed motors at these shops may be subdivided into four types, namely:

I. Variable-speed motors having a controller to operate on a three-wire system, enabling the machine-hand to operate the motor on either of the two voltages. Further speed variation is obtained on each voltage by introducing or cutting out resistance coils in series with the motor field. This motor field is always across the outside wires of the three-wire system, and therefore, on the maximum obtainable voltage. The rheostat governing the field current is operated through the controller.

II. Variable-speed motors having a controller to operate on a two-wire system. Speed variation is obtained by means of a bank of resistance coils in series with the motor field, and operated through the controller.

III. Variable-speed motors having separated starting boxes with an auxiliary rheostat in the field circuit and operated by a hand wheel.

IV. Variable-speed motors having a reversible controller similar to those in use in street-car service and to reverse the direction of motion of the motor when desired.

Type I is used on boring mills, slotters, driving wheel and engine lathes. Type II is used on car-wheel borer and car and truck-wheel tire-turning lathes. Type III is used on planers and cylinder-boring machines. Type IV is used on bending rolls.

The following tests were made on motors on the various tools mentioned above, each being tabulated, giving the kind of machine, class of work and the electrical horse-power.

Tests 1 to 6 were made on motors of Type I. Column 1 shows the position of the rheostat arm. There are for each voltage sixteen successive steps, giving sixteen different speeds on each voltage. These positions are given by numbers indicating the number of contacts from the O point to where the rheostat arm is set. Column 2 gives the field current and column 3 the armature current. Column 4 gives the armature voltage, which is about 115 volts over the first range of speed, and 230 volts over the second. Column 5 gives the electrical horse-power delivered to the motor. Column 6 gives the cutting speed in feet per minute.

Tests 7 and 8 are of motors of Type II, and tests 9 to 11 are of motors of Type III. Test 12 is of a group of tools on a motor-driven line shaft.

TEST 1.—69-IN. DRIVING WHEEL LATHE, TURNING 62½-IN. TIRES; MOTOR TYPE CK. 8-15-150/600.

Rheo-stat.	Field Amps.	Armature. Amps.	Armature. Volts.	Elec. H.P.	Cutting Speed. F.P.M.	Remarks.
00	5.55	5	118	1.6	....	Motor running light. Two chips, 3-16 x ¼ deep x .089 per rev.
0	4.70	22	104	..	7.5	
3	4.00	23	116	4.0	8.0	
4	3.90	23	116	..	....	
5	3.30	26	116	..	....	
6	3.10	25	116	..	....	
7	2.90	27	116	5.1	....	
9	2.90	25	116	..	....	
10	2.45	26	116	..	....	
11	2.20	30	116	5.3	....	
12	1.95	30	116	..	11.45	
14	1.95	30	115	..	....	
16	1.50	38	113	6.3	12.90	
0	4.60	36	230	12.5	14.60	

TEST 2.—SPEED VARIATION, WHEEL LATHE WITHOUT LOAD.

Rheostat.	Field Amperes.	Volts.	R. P. M.
Off.	3.00	114	0
1	5.55	114	150
2	4.80	113	158
3	4.15	113	165
4	3.75	113	170
5	3.25	113	175
6	3.00	112	185
7	2.75	111	195
8	2.50	114	205
9	2.30	113	215
10	2.15	114	225
11	2.00	113	230
12	1.90	113	240
13	1.80	113	250
14	1.70	113	265
15	1.60	114	275
16	1.55	114	295
1	5.45	227	290
16	1.55	227	630

TEST 3.—18-INCH SLOTTER; MOTOR, TYPE CK. 8-15-150/600.

Rheostat.	Amperes.	Volts.	El. H. P.	Remarks.
3	1 to 10	115	1.4	Chip 5-16 x 3-64.
8	1 to 24	115	3.7	Chip ⅝ x 3-64.
8	1 to 30	115	4.6	Chip ¾ x 3-64.
12	1 to 28	115	4.3	Chip ½ x 3-64.
16	4 to 10	115	1.4	Chip 1-16 x 3-64.

Slotter was making 2 cycles on the 12th point of rheostat on work about 5 inches deep.

TEST 4.—72-INCH BORING MILL, BORING STEEL TIRE, 52 INCHES INSIDE DIAMETER; MOTOR, TYPE CK. 6-10-275/1000.

Amperes.	Volts.	El. H. P.	Cut F. P. M.	Remarks.
17	115	2.6	17.7	
23	115	3.1	18.5	
26	115	3.5	18.5	
30	115	4.0	19.4	One chip ¼ x 3-64.
33	115	4.4	20.4	One chip 3-16 x 3-64.
39	115	5.2	22.2	Chips of dark blue.

The following readings were taken at intervals of approximately three seconds:

44	115	...	22	Two chips, ¼ x 3-32 each. Cutting tools would not stand up under this work. Although there was an excessive ampere overload there was no sparking or heating at any point about the motor.
48	115	4.8	22	
37	115	...	22	
39	115	...	22	
38	115	...	22	
52	115	...	22	
50	115	...	22	
50	115	...	22	
48	115	...	22	
49	115	...	22	

TEST 5.—DRIVING AXLE LATHE; MOTOR, TYPE CK. 8-15-150/600.

Rheo. stat.	Field Amps.	Arm. Amps.	Volts.	El. H. P.	Cut F. P. M.	Remarks.
0	5	29	114	5.9	17	Two cuts on 8-in. axle, 3-16 x 5-64.
2	..	31	112	...	..	
3	4	32	111	...	..	
4	3.9	33	112	6.15	..	
5	3.3	35	112	...	..	
6	3.1	36	112	...	18.7	
7	2.9	39	112	6.85	..	
8	2.8	42	112	...	..	
9	2.6	44	112	...	21.9	
10	2.4	47	114	8.0	..	
11	2.2	48	116	...	..	
12	1.9	52	118	8.7	25	

Did not get over on to 230-volt side.

TEST 6.—36-IN. TRIPLE-GEARED LATHE; MOTOR, TYPE CE. 8-5-400/1600.

Rheo. stat.	Arm. Amps.	Volts.	El. H. P.	Cut F. P. M.	Remarks.
0	1	117	.5	..	Motor light.
0	10	117	1.5	42	Back gear in with heavy cut, cast iron, 11 ins. diam.
0	22	117	3.5	42	Back gear in, light.
4	1.5	118	.7	48	Back gear in with heavy cut, cast iron, 11 ins. diam.
4	8	118	1.3	48	
4	23	118	3.7	48	
4	30	118	4.9	48	
4	40	117	6.3	48	

TEST 7.—42-IN. STEEL-TIRE LATHE; MOTOR, TYPE CE. 6-10-550/1100.

Rheo. stat.	Field Amps.	Arm. Amps.	Volts.	El. H. P.	Cut in F. P. M.	Remarks.
0	3	7	236	3.1	...	Lathe running light.
0	3	12	229	4.7	9.6	Starting two cuts 30-in. wheels, 3-32-in. feed.
4	1.9	13	231	4.6	15	2 cuts, 3-32 x 3-32.
5	1.75	23	231	5.5	15.2	2 cuts, 3-16 x 3-32.
6	1.42	30	230	9.7	15.7	2 cuts, 3-16 x 3-32.
8	1	34	230	10.7	16.1	2 cuts, ¼ x 3-32.
10	1	36	229	11.3	17.2	2 cuts, ¼ x 3-32.
12	1	38	230	12	21.8	2 cuts, ¼ x 3-32.

TEST 8.—SPEED VARIATION, 42-IN. STEEL-TIRE LATHE WITHOUT LOAD.

Rheostat.	Field Amperes.	Volts.	Spindle R.P.M.
1	3.00	230	1.22
2	2.55	230	1.33
3	2.20	230	1.43
4	1.95	230	1.53
5	1.75	230	1.62
6	1.62	230	1.62
7	1.45	230	1.66
8	1.35	230	1.71
9	1.25	230	1.81
10	1.25	230	1.87
11	1.15	230	1.93
12	1.12	230	2.00
13	1.05	230	2.20
14	1.00	230	2.40
15	.95	230	2.50

TEST 9.—SPECIAL ROD PLANER; MOTOR, TYPE CK. 8-15-275/550.

Rheo-stat.	Field Amps.	Arm. Amps.	Volts.	El. H.P.	Cut in F.P.M.	Remarks.
0	4.8	5	227	3	..	Planer running light
0	4.8	20	225	7.5	17	2 cuts, 3-16 x .083.
2	3.1	21	224	7.2	20	Cutting.
2	3.1	6	224	..	..	Returning.
3	2.2	25	225	8.2	24	Cutting.
3	2.2	5	225	..	..	Returning.
4	1.8	30	228	9.7	28	Cutting.
4	1.8	6	228	..	..	Returning.
5	1.5	32	226	10.1	32	Cutting.
5	1.5	9	226	..	..	Returning.
6	1.2	36	225	11.2	35	Cutting.
6	1.2	10	225	..	..	Returning.
7	1.1	36	226	11.2	38	Cutting.
7	1.1	11	226	..	..	Returning.
8	1.	36	224	11.1	40	Cutting.
8	1.	12	224	..	..	Returning.
9	.85	44	225	13.5	45	Cutting.
9	.85	16	225	..	..	Returning.

This planer has done work on babbitt metal at the rate of 70 feet per minute, the motor running cool and sparkless at 1,300 R.P.M., although the maximum rated R.P.M. is but 550.

TEST 10.—48 BY 48 BY 6 PLANER; MOTOR, TYPE CK. 8-15-275/550.

Rheo-stat.	Field Amps.	Arm. Amps.	Volts.	El. H.P.	Cut in F.P.M.	Remarks.
0	4.8	12	224	5	..	Cutting 7-16 x 1-32 C. I.
0	4.8	14	224	5.7	..	Returning.
6	1.2	12	224	..	18	Cutting.
6	1.2	14	224	..	..	Returning.
10	1	13	224	..	22.5	Cutting.
10	1	14	224	..	..	Returning.
14	.8	18	224	5.7	..	Cutting.
14	..	20	224	6.3	..	Returning.
15	.8	20	224	..	..	Cutting.
15	..	21	224	..	..	Returning.
16	.75	26	224	7.9	..	Cutting.
16	..	28	224	8.5	..	Returning.

In order to show the variation in load on the motor, the following readings were taken on one point of the rheostat:

0	..	12	224	5	..	Bed returning.
..	..	32	224	9.6	..	Reversing to cut.
..	..	14.5	224	5.7	..	Cutting.
..	..	54	224	15.6	..	Reversing from cut.
..	..	12	224	5	..	Returning.

TEST 11.—54 BY 54 BY 34 FRAME PLANER; MOTOR, TYPE CL. 6-20-375/750.

Rheo-stat.	Field Amps.	Arm. Amps.	Volts.	El. H.P.	Cut in F.P.M.	Remarks.
0	5.6	12	230	5.4	12.8	Planer running light
0	5.6	18	228	7.2	..	Returning.
4	2.7	12	230	..	16.75	Two cuts ⅜ x 5-32 C. I.
4	..	18	232	..	..	
8	1.6	14	230	..	22.66	
8	..	20	232	..	..	
12	1.1	18	230	..	28	
12	..	24	232	..	..	
16	..	28	230	8.9	..	
16	.82	22	230	7	31.4	

In order to show the variation in load on the motor, the following readings were taken on the 12th point of the rheostat:

12	1.1	24	230	7.7	28	Cutting.
..	1.1	56	230	17.6	..	At reverse from cut
..	1.1	22	230	..	..	Returning.
..	1.1	30	230	9.5	..	Reversing to cut.

TEST 12.—The following test was made on a motor driving a group of machines in a toolroom. These tools were added one at a time after readings had been taken on the power required for the motor alone, motor and line shaft, and also with the countershafting. The final reading is the total power required, but it is not generally the case that all of the tools of a group are running full at one time:

MOTOR, 15 H.P.; SEMI-ENCLOSED, CONSTANT SPEED, SHUNT WOUND, SILENT CHAIN DRIVE, SHORT CENTERS.

Reading.	Amps.	Volts.	El. H. P.	Remarks.
1	5	235	1.6	Motor running light.
2	6	238	1.9	Motor running line shaft.
3	11	226	3.3	Motor, line and countera of following tools.
4	12	225	3.6	No. 3 LeB. milling machine fluting tap.
5	13	227	3.95	No. 3 LeB milling machine fluting reamer.
6	18	226	5.4	24 x 24 Planer at reversing point.
7	20	227	6.1	14-inch lathe, boring 1⅜-inch hole.
8	26	228	7.0	10-inch lathe, 1-16 cut.
9	26	229	7.9	14-inch lathe running to capacity.
10	30	229	9.2	21-inch drill press drilling 1-inch hole in steel.
11	37	228	11.3	Tool dresser.
12	38	228	11.6	Power hack saw.
13	44	227	13.4	Two aut. tool grinders.

BOILER DESIGNS.

COMMITTEE: D. VAN ALSTYNE, W. F. M. GOSS, C. E. FULLER, H. T. BENTLEY, O. H. REYNOLDS.

With reference to the location of water glass and gauge cocks, we recommend that the lowest visible part of the water glass and lowest gauge cock be not less than 3 ins. above the highest point of the crown sheet for curved and flat crown sheets, and that the water glass and gauge cocks be as near the vertical center line of the boiler as they can be conveniently located without having the gauge cocks out of reach of the engineer. We also recommend 8 ins. of exposed length of water glass and three gauge cocks with vertical spacing of 3-in. centers.

Replies indicate that crown sheets, sloped ⅝ in. per foot, represent very general practice, and that this slope has proved satisfactory.

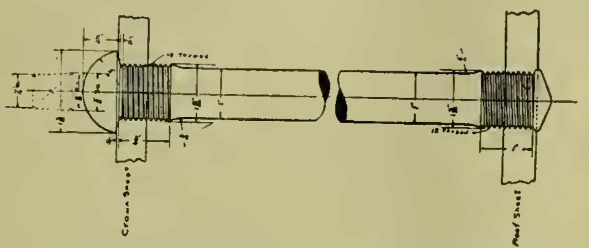
For various reasons given, an automatic low-water detector seems not to be a desirable attachment to locomotive boilers.

Regarding the best form of radial stays, the design shown in the accompanying engraving appears to be general practice, and is recommended.

In order to obtain information as to the temperatures inside a boiler as related to leaky flues and burned side sheets, the committee made temperature tests with fusible metal in the water leg, between the flues and inside flues plugged up. The results are given in Tables I and VI inclusive. While the tests show temperatures considerably above saturated steam temperatures in most cases, the committee has concluded that the method of determining temperatures by means of fusible metal is not satisfactory, and believes that temperatures should be determined by more delicate means, such as the thermopile, and that such determinations should be as numerous as possible in order to trace the direction of circulation in the boiler. On the other hand, it is quite possible that the very high temperatures which are probably required to destroy sheets and cause leaky flues are confined to the sheets themselves, and that little if any higher temperatures exist in the water than have already been found by the fusible metal tests.

This point is one which, so far as we know, is definitely determined, although it has been proven that the temperature of the sheet approaches much more closely that of the water than that of the heated gases. It is essential that the circulation within the boiler shall follow such lines and proceed with such regularity that solid water many overlie all portions of the heating surface.

Since circulation is due to the excess of weight of a comparatively cool column of water over a hotter and lighter body, or a mixture of hotter water and steam, the design of boiler which least impedes the flow due to this head will permit of the most rapid circulation, and hence, most rapid carrying away of heat from sheets. It would follow also that the greater the depth of boiler the greater the head to produce circulation at the point where most needed, namely, just above the fire line.



BOILER CROWN STAY.

It would appear that for a given boiler there is a maximum allowable steam generation without injury to the sheets, determined by a maximum possible circulation in that particular boiler.

Through the courtesy of Mr. F. H. Clark, superintendent motive power, Chicago, Burlington & Quincy Railway, the committee is permitted to present the results of experiments made to determine the temperature of the water in various portions of the boiler when the locomotive is standing, no steam being used from the boiler excepting as required to supply the injector. The results of these experiments indicate that when the feed is delivered in the usual manner to the boiler, the water in the water-leg on the opposite side may have a temperature 100 degrees less than the normal temperature of the boiler, and that the intermixing is greatly improved by using a perforated pipe extending beyond the check within the boiler either longitudinally or transversely, and, also, by the omission of a pipe but by means of an orifice which opens upward. In the progress of the tests it was found also that when the intermixing was most complete the drop in steam pressure was greatest, so that it may almost be said that the degree of intermixing in any given boiler may be judged by noting the rapidity with which the steam pressure falls under the action of the injectors when the locomotive is at rest. The details of these tests and of the results obtained from them are given in Appendix 3.

Recognizing the difficulty of getting conclusive information from road tests we recommend that laboratory tests be made for the purpose of determining the rapidity of circulation in a boiler generating varying amounts of steam up to its maximum, and also for determining temperatures in the sheets where the greatest trouble is experienced.

SUBJECTS FOR 1905.

COMMITTEE—H. BARTLETT, J. F. DEEMS, A. W. GIBBS.

COMMITTEE WORK.

1. Motive-Power Terminals.—What can and should be done to reduce locomotive terminals to the basis of a machine for treating and handling engines, apart from the question of housing, the object being prompt handling of power, greater efficiency in service and less detention at terminals, while affording more time and better facilities for care and repair of engines.
2. The best practice in ashpan construction, with special reference to wide-firebox engines having trailing wheels—consideration to embrace best design of trailing-wheel arrangement.
3. Merits of the balanced compound locomotive.
4. Investigation of design and material for locomotive fronts and front doors, with a view to affording relief from leaky front ends.
5. Investigation of the subject of staybolts—committee to consider the material, iron, bronze and copper, as well as the form of the bolt under the conditions and temperatures met in service.
6. Modification in design of wide fireboxes of locomotives, with a view of limiting injury in case of low water, committee to consider the question of fusible plugs, as to number, location and size, and also the application of water-circulating pipes from throat to crown sheet, and other devices which will localize the damage.
7. The practicability of water-softening for locomotive use by means of chemicals or the application of heat, and the maximum cost per 1,000 gals. permissible, that the expenditure could be recovered in reduced motive-power expenses.
8. The value of superheated steam for locomotive work.
9. The advisability of a 4-4-2 Atlantic type locomotive for light passenger service and a 4-6-2 locomotive for fast freight service.
10. Committee appointed to act as an advisory committee to the Pennsylvania Railroad Company with reference to the locomotive-testing plant at St. Louis fair to present to Master Mechanics' Association summarized statement of important results which are obtained.
11. Best method of heating and ventilating roundhouses.
12. Best method of fire protection for railroad shops.

INDIVIDUAL PAPERS.

1. The strict observance of the Golden Rule in management of workshops.
2. The most efficient organization for mechanical department.
3. The average engine hours locomotives are in service, in shop under repairs, or waiting to get in shop, per annum, and the percentage of total time locomotives are actually in and out of service per annum.
4. Shop layouts for roads having 350, 500, 750 and 1,000 locomotives.

COST OF LOCOMOTIVE REPAIR SHOPS.

COMMITTEE—R. H. SOULE, L. R. POMEROY, T. H. CURTIS, S. F. PRINCE, A. E. MANCHESTER.

Your Committee on Cost of Locomotive Repair Shops submits, in tabulated form, figures obtained from members; as much data relating to the cost of car-shop buildings was returned, it has been included in the statements.

In selecting units on which to base cost figures the square foot and the cubic foot have generally been used for buildings; in power plants the engine horse-power, boiler horse-power and generator kilowatts have also been used; in roundhouses the stall has been taken as the proper unit.

In computing the square feet of buildings the outside dimensions have been used (giving the ground area covered); in computing the cubic feet of buildings the average external height has been taken (giving the total volume occupied).

The circular of inquiry sent out by the committee contained the following clause:

"The committee will treat the data confidentially and use them only in the determination of units, averages, etc., which will be embodied in its report to the association; in no case will the committee publish the name of the railroad, or the locality, or the officer giving the data."

It was foreseen that such a stipulation was necessary in order to secure any data; and in the figures which follow, the different items are identified by reference numbers only, with such explanatory notes added as will aid in interpreting the unit prices; shops built prior to 1895 are designated as "old," those built since 1895 as "modern"; in a few cases the notes are based on uncertain information and are followed by an interrogation mark (?).

POWER PLANTS.—BUILDINGS ONLY (WITHOUT CONTENTS).

Item.	Cost per Sq. Ft.	Cost per Cu. Ft.	Notes.
1	2.14	.076	Far West, modern, brick and concrete, with steel frame roof.
2	2.25	.057	Middle West, modern; brick and steel, fire-proof, basement under engine room.
3	2.45	.060	East modern; brick and steel with roof of tile and cement, the whole thoroughly fire-proof, a very fine and somewhat ornate building.
4	1.71	.064	Middle West, old; brick and steel with shingle roof.
5	3.50	....	Southeast, modern; brick and steel, building relatively long and narrow, increasing ratio of wall area to floor area; very deep and heavy foundations, coal trestle inside of boiler room. (These figures should be used with caution as they are not official, but were taken from a published statement.)
6	4.20	.130	Middle West, modern; brick and steel, a very large plant, has two small wings which increase the ratio of wall area to floor area; basement under whole of engine room and about half of boiler room; interior finish highly ornamental.
7	2.42	.071	Middle West, modern; brick and steel, low (on account of locomotive boilers), no basement, only pits.
8	6.48	.138	Middle West, modern; brick and steel, basement throughout, overhead coal bunkers, fireproof, considerable architectural ornamentation.
9	3.32	.083	Middle West, modern; brick and steel, fire-proof.
10	2.83	.157	East, modern; concrete construction including the roof, low building, basement under the engine room only.
11	2.85	.084	Middle West, modern; brick and steel, basement under part of engine room only.
12	3.15	.120	West, modern; brick and steel.

POWER PLANTS.—BOILERS.

With Settings (except where noted).

Item.	Cost per B. H. P.	Notes.
13	11.70	Marine type internally fired.
14	13.64	Horizontal tubular, bricked in.
15	10.64	Water tube.
16	11.02	Water tube.

17	20.40	Vertical water tube, bricked in and including automatic stokers, stoker engines, stoker engine piping, fan engine and piping, feed pumps and piping.
18	13.09	Horizontal water tube with superheater.
19	12.00	Horizontal return tube, boilers in units of 100 horse-power.
20	17.39	Horizontal water tube boilers in 300 horse-power units; automatic stokers included.
21	12.84	Horizontal fire tube.
22	8.44	Horizontal water tube; without settings.
23	15.35	Water tube, including automatic stokers.
24	19.25	Horizontal water tube; closed ash pit for forced draft.
25	13.25	Horizontal water tube in 275 horse-power units.
26	14.45	Horizontal water tube, includes feed-water heater and feed pumps.
27	6.50	Plain horizontal, brick set.
28	11.87	Vertical water tube in 800 horse-power units.

POWER PLANTS.—MECHANICAL STOKERS.

Item.	Cost per B. H. P.	Notes.
29	4.48	Chain grate.
30	3.09	

POWER PLANTS.—COAL AND ASH HANDLING APPARATUS.

Item.	Cost per B. H. P.	Notes.
31	4.46	Wooden trestle 12 feet high, with sloping bottom (for shooting coal into boiler room), and necessary incline approach.
32	4.75	Power conveyor for coal and ashes.
33	2.14	Coal handling apparatus, simply gravity hoppers and push cars; ash handling apparatus, buckets handled by electric telpher.
34	6.16	Includes coal conveyor from basement to roof, and separate ash conveyor; also a seperate ash house with connecting tunnel, elevator, bin, etc.
35	5.30	Based on ultimate boiler horsepower capacity of the plant.
36	3.42	Includes crusher, conveyors, elevators, etc.
37	1.73	Designed large enough to take care of an eventuel one-third increase in boiler capacity.

POWER PLANTS.—MECHANICAL DRAFT APPARATUS.

Item.	Cost per B. H. P.	Notes.
38	1.30	Based on ultimate boiler horse-power capacity of the plant; includes stack 7 feet 8 inches diameter, by 60 feet high.
39	1.45	Includes small sheet-iron stack 5 feet diameter and 25 feet high.
40	2.74	Induced draft, stack extends five feet above roof.
41	1.50	

POWER PLANTS.—ECONOMIZERS.

Item.	Cost per B. H. P.	Notes.
42	2.33	Based on ultimate boiler horse-power capacity of plant; includes setting, bricking in, etc., complete.
43	3.75	Quoted by E. B. Katte (Electrical Engineer N. Y. C. & H. R. R. R.), in paper entitled "An Economizer Discussion," read at the November, 1903, meeting of the New York Railroad Club, as representing cost of economizers completely erected in New York city; this estimate is based on 3.25 square feet of economizer tube heating surface to each boiler horse-power.
44	5.40	Quoted by Henry G. Meyer, Jr., in his book "Steam Power Plants," Chap. VIII, p. 118, as representing cost of economizers (for plants of 1,000 boiler horse-power or over) erected, bricked in and connected, ready for use; this estimate is based on 4.8 square feet of economizer tube heating surface to each boiler horse-power.

POWER PLANTS.—FEED PUMPS.

Item.	Cost per B. H. P.	Notes.
45	1.96	Outside central packed, double plunger.
46	2.66	

POWER PLANTS.—FEED-WATER HEATERS.

Item.	Cost per B. H. P.	Notes.
47	1.28	Open type.
48	.96	Vertical, 48 inches diameter by 9 feet 10 inches high.
49	.50	Open type.
50	.60	Vertical.

POWER PLANTS.—ENGINES DRIVING GENERATORS ONLY.

Item.	Cost per H. P.	Notes.
51	24.80	Horizontal, simple.
52	12.90	Horizontal cross compound, in 300 horse-power units.
53	12.15	One large horizontal Corliss, and one small high-speed, both simple.
54	19.34	Horizontal cross compound in 600 horse-power units.
55	6.66	Horizontal, simple. (?)
56	12.00	Horizontal cross-compound in several units of different sizes.
57	17.62	Average quotations of twenty-six bidders on 350 horse-power compound engines, and nineteen bidders on 225 kilowatts generators for municipal electric light plant at Jamestown, New York, see *Engineering News* (Supplement), of February 11, 1904.
58	10.49	Horizontal cross-compound, in units of 650 horse-power and less.
59	21.45	Vertical compound non-condensing engines in units of 250 horse-power.
60	16.40	Extra strong frames and parts, to stand when necessary very heavy load, in units of 175 horse-power.
61	16.00	Vertical compound non-condensing, in 250 horse-power units.
62	13.60	Part horizontal cross-compound condensing, part vertical compound condensing.
63	11.70	Horizontal tandem compound.

POWER PLANTS.—ENGINES NOT DRIVING GENERATORS.

Item.	Cost per H. P.	Notes.
64	12.80	Horizontal, simple.
65	8.25	Horizontal Corliss in a 350 horse-power unit.
66	8.28	Plain horizontal engine without refinements.

POWER PLANTS.—ENGINES AND GENERATORS DIRECT CONNECTED.

Item.	Cost per H. P.	Cost per K. W.	Notes.
67	36.28	60.64	Simple vertical 250 horse-power engines with engine type 150 kilowatts generators.

POWER PLANTS.—CONDENSERS.

Item.	Engine Cost per H. P.	Notes.
68	5.70	
69	2.26	Surface condenser; includes air pump.

POWER PLANTS.—GENERATORS.

Item.	Cost per K. W.	Notes.
70	28.00	Direct current.
71	20.21	Direct current in 200 kilowatts and 110 kilowatts units.
72	22.89	Direct current in 200 kilowatts and 100 kilowatts units.
73	32.58	Generators in 400 horse-power units; includes also switchboard and station wiring.
74	17.04	Very small generators.
75	17.33	Direct current in 500 kilowatts and 250 kilowatts units.
76	30.48	Average quotations of twenty-six bidders on 350 horse-power compound engines, and nineteen bidders on 225 kilowatts generators for municipal electric light plant at Jamestown, N. Y., see *Engineering News* (Supplement), of February 11, 1904.
77	17.71	Direct current in 400 kilowatts and 75 kilowatts units.
78	22.61	Generators in 75 kilowatts units.
79	19.20	Units of 100 kilowatts direct current at 240 volts.
80	17.40	Units of 150 kilowatts direct current.
81	21.10	Units of 200 kilowatts direct current at 220 volts.
82	20.30	Direct current at 220 volts.

POWER PLANTS.—SWITCHBOARDS.

Item.	Cost per Generator K. W.	Notes.
83	11.30	One small generator, 50 kilowatts capacity.
84	5.20	Direct current only.
85	3.65	Small and simple.
86	7.08	Direct current only.
87	5.33	Direct current only.
88	4.45	In place, but not connected.
89	8.33	Direct current only.
90	2.50	Simple and plain, direct current only.
91	3.50	Direct current 220 volts.
92	4.00	Direct current only.

POWER PLANTS.—AIR COMPRESSORS.

Item.	Cost per 100 Cu. Ft. Free Air per Min.	Notes.
93	508.47	Steam end simple, air end two stage.
94	507.53	Simple steam cylinder; compound air cylinders with inter-cooler.
95	385.00	One large and one small duplex cross-compound.
96	647.00	Steam and cross compound; air end two-stage, units, 1,500 cubic feet free air per minute.
97	412.03	Duplex, steam end compound, air end two-stage, capacity 1,000 cubic feet free air per minute.
98	271.00	Duplex, steam end compound, air end two-stage. (?)
99	400.00	Steam end cross-compound, air end two-stage.
100	290.46	Steam end simple, air end two-stage with inter-cooler, capacity 1,200 cubic feet free air per minute.
101	372.53	Steam end compound, air end two-stage.
102	866.66	Steam end compound, air end two-stage; very elaborate valve gear with refinements in cut-off, etc., capacity 1,500 cubic feet free air per minute.
103	338.20	Single stage air compressor subdivided into two units.
104	370.00	Duplex, steam end simple, air end compound with inter-cooler.
105	682.00	Duplex, steam end compound, air end two-stage.
106	533.00	Steam end simple, air end two-stage.

POWER PLANTS.—PIPING.

Item.	Cost per Engine H. P.	Notes.
107	1.64	Connections close and short.
108	11.67	Includes the Holly automatic return system.
109	7.60	An average installation.
110	7.75	A most complete and well arranged installation; plant has 2,000 horse-power of boilers and 2,250 horse-power of engines; boilers are vertical, requiring a maximum amount of piping.
111	1.94	Small plant, with boilers, feed-water heater, engine and air compressor close together.
112	10.93	Plant includes economizer, induced draft apparatus, hydraulic pumps and accumulator, etc.
113	10.88	A very complete installation, based on rigid specifications.
114	10.72	Designed with a view to an eventual increase of one-third present engine horse-power.
115	4.00	Simple and direct.
116	8.20	Includes hydraulic system.
117	.88	Short, simple and direct.
118	3.78	Simple and direct.

POWER PLANTS.—CHIMNEYS.

Item.	Cost per B. H. P.	Notes.
119	1.12	Steel, 3 feet 8 inches diameter, by 80 feet high.
120	12.62	Hollow brick, 7 feet diameter inside, by 175 feet high.
121	4.93	Common brick, fire brick lining, 7 feet 3 inches inside diameter, and 140 feet high.
122	3.19	Hollow brick, 10 feet inside diameter and 125 feet high, supplemented by undergrate forced draft.
123	2.47	Square brick base 25 feet high, surmounted by steel stack 4 feet 6 inches diameter, and 75 feet high; total height 100 feet.
124	4.25	Circular brick chimney, diameter inside, 6 feet; height, 120 feet.
125	6.74	Hollow brick, 4 feet diameter and 80 feet high.
126	3.33	Steel, brick-lined part way up.
127	4.51	Designed of sufficient size to take care of one-third increase of boiler capacity.
128	9.50	Brick, 9 feet diameter and 188 feet 6 inches high.
129	5.00	Steel, 4 feet diameter and 150 feet high.
130	4.16	Brick.

POWER PLANTS—TOTAL COST.

Item.	Cost per Engine H. P.	Cost per Generator K. W.	Cost per Sq. Ft.	Cost per Cu. Ft.
131	131.33	219.00	11.40	.40
132	140.27	210.00	7.00	.18
133	115.00	167.00	12.20	.28
134	185.06	278.00	11.50	.36
135	129.28	210.60	14.62	.33
136	123.00	191.00	14.30	.36
137	129.00	225.00	10.40	.58
138	90.90	151.50	10.40	.24
139	128.60	211.00	10.55	.31

NOTES.

131. Far West, modern; a substantial, effective plant devoid of ornamentation or refinements; coal dumped from trestle and shoveled, ashes shoveled.
132. Middle West, modern; building has considerable ornamentation inside and out, but the equipment auxiliaries are simple, overhead crane in engine room.
133. East, modern; building has considerable ornamentation inside and out; principally alternating current apparatus with auxiliary direct current equipment.
134. Middle West, modern; includes (besides boilers, engine generators and air compressors), induced draft apparatus, coal and ash handling apparatus, hydraulic plant, etc.
135. Middle West, modern; a very complete plant both mechanically and architecturally.
136 Middle West, modern; large enough to allow for a one-third increase in capacity of the plant.
137. East, modern; fireproof construction throughout.
138. West, modern; a simple but effective plant limited to direct current, no coal or ash handling apparatus.
139. Middle West, modern; condensing equipment.

ERECTING AND MACHINE SHOPS.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building. Only.	Total.
140	3.50	1.08	.71	5.34	.076	.115
141	1.03	2.49	.187	3.70	.034	.123
142	.706	1.78	..	..	.029	..
143	1.67	2.05	.086	3.79	.051	.118
144	2.43	.81	..	..	.051	..
145	1.65	2.69	..	..	.041	..
146	1.80	1.65	..	..	.046	..
147	1.82	..	..	..	.050	..
148	3.08	1.63	..	..	.073	..

NOTES.

140. East, modern; brick and steel, transverse shop, erecting shop has both heavy and light cranes; machine shop has crane service throughout; saw-tooth roof.
141. Middle West, old; brick and wood, transverse shop in two parts, one part one story with slate roof, the other part two stories with gravel roof.
142. Middle West, old; stone and wood, transverse shop, gravel roof supported by posts.
143. Middle West, old; brick with wood and iron roof trussing and shingle roof, longitudinal shop, machine shop on one side, traveling cranes in erecting shop.
144. Middle West, modern; brick and steel, transverse shop, high for two-thirds of width, with heavy crane, the remaining one-third being low, with saw-tooth roof.
145. Middle West three-fourths old, one-fourth new, brick and steel, transverse shop, new part two stories; no traveling cranes.
146. Pacific Northwest, modern; brick and steel, overhead crane.
147. Pacific Southwest, modern; brick and steel, overhead crane.
148. Far West, modern; brick and steel, overhead crane.

ERECTING, MACHINE, BOILER AND TANK SHOPS.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building Only.	Total.
149	1.35	.966	.336	..	.033	..
150	2.20	..	..	..	..	..
151	1.91	..	..	..	..	..
152	2.42	1.50	.866	4.79	.051	.101
153	1.63	..	..	2.00	.017	.021
154	.58	1.48	.246	2.31	.033	.132

NOTES.

149. Middle West, modern; steel and brick, longitudinal shop, machine shop on one side, boiler shop on other side, crane runways throughout.
150. East, modern; brick and steel, longitudinal shop, machine shop on one side, boiler and tank shop on other side; crane runways. (These figures should be used with caution, as they are not official, but were taken from a published statement.)
151. Middle West, modern; brick and steel, longitudinal shop, machine shop on each side (one side two stories), wings have saw-tooth roof; boiler and tank shop is a continuation of erecting and machine shop; crane runways throughout.
152. Middle West, modern; brick and steel, transverse shop; erecting shop has both heavy and light crane, machine shop has partial crane service and boiler shop full crane service.
153. East, modern; brick and steel, longitudinal shop; heavy cranes in erecting shop, crane over one bay of machine shop; boiler and tank shop is a continuation of erecting and machine shops with joint crane service.
154. Middle West, old; wood, transverse shop, no overhead cranes.

ERECTING, MACHINE, BOILER, SMITH AND WHEEL SHOP.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building Only.	Total.
155	2.60	1.33	.475	4.42	.046	.079

NOTE.

155. Far West, modern; transverse shop, concrete, brick and steel, three fire walls, gravel roof, cranes in both erecting and machine shops.

ERECTING, MACHINE, BOILER, SMITH SHOP AND POWER PLANT.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building Only.	Total.
156	2.20	1.39	1.38	4.97	.050	.114

NOTE.

156. West, modern; brick and steel, transverse shop, gravel roof; erecting and machine shop, also boiler shop, same cross section, power plant and smith shop same width but lower; crane equipment erecting and machine shops.

MACHINE SHOP.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building Only.	Total.
157	.952	..	..	..	.038	..

NOTE.

157. Middle West, old; brick and wood, gravel roof supported by posts.

BOILER AND TANK SHOPS.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building Only.	Total.
158	2.98	.72	84	4.54	.083	.127
159	1.58	.40	..	..	.049	..
160	.84	.94	.076	1.87	.033	.075
161	1.66	.48	.083	2.24	.059	.080
162	.99	..	..	..	.025	..
163	1.53	.96	..	..	.095	..

NOTES.

158. East, modern; brick and steel, cranes cover entire floor, saw-tooth roof.
159. Middle West, modern; brick and steel, one-half of width high for crane service, the other half lower and without cranes.
160. Middle West, old; brick and wood, with slate roof.
161. Middle West, old; brick and wood, shingle roof, gallery along one side, cranes over part of floor space.
162. Pacific Southwest, modern; brick and steel, overhead crane, smith shop in one end.
163. Middle West, two-thirds old, one-third new; brick and wood, new part two stories, no overhead cranes. (?)

SMITH SHOPS.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Tools.	Cost per Cu. Ft. Building Only.	Total.
164	..	.734	.110	..	..	..
165	2.63	.982	.171	3.78	.080	.115
166	1.79	1.44	..	..	.049	..
167	.432	2.26	.086	2.77	.019	.126
168	1.06	1.09	.050	2.22	.035	.074
169	2.25	..	..	..	..	..
170	1.43	.665	.435	..	.042	..
171	1.50	..	..	..	..	..
172	2.37	1.96	.348	4.68	.052	.104
173	1.21	..	..	..	.041	.055
174	1.38	..	..	..	..	..
175	.91	.60	..	..	.031	..

NOTES.

164. Middle West, old.
165. East, modern; brick and steel, high and light, thoroughly equipped.
166. Middle West, modern; brick and steel, 100 ft. wide, hip roof without posts.
167. Middle West, old; brick and wood, with slate roof.
168. Middle West, old; brick and wood, shingle roof.
169. Southeast, modern; brick and steel, unusually high (33 ft. from floor to lower chord of roof truss). (These figures should be used with caution, as they are not official, but were taken from a published statement.)
170. Middle West, modern; brick and steel.
171. Middle West, modern; brick and steel, tile and gravel roof.
172. Middle West, modern; brick and steel, brass foundry and car machine shop under same roof; equipment very complete.
173. East, modern; concrete and steel, 80-ft. span, no posts.
174. Northeast, modern; brick and wood, 60-ft. span, no posts, simple construction.
175. Middle West, two-thirds old, one-third new; brick and wood. (?)

IRON FOUNDRY.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building Only.	Total.
176	3.18	..	..	..	..	..

NOTE.

176. Brick and steel, modern; U. S. Navy Yard, Bremerton, Wash.

IRON AND WHEEL FOUNDRY.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building Only.	Total.
177.	.711	..	.432	..	.024	..

NOTE.

177. Middle West, old; wooden building; cost includes several annexes. (?)

PATTERN AND UPHOLSTERY SHOP.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building Only.	Total.
178	.857	..	.131	.988	.043	.050

NOTE.

178. Middle West, old; wooden building, two stories.

PASSENGER CAR REPAIR SHOPS.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building Only.	Total.
179	1.24	..	.016	1.25	.042	.043
180	1.20	..	..	..	..	..
181	2.64	.044	.096	2.78	.099	.105
182	1.34	..	.015	1.35	.056	.057
183	.68	.003	.057	.74	.026	.028
184	.83	..	..	..	.029	..

NOTES.

179. Middle West, modern; longitudinal shop, brick and wood.
180. Southeast, modern; transverse shop, brick and wood; has upholstery and cabinet shops under same roof. (These figures should be used with caution, as they are not official, but were taken from a published statement.)
181. Middle West, modern; transverse shop, brick and steel; includes upholstery and trimming shop and hot-air heating.
182. East, modern; transverse shop, brick and steel, with cement foundations, saw-tooth wooden roof.
183. Southeast, modern; transverse shop, brick up to window sills, corrugated galvanized iron sheathing on wooden frame above, gravel roof, granolithic floor, used also for painting and varnishing. (Identical with Passenger Car Paint Shop No. 193.)
184. Middle West, old; brick and wood. (?)

PASSENGER CAR PAINT SHOPS.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building Only.	Total.
185	1.24	..	.004	1.24	.04	.04
186	1.94	.055	.092	2.09	.072	.078
187	1.02	..	..	..	.033	..
188	1.20	..	..	..	..	..
189	1.01	..	.039	1.05	.035	.036
190	.35	..	..	..	..	..
191	2.36	.009	.056	2.43	.081	.084
192	1.13	..	.009	1.14	.051	.052
193	.68	.003	.057	.74	.026	.028
194	.89	..	..	..	.032	..

NOTES.

185. Middle West, modern; longitudinal shop, brick and wood.
186. East, modern; longitudinal shop, brick and steel, saw-tooth roof, hot-air heating.
187. Pacific Southwest, modern; transverse shop, brick and steel.
188. Southeast, modern; transverse shop, brick and wood; has varnish room and pipe shop under same roof. (These figures should be used with caution, as they are not official, but were taken from a published statement.)
189. Northeast, modern; longitudinal shop, brick and steel; includes small paint, varnish and boiler rooms at one end.
190. South, old; wooden structure.
191. Middle West, modern; transverse shop, brick and steel; includes cleaning room, varnish room and hot-air heating.
192. East, modern; transverse shop, brick and steel, with cement foundations, saw-tooth wooden roof.
193. Southeast modern; transverse shop, brick up to window sills, corrugated galvanized iron sheathing on wooden frame above; gravel roof, granolithic floor; used also for coach repairs. (Identical with Passenger Car Repair Shop No. 183.)
194. Middle West, old; brick and wood. (?)

FREIGHT CAR REPAIR SHOPS.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building Only.	Total.
195	.40	..	.016	.415	.022	.023
196	2.12	.123	.047	2.29	.075	.080
197	.29	..	..	.29	.015	.015

NOTES.

195. Middle West, old; wooden building, longitudinal, entirely enclosed.
196. Middle West, modern; brick and steel, longitudinal; includes cabinet shop and hot-air heating.
197. Middle West, old; large shop, longitudinal; construction not known, but probably wood with partly open sides.

CAR SHOP, PAINT SHOP, PLANING MILL, CABINET SHOP, UPHOLSTERY SHOP.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building Only.	Total.
198	1.48	.302	.216	2.00	.071	.095

NOTE.

198. West, modern; brick and steel, transverse shop; gravel roof with central posts; car shop (for both passenger and freight) and paint shop, one-story, remainder of building two-story, with cabinet shop and upholstery shop over planing mill.

CAR SMITH AND CAR MACHINE SHOP.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building Only.	Total.
199	.77	1.06	..	..	.028	..

NOTE.

199. Middle West, old; brick and wood. (?)

WHEEL AND AXLE SHOP.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building Only.	Total.
200	4.03	2.16	.72	6.91	.16	.276

NOTE.

200. West, modern; brick and steel, for car work only.

CAR REPAIR SHOP AND PLANING MILL.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building Only.	Total.
201	.975	..	..	..	.031	..

NOTE.

201. Pacific Southwest, modern; brick and steel; has intermediate two-story section for sub-departments.

PLANING MILLS.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building Only.	Total.
202	.487	.54	.010	1.04	.026	.056
203	1.15	1.18	.25	2.58	.045	.102
204	.76	1.21	.292	2.26	.033	.098
205	1.85	..	..	..	..	..
206	.37	..	..	..	..	..
207	2.54	1.44	.082	4.06	.095	.153
208	2.53	.558	..	..	.057	..
209	.39	.50	..	..	.014	..
210	.74	.485	.239	1.47	.037	.073

NOTES.

202. Middle West, old; wooden building, tools and equipment very light.
187. Pacific Southwest, modern; transverse shop, brick and steel. vanized iron on insulated wooden frame, basement and one story, gravel roof, mechanical power plant in annex, cabinet shop in wing.
204. Middle West, old; brick and wood, slate roof.
205. Southeast, modern; steel and brick. (These figures should be used with caution, as they are not official, but were taken from a published statement.)
206. South, old; wooden structure.
207. Middle West, modern; brick and steel; does not include cabinet shop, which is separate.
208. Middle West, old; brick and wood; includes pattern shop. (?)
209. Middle West, old; wooden building. (?)
210. West, modern; wooden. (?)

STOREHOUSES.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building Only.	Total.
211	1.142	..	.168	1.31	.044	.050
212	3.60	..	..	..	..	..
213	3.05	..	.67	3.72	.073	.089
214	2.40	..	..	2.72	.110	.124
215	2.00	..	..	..	.050	..

NOTES.

211. Southeast, modern; brick up to window sills, then corrugated galvanized iron on unsheathed wooden frame; two stories, gravel roof, platform, bins, shelves, etc., complete.
212. Southeast, modern; brick and steel, two stories and basement, extensive offices in one end on both floors. (These figures should be used with caution, as they are not official, but were taken from a published statement.)
213. Middle West, modern; brick and wood, three stories.
214. East, modern; concrete construction, one end two stories, upper floor used for offices.
215. Middle West, old; brick and wood, two stories. (?)

OIL HOUSES.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building Only.	Total.
216	5.41	..	1.43	6.84	.208	.263
217	3.52	..	1.55	5.07	.196	.302
218	1.33	..	..	..	.089	..
219	2.15	..	1.34	3.49	.097	.159

NOTES.

216. Middle West, modern; brick and steel, basement and one story, full equipment of tanks, etc.
217. East, modern; concrete walls and roof, one story with deep basement.
219. West, modern; brick and steel, tile roof, two stories.

ROUNDHOUSES.

Item.	Number of Stalls.	Cost per Stall — Building Only.	Tools.	Misc. Eqpt.	Total.
220	18	1,388.88	.....	.....	......
221	46	1,155.00	.....	.....	......
222	10	2,400.00	.....	.....	......
223	10	1,757.70	.....	.....	2,090.60
224	30	......	.....	.....	1,500.00
225	13	1,040.00	.....	.....	......
226	8	2,750.00	.....	.....	......
227	7	1,033.00	.....	.....	......
228	33	......	.....	.....	2,200.00
229	..	......	.....	.....	1,845.00
230	44	1,998.00	133.00	328.00	2,459.00
231	30	4,150.00	.....	.....	......
232	25	1,950.00	.....	.....	2,455.00
233	48	2,480.00	.....	.....	......
234	25	1,719.00	.....	.....	......
235	18	1,011.00	.....	.....	......
236	23	1,065.00	.....	.....	......
237	44	1,740.00	.....	.....	......
238	40	1,875.00	87.50	787.50	2,750.00

NOTES.

220. Middle West, old; 63-ft. span, brick and wood, slate roof, trussed (no posts).
221. Pacific Southwest, modern; 80-ft. span, brick and wood, roof supported by posts.
222. Far West, modern; part 75-ft. span, part 85-ft. span, brick and wood, gravel roof, supported by posts.
223. Far West, modern; 85-ft. span, brick and wood, gravel roof, supported by posts.
224. Middle West, old; 65-ft span, brick and wood, gravel roof, supported by posts.
225. Middle West, old; 78-ft. span, brick and wood, gravel roof, supported by posts.
226. Middle West, modern; 89-ft. span, brick and wood, gravel roof, supported by posts.
227. Middle West, old; 80-ft. span, brick and wood, gravel roof, supported by posts.
228. East, modern; 81-ft. span, brick and steel, gravel roof, supported by flat truss (no posts), rolling steel doors; cost does not include heating equipment.
229. Northwest, modern; 80-ft. span, brick and wood, gravel roof, supported by posts, annex with boilers, heating apparatus (hot air), and air compressor.
231. East, modern; 90-ft. span, brick and steel, slag roof, with crane runway covering outer half of span; has very heavy pile and stone foundations.
232. East, modern; 80-ft. span, concrete and wood, gravel roof, supported by posts.
233. Northeast, modern; 75-ft. span, brick and wood, gravel roof, supported by posts.
234. Northeast, modern; 75-ft. span, brick and wood, gravel roof, supported by posts.
235. Northeast, modern; 72-ft. span, brick and wood, gravel roof, supported by posts.
236. West, modern; 80-ft. span, brick and wood gravel roof, supported by posts.
237. Middle West, part old, part modern; 70-ft. and 85-ft. span, gravel roof, supported by posts. (?)

LAVATORY.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building Only.	Total.
239	..	..	..	2.55	..	..

NOTE.

239. Middle West, modern; average of three large lavatories (including water closets, urinals, washroom and locker-rooms); buildings of concrete and brick, with tile roofs and wooden trusses; cement floors, complete with contents, ready to use.

OFFICE BUILDINGS.

Item.	Cost per Sq. Ft. of Ground Area. Building Only.	Tools.	Misc. Eqpt.	Total.	Cost per Cu. Ft. Building Only.	Total.
240	.306	..	..	..	.030	..
241	8.01	.557	.295	8.86	.167	.187
242	1.04	..	..	..	.034	..

NOTES.

240. Middle West, old; frame building with brick foundation, includes M. M. store department, steam heat.
241. Middle West, modern; brick and wood, basement, two stories and attic, ornamental architecture.
242. Middle West, old; wooden, two stories and basement. (?)

TRACK.

Item.	Cost per Lin. Ft.	Add. for Each Switch.	Notes.
243	0.70	170.00	Based on use of "fit" (second-hand), 67-lb. rail.
244	1.00	180.00	Based on use of "fit" (second-hand), 85-lb. rail.
245	1.00 to 1.25	75.00 to 125.00	Based on use of new rail, according to weight.

TURNTABLES.

Item.	Diameter.	Cost.	Notes.
246	70 ft.	$3,000	Exclusive of pit.
247	70 ft.	5,091	Including pit. (?)

TRANSFER PITS AND TABLES.

Item.	Cost per Square Foot of Pit. Pit.	Table.	Total.	Notes.
248	.31	.17	.48	Far West, modern; to handle the heaviest class of engines.
249	.43	.16	.59	East, modern; pit of concrete throughout; capacity of the table, 200 tons.

MISCELLANEOUS STRUCTURES.

Item.	Name.	Cost.	Notes.
250	Ash pit	$30.20 per lineal ft.	
251	Coal chute	.65 per sq. ft...	Two-sided, with trestle approach. (?)
252	Water tank	1,900.00 total	50,000-gal. capacity, on timber trestle.
253	Water pipe, underground laid	1.43 per lin. ft.	Large system, pipes from 12-in. down to 4-in.
254	Sewer pipe, underground laid	2.88 per lin. ft.	Large system, pipes from 24-in. down to 12-in.
255	Long lines of wrought-iron pipe (for air, gas or water), with usual proportion of valves, fittings, etc., in place.....	25.00 pr. 100 ln. ft. 45.00 pr. 100 ln. ft. 85.00 pr. 100 ln. ft. 130.00 pr. 100 ln. ft.	*1-in. diameter. *2-in. diameter. *3-in. diameter. *4-in. diameter.

*Given by a large pipe-contracting firm of Pittsburgh.

MINOR BUILDINGS.

Item.	Name.	Cost per Sq. Ft.	Cost per Cu. Ft.	Notes.
256	Iron storehouse ...	.24	.011	Old, wooden. (?)
257	Brass foundry	1.96	.098	Old, brick and wood. (?)
258	Upholstery shop ...	.58	.029	Old, brick and wood (?)
259	Paint-mixing shop..	.58	.029	Old, brick and wood (?)
260	Paint storehouse ...	1.75	.087	Old, brick and wood. (?)
261	Freight repair shed.	.11	...	New, wooden, open sides. (?)
262	Dry kiln	.79	.039	Old, wooden. (?)
263	Lumber shed	.21	...	Old, wooden, open sides. (?)
264	Storehouse shed ...	.31	.015	Old, wooden. (?)
265	Coal shed	.24	.020	Old, wooden. (?)
266	Coal shed	.25	.021	Old, wooden. (?)
267	Charcoal shed	.21	.017	Old, wooden. (?)
268	Ice house	.57	.028	Old, wooden. (?)
269	Ice house	.60	.030	Old, wooden. (?)
270	Crematory	2.52	.210	
271	Small office building	.50	...	Old, wooden, one-story.

It is believed that in most cases the cost of a proposed shop will be asked for as soon as the layout plan has been completed, and that the following is the best basis for making an estimate:

List up all the buildings, with their ground area in square feet; all the miscellaneous structures, either on the square foot, the lineal foot or the unit basis (as may appear best); all the track on the lineal foot basis, the turnouts on the unit basis, etc.; assign a unit price to each item, as determined by the special local conditions; carry out the cost extensions, and totalize. To the totals thus obtained add a percentage to cover incidentals and items not shown by the layout plan; this percentage may vary from a minimum of 10 per cent. to a maximmu of 25 per cent., according to the completeness of the layout plan and the degree of confidence which may be felt in the unit prices assumed. The grand total should represent the approximate cost of the plant, exclusive of the cost of land and grading, which should be estimated separately, these two items not being susceptible of reduction to a unit basis.

If the buildings have been designed in detail, their cost may be checked upon the cubic-foot basis.

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CONTENTS.

*Illustrated.

PIECE WORK.

WITH PARTICULAR REFERENCE TO THE CAR DEPARTMENT.

Conditions To Be Understood by Management and Men.

BY LE GRAND PARISH.*

Schedule making, or making of piece prices, should be approached with great care. Schedules should not be made by other than experienced men. Before a piece price can be properly made it is necessary to know whether the output under day work is up to the proper standard. It is necessary to look into conditions and location of machines, speeds, feeds and cuts, condition and speeds of engines and pulleys, unnecessary operations, patterns and conditions in general. After all these conditions have been carefully studied and necessary changes made, we are confronted with the usual question of whether the prices should be set by the foreman of each department or by an expert price maker. As we are treating with the car department problem, it may be well to refer to the usual manner of making prices, generally known as the timing system. The time of the workman is taken on each job and the time taken as a basis in fixing the price. This is a very uncertain method. Some of the more advanced shops use specially trained mechanics for this purpose and "try out" each job before fixing a price. The method of keying out the work by the number of bolts, nuts, lag screws, nails, screws, holes bored, etc., is no doubt the best for pricing car work, if the prices set on these elements are correct. This system should only be used by one thoroughly familiar with car construction.

* Master Car Builder, Lake Shore & Michigan Southern Railway, Englewood, Illinois.

It is sometimes necessary to guarantee the day rate to men starting piece work; this guarantee, if made, should be based on the earnings per month. It is not possible to make the guarantee on each piece work job on account of the tendency of some men to work hard on an easy job, or during good weather, and doing directly opposite on a job which looks hard or when the weather is bad. This would lead to great trouble and the necessary discharge of men who would act fairly if the guarantee was not given. The guarantee should not be given in any way if it can be avoided.

There are times when it pays both the men and the company to arrange the schedule so that a premium is paid to save material which otherwise would be destroyed.

In steel car work the prices may be based on the number and size of rivets in each part repaired, two-fifths of the price being given for cutting up and three-fifths for bolting up and riveting. This will enable the regular force to work on assembling and an extra force to work on cutting up when necessary. Piece work forces are not as flexible as day work forces, and we must provide as much as possible for such conditions. All operations in general which do not require skill should be started by unskilled labor. The unskilled labor will soon become skilled on the common operations and be able to greatly increase earnings above the day rate.

A system of cost sheets should be kept in order that the manager may know at once the reason for any decrease or increase in cost of work. This is a matter for an expert to look after, as it requires one of special training to do it right. Piece work statements should be made at the end of each month showing the amount earned per hour on piece work and the percentage of increase or decrease as compared to day work. A record should also be kept of the work completed by each gang of workmen in order that any decided increase or decrease may be discovered at once and the cause given careful study.

There are several systems of piece work: those in common use are the straight piece work, premium plan and differential system. The first, or straight, piece work system is the one in common use in car repairs. The other systems may be applied to the machine shop, wood mill, blacksmith shop, etc., but cannot be successfully applied to car repair work. Consideration should also be given to the fact that a certain percentage of old employes must be employed on day work for various reasons. Their number is never great, and they should be assigned to work which does not come in contact with piece work. A statement should be made each month showing the percentage of men working piece work and day rate in each department.

One of the most important points which must never be lost sight of is fixing the price on the item of work which is performed the greatest number of times. A mistake may be made in fixing the price on an item which is only performed once a month and not do much harm, but if, on the other hand, it is performed several hundred times per month the mistake would be serious. The adjustment of such mistakes is one of the most difficult things in connection with the management of piece work. This, of course, can be avoided if the schedule is properly made.

One of the common mistakes, and a very dangerous one, is to adopt a schedule used by some other road. Schedules of other roads are dangerous, as they cannot describe the conditions under which they are applied. Schedules should describe fully whether the material is to be delivered to the workmen or not; full explanation of the work should be given to avoid misunderstanding.

A correct history of all the prices should be kept showing when they were established, whether made by the foreman or piece work expert; also all changes in prices and the cause and date.

If prices or earnings at one shop on the system are compared with those of another, the following should be carefully considered and investigated:

Nationality of workman.

Average length of service.

Percentage of property owners.
Organization of shop.
Organization of storekeeping department.
Condition and location of material.
Percentage of heavy and light repairs.
Location of shops.
Length of time shops have been working piece work.

The first law of piece work is honesty, and departure from this law should meet with instant dismissal from the service. This applies to foremen as well as workmen.

Unnecessary haste is the cause of more mistakes when piece work is first started than all else combined. The management and workmen must gradually adjust themselves to the changed conditions, and great care must be exercised to avoid friction. If there is a mutual forbearance everything will soon move smoothly; mistakes will be made, but if a spirit of fairness prevails piece work will soon get down to a bearing and all will participate in the benefits. That it is of mutual benefit is conceded by those who are familiar with its workings.

The most important matter to watch closely is the instruction of piece work inspectors and foremen in the piece work schedules. They should not be allowed to give an interpretation of the schedule to the men until they can successfully pass an examination. All piece work inspectors should be instructed under the supervision of a competent instructor; this instructor to teach all inspectors on one railroad. This will insure a uniform understanding of the schedules and avoid an endless amount of trouble in the future. Great care and patience in the beginning are necessary to bring good results.

The foreman should receive careful attention when piece work is first started, as his relation to the men undergoes some radical changes. The workmen immediately find themselves in closer relation to the foreman; the elements "push" and "hustle" are largely transferred to them, and in view of this fact the foreman is liable to show some irritation when the workmen insist on prompt assignment to cars and immediate delivery of material, therefore, the foreman should be made familiar with these changes in conditions to avoid unnecessary friction.

When piece work is first started the foreman will be greatly surprised at the amount of material rejected by the workmen on account of improper workmanship in the wood mill, blacksmith shop and machine shop. Attention should be given to see that bolts, nuts, tenons, mortises and a large variety of items are of the right dimensions and fit properly. These are matters for the foreman to check up at frequent intervals. It is absolutely necessary to have a proper system of taking away refuse from repair sheds. The old material must be removed promptly in order to give the workman room to perform his work properly. The labor gang should be thoroughly organized and certain territory assigned to each man or each group of men and their efficiency judged by their ability to keep their respective stations clean. A dirty repair yard indicates poor management.

The selection of piece work inspectors and foremen should be made in a careful manner, as upon such selection depends the success of the system. The inspector should be absolutely honest; have a good education; write a plain hand, and, above all, be of proper mental balance; meet anger or misunderstanding with cool judgment and good nature; never give an answer to the workmen without first giving the question careful consideration. All of the above applies with equal force to the selection of a foreman. An absolutely correct knowledge of the schedule should be required of the piece work inspector and foreman before a piece work system can be called successful.

It is the first duty of the foreman to watch the work carefully to see that it is properly done; secondly, to see that the skill of the best workmen is explained to those who are not equally skillful, in which way the men are brought up to a higher standard and greater earning capacity. It is a fact that the man who makes the largest earnings, based on good work, is the most valuable man to the management. This is true because the earnings of a railroad depend upon the necessary equipment to handle traffic, therefore, every hour gained by the workmen in the time of repairing the car brings him increased earnings, and every hour so gained adds to the earning capacity of the car.

Voluntary service is without doubt the most valuable element in all organizations, therefore this should be kept in mind at all times in connection with the piece work question. Men as a rule are fair, and the truth must be made clear to them in order that they may understand that the man who earns a high rate for himself earns an equally high rate for the company.

In order that there may be no excuse for decreased earnings, the men should be advised as soon as possible after a car is completed the amount earned per hour.

All cars should be taken in regular order on tracks. A foreman should not be allowed to place men on a car out of their regular order, without authority given by the general foreman, the general foreman to make a report of all such transactions to the master car builder, master mechanic, or his direct superior, except as may be hereafter provided.

Forceful action should be taken to prevent the above mentioned practice, or one gang of men may do an injustice to the next gang following them. This practice is common with day workers and will be continued by men on piece work if it is not closely watched.

The success of the system depends largely on the storekeeper, as the material question is the most important of all. Without an efficient storekeeping department and thorough co-operation of the storekeeper and foreman, a permanent success is impossible. Material must be in stock all of the time, not part of the time. If it should happen that certain materials are not in stock when required by the workmen, the responsibility for such a serious condition should be placed where it belongs, and the management should take necessary action to prevent such a condition thereafter. Extraordinary effort must be made to keep all material in stock at all times, otherwise piece work is an absolute failure.

Proper location of supply racks and methods of handling material from the storeroom, wood-mill, blacksmith shop and machine shop is a very important factor in the cost of piece work. An industrial track system is necessary in a large repair yard; properly designed ball bearing trucks may be used to an advantage in a small yard. Attention is called to the usual delapidated condition of trucks, wheelbarrows, planking, etc. These conditions usually increase the labor cost and should be looked after by a competent man. If the material racks are widely distributed, the workmen will help themselves to a great extent and the cost of distribution will be materially reduced.

The supply gang should be carefully organized; a competent man put in charge with the necessary authority to see that the men are prompt to anticipate the wants of the workmen and treat all with equal fairness. The general foreman should take particular care to insure prompt and courteous treatment of the supply men by the foremen of the various shops. The earnings of the men depend largely on the efficiency of the supply organization and this fact must be strongly impressed on the minds of the general foreman, shop foreman and storekeepers. The foremen should make it a practice to repeatedly ask the men if they have the proper material with which to repair a car. It is the duty of the foreman and supply men to see that the workmen are promptly supplied with such material as should be delivered and also see that the material racks or local storeroom are properly supplied with such material as the men are required to procure.

Careful attention should be given to the selection and condition of all tools and appliances furnished the workmen. The piece workers will select the tools which will do the work the quickest and will discard all devices which are difficult to handle. It frequently occurs that a foreman or official in charge has some device of his own which he considers the best of its kind. He must be prepared to see it consigned to the scrap heap if the workman discovers some quicker method. The workmen will soon discover that it pays to keep their saws, chisels and other tools in good condition and the foreman should call attention to this when he finds workmen who do not understand its importance.

Experience has taught that one man will earn more when working alone than when two or more work together. The best plan in order to reduce the heavy labor to a minimum is to place two men in a gang. This is better for the men. It is possible in bad weather to work four men in a gang on cars under cover. The grouping of men should be thoroughly understood before starting piece work and will be appreciated by the workmen when they understand the conditions.

The number of men who can work on repair tracks to an advantage is determined by the output of the machinery and the amount of track room available. The repair track room is frequently used for storage of wheels and material of various kinds. This loss can be reduced by careful attention. There is a greater loss by poor management in switching tracks. This is not necessarily the fault of the switchman. It may be the fault of the foreman on account of not making up a switch list, showing the switchman just what is required. It is bad practice to have more cars on a repair track awaiting repairs than are necessary. If a foreman goes home at night and leaves a track tied up on account of work on one or two cars, he should be required to explain. There is a large amount of car service lost in such a case. A paint shop will greatly facilitate the movement of cars. Repair tracks which are not covered are frequently blocked with cars in bad weather, waiting for painting.

Time can also be saved if supply men take the material in need of repairs to the various departments promptly. Considerable time and expense may be saved if the material located in the material racks between repair tracks is charged out, the system requiring workmen to make out orders on storekeepers for material drawn for car repairs consumes too much time. The material is usually needed at once by the workman and these delays reduce his earnings with a consequent loss to the company. The workman should not be made to make out orders for such material as he is required to procure.

Under the piece work system the necessity for covering tracks becomes more apparent; storms seriously interfere with the earnings of the men and the output of cars at a time when they are badly needed. This is particularly true during heavy rain and snow storms and the expense of removing snow from repair tracks is heavy. All tracks upon which heavy repairs are made should be covered with sheds or shops. The loss of car service from such conditions is great and there is also a heavy loss in the various departments of the shop. The whole plant slows up and adjusts itself to the conditions on the repair tracks. Under a day work system it is customary to bunch men up on cars in the shop if one is available. This plan is not practicable on piece work. It also seriously interferes with switching. This is particularly noticeable when repair tracks can only be switched from one end.

Some additional suggestions are briefly stated as follows:

Workmen should be required to correct improper work at their own expense.

Shop rules should be strictly inforced under piece work systems. The tendency to lay off increases with increased earnings. Men who are continually absent without sufficient cause interfere with the system and should not be tolerated.

Piece workers should not be placed on day work unless absolutely necessary. It is better to make a price for the day work jobs.

Schedules should be located in convenient places where workmen can look up prices at their convenience.

Men working in gangs should be taught to separate as much as possible in order to avoid helping each other when not necessary.

If any misunderstanding arises, it should be settled as quickly as possible.

Cars should be properly spaced for convenience in handling material and repairs as far as economy will permit.

Foremen should be required to make all estimates of car repairs on a piece work basis. Piece work in all departments should be introduced slowly in order to avoid mistakes.

HIGHSPEED STEEL IN RAILROAD SHOPS.

Its Great Advantages and How to Obtain Them.

By Henry W. Jacobs.

As a result of extended observation and considerable experience in handling the new steels and applying progressive methods in connection with them, I would lay it down as a cardinal principle that before any attempt is made to put in so radical a factor of increased production as the new highspeed steel, the fullest attention should be given to the machine end of the plant, and to the methods in vogue at the place where these steels are to be introduced. No amount of steel, bought out of hand, is going to revolutionize the manner of doing the work; and mere purchase of expensive grades of steel will not

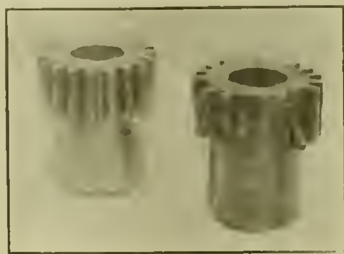


Fig. 1.—Steel Pinion to Replace Cast-Iron One in Coach Wheel Lathe.

cheapen the cost of production. Even if the new tools are being introduced by men who understand them thoroughly and who exercise energy in applying them to practical work, the result will not always be up to expectations, and a host of unsuspected and discouraging evils will be brought in

In the first place, the majority of machine tools in railroad shops to-day are not designed or built to stand the service that the highspeed steel would demand of them. To introduce these steels in the ordinary course of events will often prove disastrous to the machines (Fig. 1), if these are speeded up or

Fig. 2.—Steady Rest, Redesigned for Heavy Cutting Service.

worked with heavy cuts, unless proper safeguards are taken. The depreciation rate becomes much greater under the new condition than under the old; but with proper management it will be found profitable to do this when the increased production capacity is realized.

The most difficult factor to deal with, however, when there is not the whetting of competition (as in the case of commercial shops) to force the management to be vigorous in prosecuting improved methods, is the attitude of the men, who have grown used to the old ways, and who view with hostility and

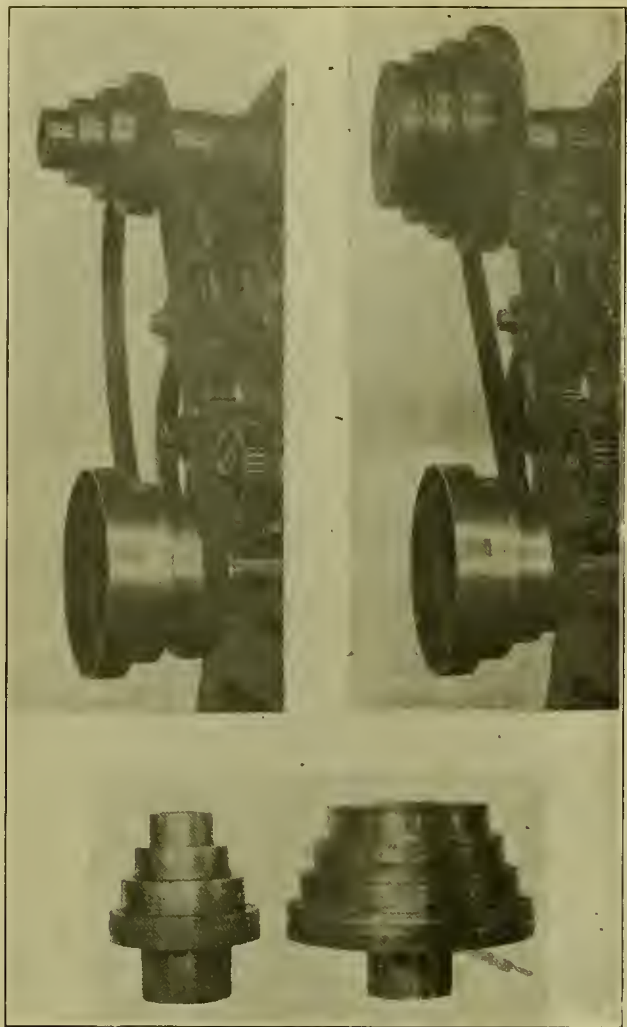


FIG. 3.—FEED CONE PULLEY FOR LATHE INCREASED TO ACCOMMODATE NEW FEEDS.

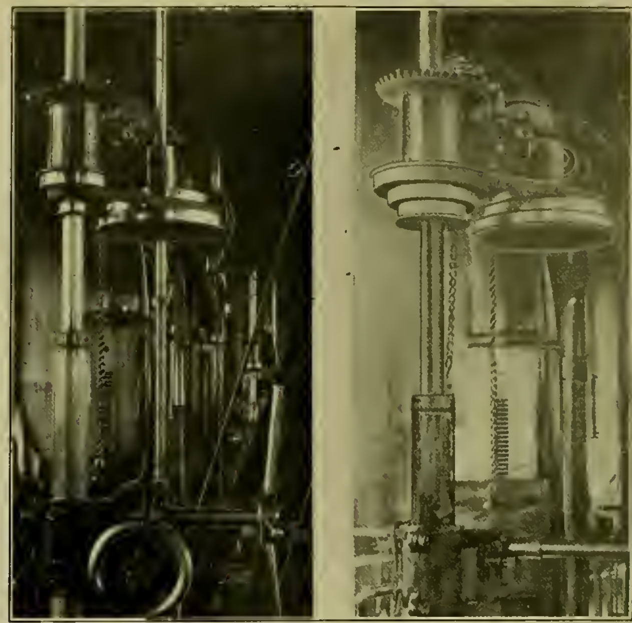


FIG. 3A.—FEED CONE PULLEY FOR DRILL PRESS, SHOWING INCREASE.

FIG. 4.—ROUGHING TOOLS. NEW ROUND NOSE, SUPPORTED CUTTING EDGE STYLE, AND OLD DIAMOND POINT, UNSUPPORTED STYLE.

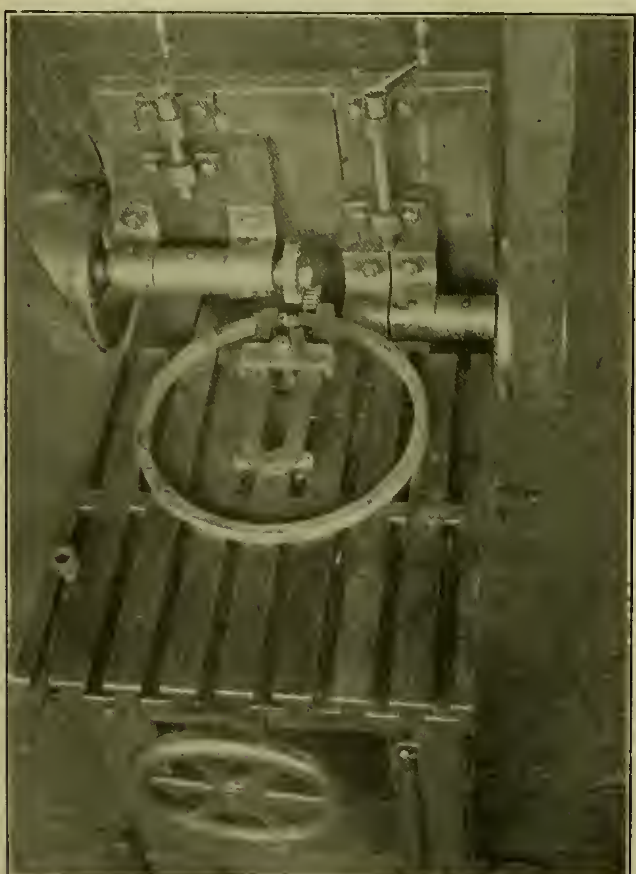


FIG. 5.—SNAP RING MILLING MACHINE. WHAT A MACHINE FOREMAN WILL DO WHEN ENCOURAGED.

FIG. 6.—EXTENDED PISTON RODS.

suspicion any innovation of this character. Unless a Director of Methods or Demonstrator is employed, whose special duty it is not only to direct how the tools shall be made and used, but also to keep the men up to the new cuts and speeds, the great majority of the men will be most loath to maintain the increased pace that the new steel necessitates in order to be a paying proposition. To get around this difficulty the writer has found it an excellent plan: First, to examine the machines as to their capability of standing the increased service, to remedy what defects might be found (Fig. 2). Then immediately to increase the speeds, by changes in pulley sizes on both main and countershafts, so as to have the machines in general running at a rate of speed much above that used with the older tool steels.

These speed increases may vary from 30 per cent. to over 200 per cent. above the original speed. They are not attained by one jump, but by a succession of judicious increases, gradually getting the men used to the higher speed, to a busier hum of pulleys and machines, to a greater rapidity in turning out the work. By making these changes (Fig. 3 and Fig. 3a) and at the same time following up the matter of proper use of cutting tools, with proper feeds and cuts, the men are induced, almost unconsciously, to fall in line with the new methods.

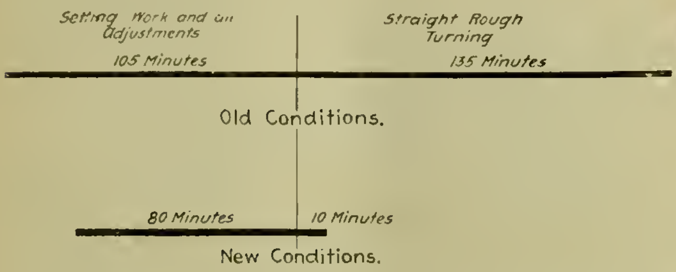


FIG. 7.

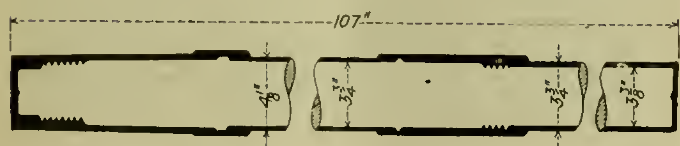


FIG. 9.—SECTION SHOWING METAL REMOVED (IN BLACK) FROM ROUGH FORGING.

One *very essential point*, which should not be overlooked, is that every tool of the older steels should be withdrawn from the shop entirely, and highspeed tools substituted, so as to prevent any tendency to cling to the old ways of doing things (Fig. 4).

Not only do the mechanics object to innovations, but the gang foremen, foremen, and general foremen even, do not accustom themselves readily to the new conditions. For it must be remembered that the foreman of a shop, more particularly of a railroad shop, has so many duties devolving upon him that he does not, as a rule, have sufficient time for looking after a new move of this kind. The introduction should, therefore, be in the hands of a man whose whole time can be devoted to the handling of the new tools. This man should be a thorough mechanic, well informed as to the care and working of these steels, and of sufficient inventive ability to devise quick methods and ways of economizing work. He should also possess the knack of being able to get along with the workman with a minimum amount of friction, for the attitude of hostility before mentioned is never so much in evidence as when the man who is responsible for these changes is actively engaged. And he should stimulate the foremen with whom he is working, to advance ideas, such as that shown in Fig. 5 (for which full credit is given when successful), even to a spirit of rivalry with himself in the introduction of time-savers.

Yet the individual capacity and tact of this demonstrator will not alone meet the problem. Unless full support is given by the superintendent of motive power himself, unless it be well understood that he intends making a success of the new methods, and it be shown from time to time, by personal talks with the more influential foremen, and in other ways, that these innovations are no mere vagaries of an unpractical man who is only "on trial," the progress of improvements will be hampered at every turn. Moreover, as the chief attention of the demonstrator will be required in the shop so as to keep the new methods moving, he should be afforded the use, when necessary, of draughtsman and stenographer, as it will not pay to have him spend his time over the drawing board, or in writing out, longhand, whatever communications he needs to make.

These are the main points to be considered in the introduction of the new alloy steel tools, or rather the obstacles to

FIG. 8.—TURNING EXTENDED PISTON RODS.

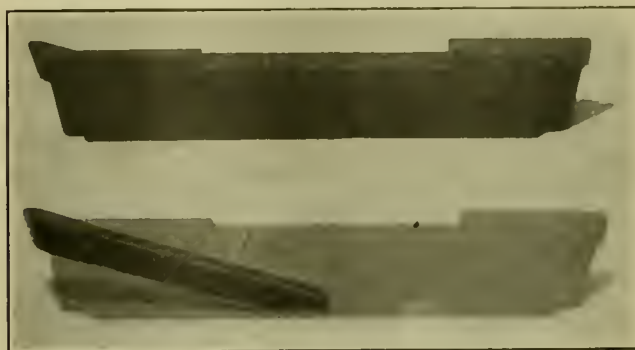


FIG. 10.—TOOL HOLDER FOR HIGH SPEED TOOL. LOWER VIEW SHOWS POSITION OF ROUGHING TOOL.

which chief attention must be given and which must be overcome before any permanently beneficial results can be obtained. As to the results themselves, no better evidence may be given of what can be accomplished than to cite examples of what has been done in a shop where these principles have been adhered to. When the new steel tools were first announced extensive tests were made in this shop of all brands that could be secured, and steps were taken to secure a man who could direct their introduction. While, of course, the superintendent of motive power could not devote time and attention to each little detail, yet he directs in a large and farsighted way the lines it would pay best to follow, and it must be acknowledged that without his interest no such degree of success could be attained. I need only add that the cases that follow are not special record ones (as was that of turning a pair of 68 in. driver tires in one hour and 31 minutes), but are typical of everyday performance. The same character of results has been attained in hundreds of other such jobs.

Extended Piston Rods.—These rods (Fig. 6) were rough forged in the blacksmith shop. The time for complete turning, threading, fitting, etc., under the old conditions, was 14 hours. When the new steels were put in, the man on this work was supplied with an outfit of tools and instructed to get the most he could out of them. The best time he made was 12 hours, but even this did not always keep up when the man was left to his own resources. This reduction in time was obtained by using a faster step on the cone pulley, and by increase in the depth of cut. However, as it was rather inconvenient to make the belt changes, the man preferred to run at a slower rate. The matter was then taken hold of by the demonstrator and a number of changes were made. First, the work was divided between two lathes, one for rough turning and one for finishing. The lathe for rough turning was an old one, but was put in shape, fitted with steady rests (see Figs. 2 and 8), etc., and adapted for turning roughly to within 1-32 in. of finished size. The pulleys on main and countershafts were changed, making a speed increase of from 140 to 320 r. p. m. This maintained the higher turning speed even on the lower cone pulley step. A second-year apprentice was used on

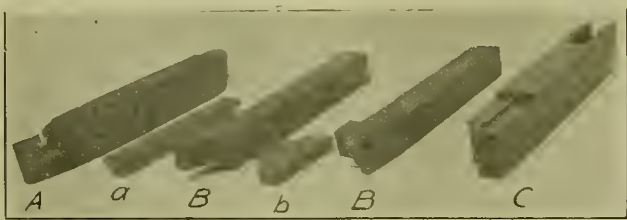


FIG. 11.—TOOL HOLDER FOR USE ON WHEEL LATHES AND SOLID TOOLS DISPLACED BY SAME.

"*a*" AND "A"—TOOL HOLDER AND BAR SIZES OF ROUGHING TOOL.
"*b*" AND "B"—TOOL HOLDER AND BAR SIZES OF FLANGING TOOLS.
"C"—TOOL HOLDER PROPER.

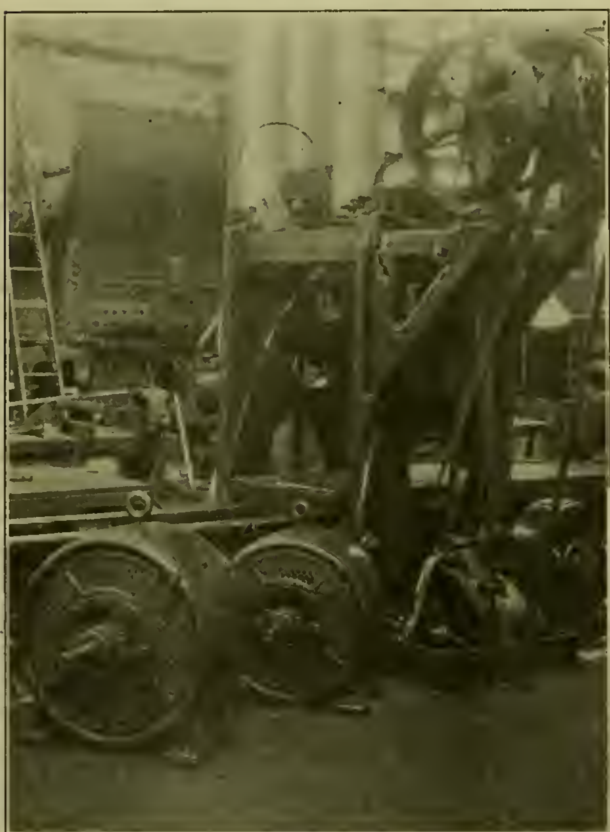


FIG. 13.—POWER INCREASE ON PLANER. 10 H.P. TO 20 H.P.

this part of the work, replacing the more conservative machinist, and he was induced to use the higher step at the cone pulley. The peripheral speed of the work was thereby changed from 20 ft. to 65 ft. per minute. On rough turning the depth of cut was doubled, thus finishing a rod with only one heavy roughing cut instead of two. The feed was increased from 1-16 in. to 5-32 in. The total time of rough turning under the new conditions was, therefore, $\frac{1}{3\frac{1}{4} \times 2 \times 2\frac{1}{2}}$ or about 1-16th of the former time. This is for *actual* rough cutting. The former time of complete rough-turning was two hours and fifteen minutes, to which must be added one hour and three-quarters for setting work, etc. Under the new conditions, although the actual rough cutting time was reduced to about *ten minutes*, the complete time of rough turning was one hour and a half, the additional hour and twenty minutes being the sum of all the times necessary to turn the rod end for end, apply and take down chucks and dogs, rough turning taper and collar, thread-

FIG. 12.—PULLEY INCREASE ON PLANER.

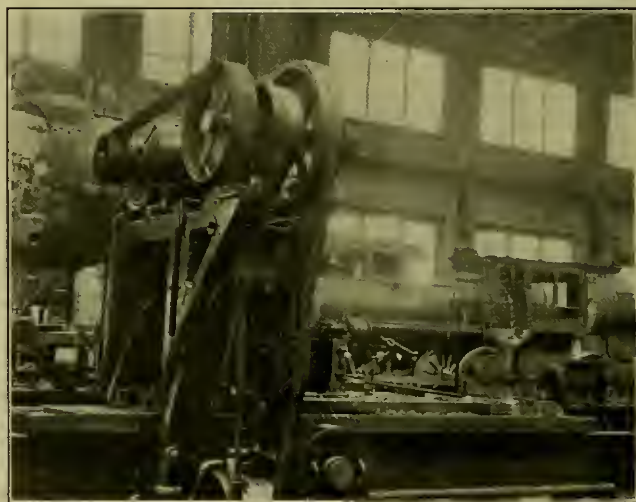


FIG. 14.—PLANER EQUIPPED FOR HIGH SPEED WORK.

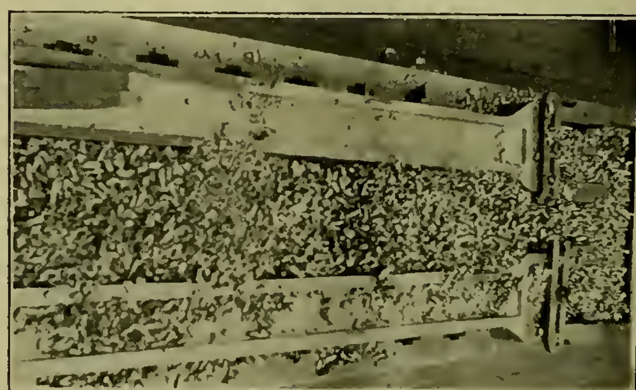


FIG. 15.—BLUE CHIPS FROM PLANER SHOWN IN FIG. 14.

ing, grinding tools, etc. In other words, the *ratio* of cutting time to total time was greatly reduced. The black line diagram, Fig. 7, illustrates where the saving was effected.

In the finishing process similar methods were employed, with similarly gratifying results, although here the principal time savings were by methods and not by high speed steel, so that, all in all, the time reduction of six to seven hours on this one job (see Fig. 9) was due as much to intelligent modification of the conditions under which the new steels were to act as to the steels themselves.

COACH WHEEL TIRES.—Another example is that of the time on one pair of steel tired coach wheels, where a reduction was made from five hours to one hour. As in the previous case, increase in pulleys, thus permanently increasing wheel lathe speed, and other changes, such as special designs of tool holders (see Figs. 10 and 11), substitution of forged steel pinions for cast iron (see Fig. 1), so the machine could stand the increased strain were all instrumental in accomplishing the desired results.

Planers.—Speed increases were made in the principal planers up to a cut of over 50 ft. per minute, or the limit under this heavy work of the tools. One result of this change is a close approach of the reverse speed to that of the cut, as nearly the limit of the machine's capacity to overcome the inertia of the table is reached under the changed conditions. Figs. 12 to 15 illustrate improvements in planer practice.

If space permitted numerous other instances could be cited, all taken from actual shop practice, such as turning eccentrics, cylinder bushings, car axles, planing shoes and wedges, etc. The time on all these was reduced from one-half to one-eighth of former time. The average increase, based on actual output, and the difference in weight of metal removed was:

Cast iron	120 per cent.
Steel	150 per cent.
Good, clean wrought iron	175 per cent.

CONCLUSIONS.

In conclusion I can but repeat that the buying of high-speed steel is of little use unless progressive methods of application in actual work are employed to effect real reduction in cost, which is the final and only test in the question. In order to introduce these methods it is always better policy to bring into each shop a man who has not been brought up in the traditions of the place, and have him make the changes, the possibility of which would not be seen as rapidly by one too used to the older conditions. A local demonstrator should report direct to the superintendent of shops, or where there is no such position, to the division master mechanic, so that he will have sufficient authority behind him to carry out his plans, and so that general and important interests may not be sacrificed to local and individual preferences. If there were a general demonstrator for an entire railroad system, the local demonstrator should report to him, and he in turn direct to the highest authority in control of the different shops, the superintendent of motive power. Of course, upon the latter person the ultimate success or failure of an enterprise of this kind must rest. So far as I know, Mr. W. R. McKeen, Jr., of the Union Pacific, has been the only, or at least the first, superintendent of motive power who has had the temerity to create a position of this kind, and who has used the force to drive his purpose home. That he has been amply justified is admitted by all who have had the opportunity to see the results accomplished in the shops on his system, not alone in the new Omaha shops, but also in the redistribution of work among all the shops, made possible by the increased capacity and concentration of manufacture in the main shops, and in the economies effected by restricting the smaller and less well equipped points to repairs requiring light machine work only.

ALTERNATING CURRENT MOTOR FOR ELECTRIC CARS.

An important development in electric car motors which promises to materially decrease the cost of the installation and operation of interurban electric lines, and that will probably be a large factor in solving the problem of applying electricity to certain parts of steam railroads, has just been made by the General Electric Company at Schenectady. On the Ballston extension of the Schenectady Railroad Company is a car in regular service operated by single phase alternating current motors. Three-phase alternating current motors have been used for this purpose in Europe, but on account of the limitations of the multipolar induction motor have never been adopted here, and this is the first instance in this country of a car being operated in regular service by alternating current motors.

Of still greater importance, however, is the fact that the motor, which is of the "compensated" type, so called because of the character of the field winding, which fully neutralizes or compensates for the armature reaction, can be operated equally well with either direct or alternating current. On the Schenectady line the car is operated through the city for 3.9 miles on a 600-volt direct current trolley and through the country for 11.6 miles on a 2,000-volt alternating current trolley. Change from one system to the other is made by shifting the trolley, which can be done while the car is running at a considerable speed, and the car starts, runs or stops equally well with either system.

In the cities it is necessary to use a comparatively low voltage direct current because of the danger from falling wires, etc., and for a long system the cost of the copper for transmitting this low voltage current becomes a serious one. With this new motor a high voltage alternating current can be used in the suburban and country districts and the cost of copper wire can thus be greatly reduced. A transformer carried under the car reduces this high voltage current to the potential required by the motors. The first cost of the power houses and the operation expense will also be reduced, for at present the larger installations are usually equipped with alternating current generators which require rotary converters or other commutating devices for changing the alternating current to a suitable direct current.

FAST RUN ON THE READING.

The Reading's 60-minute Atlantic City flyer, scheduled to leave Chestnut street, Philadelphia, at 3:40 p. m., and to arrive at Atlantic City at 4:40 p. m., last Thursday, July 21st, not only broke its own record, but established a new high-speed record for scheduled passenger trains. The distance between Kaighn's Point, Camden and Atlantic City, 55.5 miles, was made in 43 minutes, the speed for the entire distance being equivalent to 77.4 miles per hour.

To accomplish this, very high speeds were made over portions of the run but as the train sheet record, presumably taken from different timepieces, is the only one available, no attempt will be made to give maximum speeds.

Train No. 25 was the first of the 60-minute flyers between Philadelphia and Atlantic City, and made its initial run on July 2, 1897. This was an innovation in fast scheduled running to Atlantic City, and the remarkable record attained by the train in July and August of that year, the two months it was in service, attracted attention not only at home but abroad. The train during its first season distinguished itself for going into Atlantic City from 2 to 4 minutes ahead of schedule, and not once during the season did it arrive behind time. This year's best record was on July 14th, when the run of 55½ miles was made in 46½ minutes, an average of 71.6 miles per hour.

On August 5, 1898, the train made its record, which remained unbroken until July 21 of this year. On that day the train left Kaighn's Point at 3:51 p. m., one minute late, and pulled into Atlantic City at 4:36¼, 3¾ minutes ahead of schedule, having made the run in 44¾ minutes, the speed for the entire distance having been equal to 74.4 miles an hour.

An account of a regular run of this train made in August 1898, with mile post timing taken by the editor of this journal, was printed in the October number of 1898, page 341.

Two Hundred and Forty-Five Miles Without a Stop.—Two regular daily runs of this distance without an intermediate stop have been inaugurated by the Great Western Railway of England, between London and Plymouth, the time card speed being 55.6 m.p.h. According to *The Engineer*, the trains weigh about 160 tons behind the tender. In a preliminary run such a train was forced into a speed of 60 m.p.h. at the end of the third mile from the start.

THE SCHENECTADY SUPER-HEATER LOCOMOTIVE.

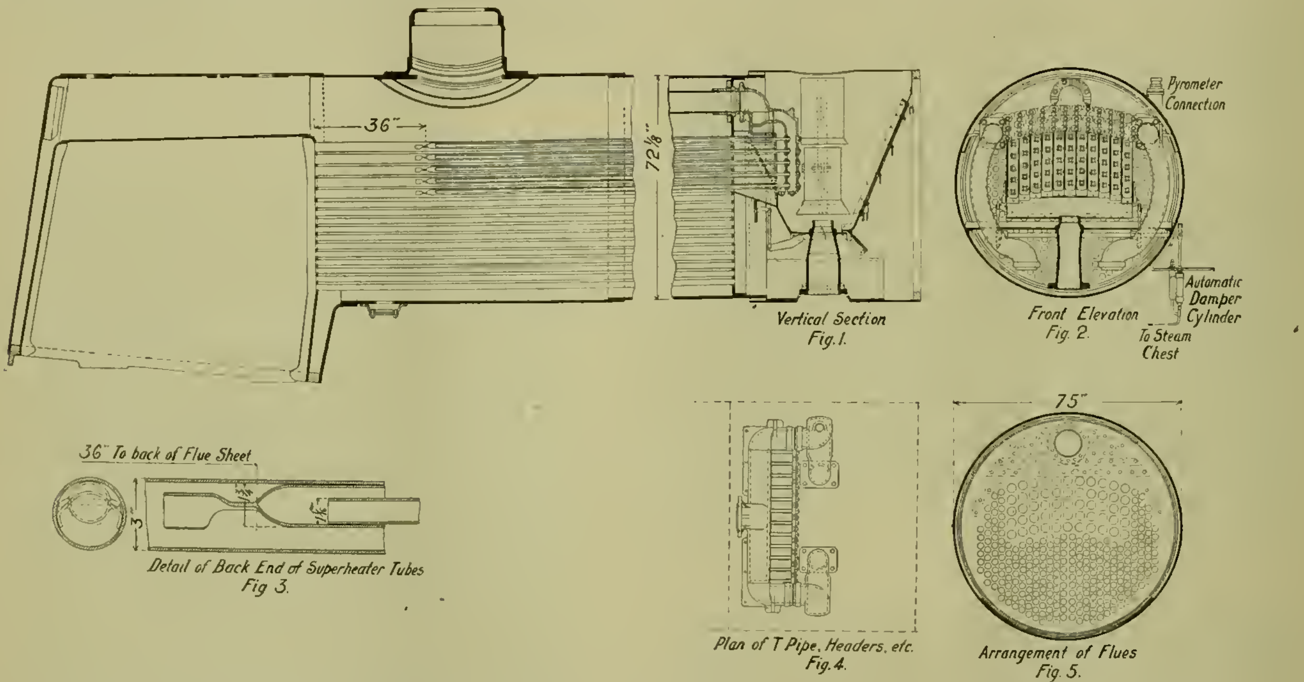
The American Locomotive Company has brought out a new locomotive super-heater, designed by Mr. F. J. Cole, mechanical engineer of the company, and which is to be known as the "Schenectady" super-heater; it has been applied to New York Central Atlantic type (4-4-2) passenger engine 2915, now in regular service on the Mohawk Division between Albany and Syracuse, N. Y., and similar to the design illustrated in this journal in February, 1901.

The objectionable features of previous locomotive super-heaters, both abroad and in this country, have been, first, the use of bent tubes; and, second, the necessity of dismantling the whole super-heater in order to secure access to a single leaky boiler tube. The accompanying illustrations show that these difficulties have been eliminated, the construction and operation of the new super-heater being as follows:

The first new feature of construction is in the T-pipe, the regular conventional T-pipe being replaced by one of special design, shown in Figs. 1, 2 and 4; it will be seen that this T-pipe is subdivided into two compartments by a horizontal partition, and that it extends nearly across the smokebox; steam entering the T-pipe from the dry pipe is admitted to the upper compartment only. To the front side of the T-pipe are attached eleven header castings, the joints being made with copper wire gaskets, as in steam chest practice. Each header casting is also subdivided into two compartments, but in this case by a vertical partition; five pipes or flues of 1 1-16-in. outside diameter are inserted through holes (subsequently closed by plugs) in the front wall of each header casting, these 1 1-16-in. tubes having first been expanded into special plugs, are firmly screwed into the vertical partition wall. These 1 1-16-in. tubes are enclosed by 1¾-in. tubes, which are expanded into the rear wall of the header casting in the usual way. Each nest of two tubes (one 1 1-16-in. and one 1¾-in.) is encased by a regular 3-in. boiler tube, which is expanded into the front and back tube sheets as usual. The back end of each 1 1-16-in. tube is left open; the back end of each 1¾-in. tube is closed; the back ends of the two tubes being located at a point about 36 ins. forward from the back flue sheet. The detail arrangement and grouping of the three flues are shown by Fig. 3. The back end of the 1¾-in. tube is closed by welding, and the tail is so formed as to support this tube in the upper part of the 3-in. tube, thus leaving a clear space below. Fig. 1 indicates that the 1 1-16-in. tubes are concentric with the 1¾-in. tubes at their back ends, but the fact is the 1 1-16-in. tube is allowed to drop and rest on the bottom of the 1¾-in. tube, as shown by Fig. 3.

Steam from the dry pipe enters the upper compartment of the T-pipe and thence enters the forward compartments of each of the 11 header castings, and then passes back through each of the 1 1-16-in. tubes, thence forward through the annular spaces between the 1 1-16-in. tubes and the 1¾-in. tubes to the rear compartments of each of the 11 header castings, thence into the lower compartment of the T-pipe, thence by the right and left steam pipes to the cylinders. In passing forward through the 1¾-in. tubes the steam is superheated by the smokebox gases and products of combustion passing through the 3-in. tubes. In this particular design 55 3-in. tubes are inserted in the upper part of the flue sheets, thus displacing as many of the regular smaller tubes as would occupy the same space. The arrangement of flues is clearly shown by Fig. 5.

In applying the super-heater to a locomotive it is necessary to provide some means by which the super-heater tubes shall be protected from excessive heat when steam is not being passed through them. In this design this is accomplished by an automatic damper, as shown in Figs. 1 and 2. That portion of the smokebox below the T-pipe and back of the header casting is completely enclosed by metal plates; the lower part of this enclosed box is provided with a damper which is automatic in its action. Whenever the throttle is opened and steam is admitted to the steam chests the piston of the automatic damper cylinder, shown in Fig. 2, is forced upwards and the damper is held open, but when the throttle is closed the vertical spring immediately back of the automatic damper cylinder (and concealed by it in Fig. 2) brings the damper to its closed position, so that heat is not drawn through the 3-in. tubes when the engine is not using steam. In this way the super-heater tubes are effectively prevented from being burned. In introducing the group of 3-in. tubes and applying the super-heater, there is a slight loss of heating surface, but it is more than offset, as regards economical results, by the super-heating process. The heating surfaces of the regular New York Central Atlantic engine and the sister engine, which is fitted with the super-heater, are shown by the following table:



Vertical Section Fig. 1.
Front Elevation Fig. 2.
Detail of Back End of Superheater Tubes Fig. 3.
Plan of T Pipe, Headers, etc. Fig. 4.
Arrangement of Flues Fig. 5.

APPLICATION OF "SCHENECTADY" SUPER-HEATER TO NEW YORK CENTRAL, ATLANTIC TYPE, PASSENGER LOCOMOTIVE.

HEATING SURFACE (sq. ft.).

	Regular Engine.	Superheater Engine.	Loss per cent.
Fire box	175.0	175.0	0.0
Fire tubes	3248.1	2837.0	12.6
Arch pipes	23.0	23.0	0.0
Totals	3446.1	3035.0	11.9

It is noticed that the application of the super-heater reduces the heating surface of the fire tubes by 12.6 per cent., and reduces the total heating surface by 11.9 per cent. The actual super-heating surface is 301 sq. ft., which is 10.6 per cent. of the fire tube heating surface, and 9.9 per cent. of the total heating surface of the super-heater engine.

A pyrometer is inserted in the left steam pipe, as shown in Fig. 2; readings from this pyrometer since the engine has been in service show that the average temperature is about 517 deg. F.; the boiler pressure being 200 lbs. per sq. in., and the corresponding temperature being 387 deg. F., a super-heating of 130 deg. is accomplished.

As indicating the possible economies which may result from the use of super-heated steam in locomotives, it may be said that service tests on the Canadian Pacific with a super-heater locomotive showed savings (on the ton-mile basis) of 33 per cent. in fuel consumption, as compared with a similar engine, and 16 per cent., as compared with a similar compound engine, when the performance was reduced to the same unit of comparison.

The piston rod metallic packings are made of a special mixture (which, in this particular case, is a mixture melting at about 1,200 deg. F.), to guarantee that they will not be unfavorably affected by the excess heat in the cylinder. When superheated steam is used no chances can be taken as regards lubrication of the cylinders, and, therefore, forced feed is resorted to instead of the usual gravity feed. Although the maximum steam temperature is about 517 deg., as stated, yet the constant temperature of the cylinder walls is probably something above the mean of 517 deg. and the average temperature (perhaps 230 deg.) of the exhaust; it is therefore probable that the constant temperature of the cylinder walls, when steam is being used, is in the neighborhood of 385 deg., which, however, is considerably higher than the corresponding temperature would be in the case of an engine not equipped with a super-heater.

The particular forced feed lubricator which is used in this case is of German make, and embodies four reservoirs, which are filled with oil before the beginning of the run, the oil being forced out of these reservoirs through connecting pipes to the cylinder by plungers which receive a gradual but constant downward impulse by a screw motion, which is actuated by a system of levers connected with a return crank on one of the rear driving wheels; in this case two oil pipes are led forward from the lubricator to either side of the engine; one of each pair of oil pipes enters the live steam passage through the cylinder saddle, and the other is led directly into the cylinder at the middle of the stroke.

Casual consideration of this design might lead to the prediction that the upper or 3-in. tubes would be likely to choke up in service; but it should be remembered that the annular space in the lower part of these tubes is quite free and unobstructed, and can easily be reached and scoured by a steam jet from the firebox end. It should also be borne in mind that the upper flues in any locomotive are not nearly as likely to choke up as the lower flues.

NEW LOCOMOTIVE AND CAR SHOPS.

McKees Rocks, Pa.—Pittsburgh & Lake Erie Railroad.

VIII.

MACHINE TOOL EQUIPMENT AND CRANES.

The arrangement of the machine tools, lavatories, foremen's offices, etc., in the machine and boiler shops is shown on the accompanying diagrams. The end of the machine shop nearest the wheel yard is entirely devoted to machines for handling the wheel and axle work for both locomotives and cars. A trolley fitted with an air hoist extends from the wheel presses to the axle lathes. About the entrance nearest the blacksmith shop are grouped several drill presses, lathes, etc., for handling the forgings. The machine tools and air press for handling driving and truck boxes and brasses are arranged so that this work can be passed from one to the other in regular order. The tools for machining heavy castings are placed near the entrances from the casting house and storehouse. A large amount of space in the middle bay of the machine shop is available for additional machines as they may be required.

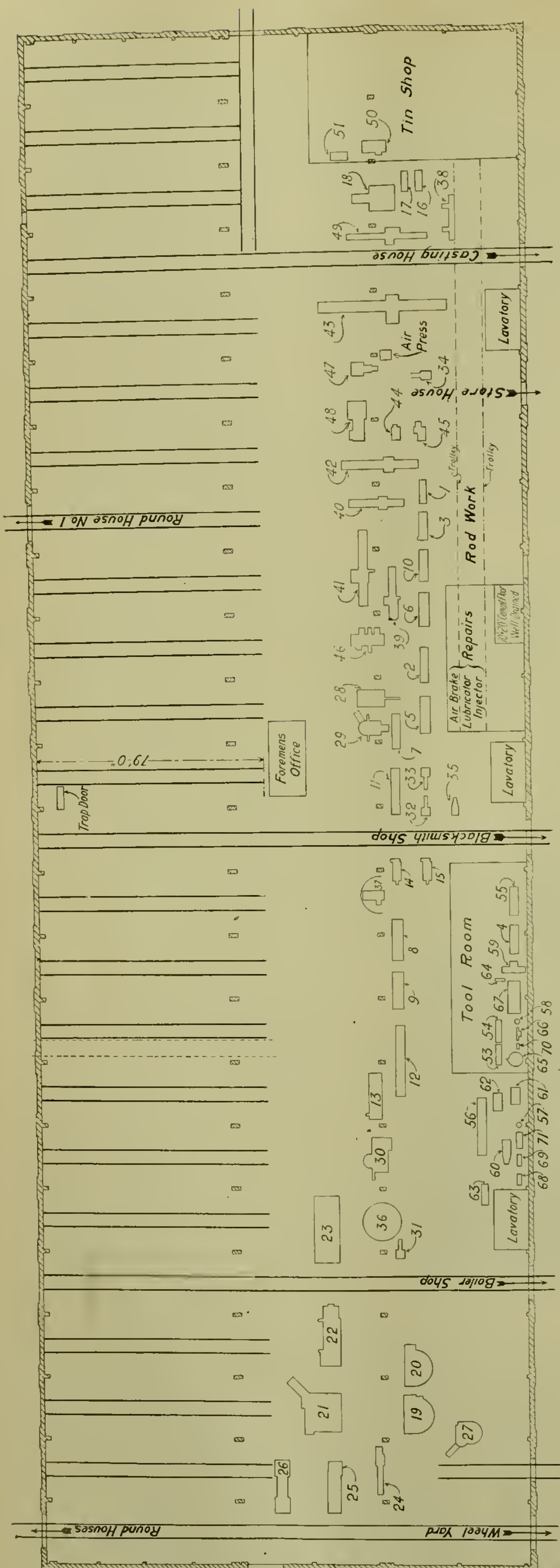
CROCKER-WHEELER CO. M.F. 21 CONTROLLER USED IN MCKEES ROCKS SHOPS.

Reference to the machine tool list will show that a large number of them were taken from the old shop and equipped with individual motors, and this may cause some comment, as we hear much these days about scapping old machines to make way for those designed especially for the use of the high-speed tool steels. When the question of what machines should be transferred from the old shops came up, the new tool steels were in an experimental stage and very little was known of them. The management, however, realized that there would probably be a considerable development along this line and decided to retain only the best of the old machines, some of which were comparatively new, to uniformly increase the spindle speeds with a view to using a better tool steel, and to replace cast iron gears by steel ones where it appeared necessary. It is interesting to note that although new tool steels and commercial methods are being introduced into the shop as rapidly as possible, yet the old machines with the individual motor drives are giving good satisfaction in practically all cases.

The reason for this is that most of the forgings and castings are made so that they can be finished by taking a comparatively small roughing cut and the old machines, even though cutting at a considerably higher speed than before, can easily handle this class of work. The application of motors to the old tools has been very completely described in the series of articles on "The Application of Individual Motor Drives to Old Machine Tools" which have appeared in this paper.

There is a group drive in the machine shop and one in the boiler shop, which contain the lighter tools and those requiring constant speed that could be gathered together in one place without interfering with the movement of the work. The group drives are in both cases arranged along the side walls and the shafting is hung below the crane runways, so as not to interfere with the cranes.

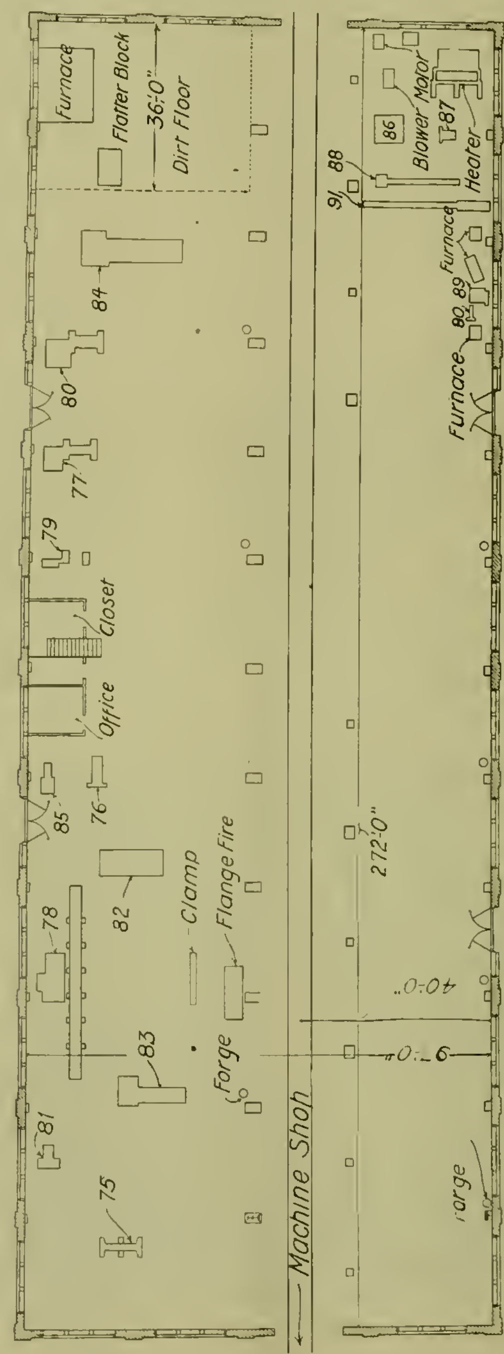
Briefly, the reasons for individually driving such a large percentage of the machines are as follows: A closer speed regulation is afforded; speeds can easily be changed; allows



MACHINE SHOP LAYOUT.—MCKEES ROCKS SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

head room for cranes; increases light and cleanliness; machines can be placed to best possible advantage and can easily be rearranged; a few machines can run overtime without operating a shop full of shafting; a tool is using no power when it is not running; construction of the building is simplified.

In general the old machines were arranged for a maximum cutting speed of 60 ft. per minute and the new ones for 70 ft. per minute. On both the old and new tools, as far as possible, all changes in driving gearing are made by means of substantial jaw clutches or an approved form of friction



BOILER SHOP LAYOUT.—MCKEES ROCKS SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

clutch operated by handles placed convenient to the operator's hand. The motor controller hand wheel is also placed in a convenient position. The first reduction from the motor to the tool is made either by a silent chain or by gearing.

The Crocker-Wheeler Company four-wire multiple voltage system, described in connection with the Collinwood shops on pages 23 and 24 of the January, 1903, issue is used with the variable-speed machine tool motors. At McKees Rocks, however, the 12-point controller, in which the intermediate speeds between the six voltages are obtained by the use of resistance placed in series with the armature, is used only with some of the boiler shop tools which do not require numerous or accurate speed changes. For the other machine tools, which are driven by variable-speed motors, a new controller, known as the M.F. 21 is used, in which the intermediate speeds between the six voltages are obtained by inserting resistance in the field circuit. Diagrams showing the relation between the speed and power of a motor using the M.F. 21 or field weakening controller and the M.A. 12 or armature resistance controller are shown on page 165 of the May, 1903, issue in connection with one of the articles on the application of motors to the old machine tools at McKees Rocks.

On the M.F. 21 controller points 1, 2 and 3 are used for starting only. Between points 4 and 21 inclusive, there is a speed range of 4 to 1, the average speed increment being 9 per cent. Experience has shown that when no resistance is used in series with the armature, there is a heavy rush of current in

LIST OF TOOLS—LOCOMOTIVE DEPARTMENT.

McKee's Rocks Shops—Pittsburgh & Lake Erie Railroad.

MACHINE SHOP.

Individual Motor-Driven.

No.	Tool.	Maker.	Motor H. P.
1	18-in. x 8-ft. lathe	Flathor & Co.	5
* 2	18-in x 10-ft. lathe	Putnam Machine Co.	7½
3	20-in x 8-ft. lathe	F. E. Reed Co.	5
4	20-in. x 8-ft. lathe	F. E. Reed Co.	5
* 5	20-in. x 11-ft. lathe	Putnam Machine Co.	7½
* 6	20-in. x 11-ft. lathe	Putnam Machine Co.	7½
* 7	20-in. x 11-ft. lathe	Putnam Machine Co.	7½
8	24-in. x 12-ft. lathe	American Tool Works Co.	7½
9	24-in. x 12-ft. lathe	F. E. Reed Co.	7½
10	25-in. x 6-ft. lathe	Putnam Machine Co.	7½
* 11	30-in. x 15-ft. lathe	Putnam Machine Co.	10
* 12	36-in. x 24-ft. lathe	Putnam Machine Co.	10
13	42-in. x 8-ft. lathe	Niles Tool Works Co.	15
14	Turret lathe	Jones & Lamson Machine Co.	5
15	Turret lathe	Jones & Lamson Machine Co.	5
16	Turret lathe	American Tool & Machine Co.	3
* 17	Turret lathe 20-in. x 7-ft.	American Tool & Machine Co.	5
* 18	Turret lathe 34-in.	Gisholt Machine Co.	15
19	Axle lathe, double	Pond Machine Tool Co.	25
* 20	Axle lathe, double	Putnam Machine Co.	35
* 21	42-in. car wheel lathe	Pond Machine Tool Co.	20
22	69-in. driving wheel lathe	Niles Tool Works Co.	25
* 23	90-in. driving wheel lathe	Putnam Machine Co.	25
24	Hydrostatic wheel press, 200-ton	Niles Tool Works Co.	† 7½
* 25	100-in. hydrostatic wheel press, 300-ton	Putnam Machine Co.	† 7½
* 26	Driving wheel quartering machine	Niles Tools Works Co.	5-5
27	42-in. car-wheel borer	Pond Machine Tool Co.	10
* 28	18-in. x 36-in. horizontal boring machine	Betts Machine Co.	15
* 29	51-in. boring mill	Baush Machine Tool Co.	15
30	72-in. boring mill	Pond Machine Tool Co.	25
31	36-in. drill press		4
32	36-in. drill press		4
33	36-in. drill press		4
34	36-in. drill press		4
* 35	30-in. drill press	J. E. Snyder	5
36	6-ft. radial drill	Niles Tool Works Co.	4
* 37	5-ft. radial drill	Dreses Machine Tool Co.	6½
* 38	Two-spindle drilling machine	Bement, Niles & Co.	7½-7½
39	30-in. x 30-in. x 8-ft. planer	New Haven Manufacturing Co.	7½
40	30-in. x 30-in. x 8-ft. planer	Powell Planer Co.	7½
41	42-in. x 42-in. x 12-ft. planer	Cincinnati Planer Co.	15
* 42	42-in. x 42-in. x 12-ft. planer	Pond Machine Tool Co.	15
43	60-in. x 60-in. x 20-ft. planer	Pond Machine Tool Co.	20
44	12-in. shaper	Hewes & Phillips	5
45	24-in. shaper	Gould & Eberhardt	7½
* 46	24-in. shaper, Traverse head	Cincinnati Shaper Co.	7½
47	12-in. slotter	Betts Machine Co.	6½
48	19-in. slotter	Putnam Machine Co.	13
49	Slab miller	Wm. Sellers & Co.	6½
50	6-in. pipe cutter	D. Saunders' Sons	7½
51	Pipe cutter, I.X.L.	D. Saunders' Sons	3

Group-Driven Tools—25 H. P. Motor.

No.	Tool.	Maker.
53	16-in. x 3-ft. lathe	P. Blaisdell Co.
54	16-in. x 4-ft. lathe	
55	18-in. x 3-ft. lathe	New Haven Manufacturing Co.
56	36-in. x 16-ft. lathe	New Haven Manufacturing Co.
57	Sensitive drill	
* 58	Sensitive drill	
59	Universal milling machine No. 3	Brown & Sharpe.
* 60	Nut tapper, 6 spindle	National Machinery Co.
61	1½-in. bolt cutter, double	Acme Machinery Co.
62	1½-in. bolt cutter, double	Acme Machinery Co.
63	2-in. bolt cutter, single	
* 64	Hack saw	
* 65	Tool grinder, No. 3 Universal	Sellers & Co.
66	Twist drill grinder	
* 67	12-in. x 32-in. Universal grinder	Iroquois Machine Co.
68	Emery grinder	
69	Emery grinder	Safety Emery Wheel Co.
70	Emery grinder, Universal	
71	Grindstone	

BOILER SHOP.

Individual Motor-Driven.

No.	Tool.	Maker.	Motor H. P.
75	Punch and shear, No. 3	Hilles & Jones Co.	†10
76	Punch 13-16-in. hole in ¾-in	Cleveland Punch & Shear Works Co.	† 5
* 77	Punch, No. 5	Hilles & Jones Co.	†15
* 78	Punch, No. 2, with spacing table	Hilles & Jones Co.	10
* 79	Punch, No. 2, horizontal	Hilles & Jones Co.	†10
* 80	Shear, No. 6	Hilles & Jones Co.	†15
* 81	Shear, No. 1, angle	Hilles & Jones Co.	†10
* 82	Straightening rolls, No. 2	Hilles & Jones Co.	15
83	Bending rolls, No. 2	Hilles & Jones Co.	7½
* 84	Bending rolls, No. 4	Hilles & Jones Co.	25-10
85	36-in. drill press		4

Group-Driven—20 H. P.

No.	Tool.	Maker.
86	Staybolt cutter, 4 heads	Acme Machinery Co.
87	Coke crusher	
88	Flue cleaner	
89	Flue welder	
90	Tube swaging machine	
91	Flue cutter	

*New tools.
†Constant speed motors.

SHAW CRANES IN LOCOMOTIVE SHOPS AT MCKEES ROCKS, PA.—PITTSBURGH & LAKE ERIE RAILROAD.

Location in Shops.	Number of Cranes.	Capacity, in Tons.	Span, in Feet.	Lift of Hook, in Feet.	Number of Trolleys.	Number of Motors.	Motors—Horse-power. Main Hoist.	Trolleys.	Bridge.	Speeds in Feet Per Minute. Main Hoist. Loaded.	Main Hoist. Light.	Trolleys. Loaded.	Trolleys. Light.	Bridge. Loaded.	Bridge. Light.
1 Erecting	1	120	65 ft.	35 ft. 4 ins.	2	6	44	10	44	6	15	75	100	150	200
2 Erecting	1	10	62 ft.	27 ft. 4 ins.	1	3	22	4½	7½	20	50	100	125	250	300
3 Machine	1	7½	46 ft. 3 ins.	19 ft. 6 ins.	1	3	18	4½	7½	24	60	100	125	250	300
4 Boiler	1	30	47 ft. 10 ins.	24 ft. 1½ ins.	1	3	35	6	22	10	25	100	125	200	250
5 Boiler	2	10	43 ft. 10 ins.	20 ft. 11½ ins.	1	3	22	4½	7½	20	50	100	125	250	300

Speeds in table are guaranteed speeds. Light load speeds actually obtained were:

	(1)	(2)	(3)	(4)	(5)
Bridge	350	500	500	500	450
Trolley	200	300	300	250	250
Hoist	17	70	80	26	60

passing from one voltage to the next, especially in the armatures of large motors. This is prevented by the introduction of resistance in series with the armature as the controller moves to a new voltage notch. This resistance is short-circuited automatically as soon as the field magnetism and the speed of motor have had an opportunity to adjust themselves to the new conditions, and the controller drum can thus be moved rapidly through a large range in speed notches without causing injurious sparking at the motor brushes or in the controller.

Three views of this controller, two with the cover removed, are shown in the half tone. It is of good mechanical design and adapted to hard and constant service. The contacts are mounted on semi-circular metallic rings which are fastened to a wooden drum. These rings are accurately located by means of keys in the drum and tongues on the rings, which fit into grooves turned in the surface of the drum and any section of controller contacts can thus be easily replaced without dismounting the entire drum. The contact fingers are very strongly constructed of drop forged copper, and are fitted with adjusting screws for regulating the pressure of the finger against the contact. The controller itself is compact and operates both forward and reverse motions with but one drum. There are twenty-three forward speeds giving a total range of 13 to 1, but this total range is only used for very special cases, the three lower speeds, as already stated, being used ordinarily for starting and the two upper speeds being used where it is necessary to obtain a greater range at reduced power. The working speed range is 4 to 1, divided into 18 speed steps with an average speed increment of 9 per cent. and there are four backward speeds with a speed range of 5 to 1.

Attached to the top of the controller is what is known as the quick-break device, the action of which, being similar to that of the ordinary quick-break switch, causes the controller drum to move at a high speed in breaking the connections and making new ones independent of the rapidity of motion of the handwheel. In passing from one voltage to another, the circuit is simultaneously broken in eight different places, which renders the contacts especially free from arcing and burning. Resistance is also inserted in the armature circuit, which is afterward automatically short circuited. The length of time which this resistance remains in circuit is regulated by means of an adjustable air dashpot. The quick-break device is interlocking and makes it impossible for motor to stop between controller notches. The cover is designed so as to be easily and quickly removed when necessary for inspection. The drum can also be readily removed without disturbing any of the wiring connections.

CRANES.

The location and arrangement of the traveling cranes have been considered in connection with the construction of the various shop buildings and the general features of these cranes are condensed in the accompanying table.

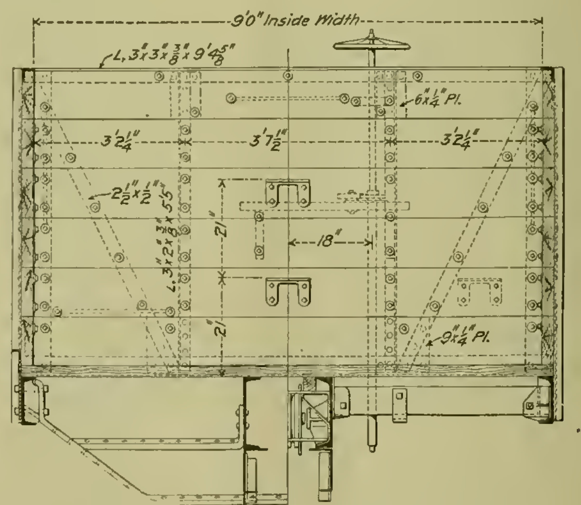
40-TON STEEL UNDERFRAME HOPPER CAR.

This engraving illustrates a steel underframe hopper car designed by Mr. George I. King, of the Middletown Car Works, and built by that company for the Berwind-White Coal Company. In its general features it follows the plan so successfully employed in the construction of the very satisfactory composite coal cars designed by Mr. C. A. Seley, for the Norfolk & Western Railway, when he was mechanical engineer of that road. It employs 15-in. 33-lb. channels as center sills and 10-in., 20-lb. channels as side sills. The side framing, which assists in carrying the load, is built of 7-in. channels for the vertical members and 3 by 2 by ⅜-in. angles for the diagonals. In the substitution of angles, in place of channels, for the diagonal members, this construction differs from that of the Norfolk & Western cars. It also differs in many of the details, but the important similarity is in the use of the side frames in assisting to carry the load. The coping angle which forms the top member of the side truss is 3 by 2½ by ½ in. and the junctions with this member are made with rectangular gusset plates. The general dimensions of this car are as follows:

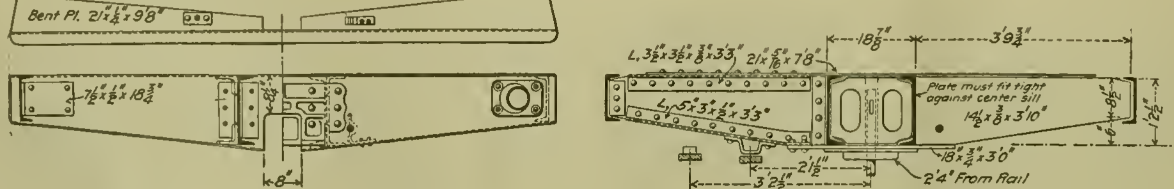
Length over end sills	29 ft.
Length inside	26 ft. 6 ins.
Width over side sills	9 ft. 5 ins.
Width inside	9 ft.
Height inside	5 ft. 3 ins.
Height from top of rail to top of side	9 ft. 3⅜ ins.
Height to lower face of center sills	2 ft. 7 ins.
Length of door openings	2 ft. 7½ ins.
Width of door openings	20½ ins.
Weight of car	37,500 lbs.

extending a short distance towards the end of the car, and to these the corner bracing is riveted. The center sills are continuous through the bolsters and the bolsters are in the form of built-up diaphragms. The door operating mechanism is placed between the center sills.

Instead of extending the center sills to the ends of the car, they stop beyond the bolsters and the draft gear is secured to



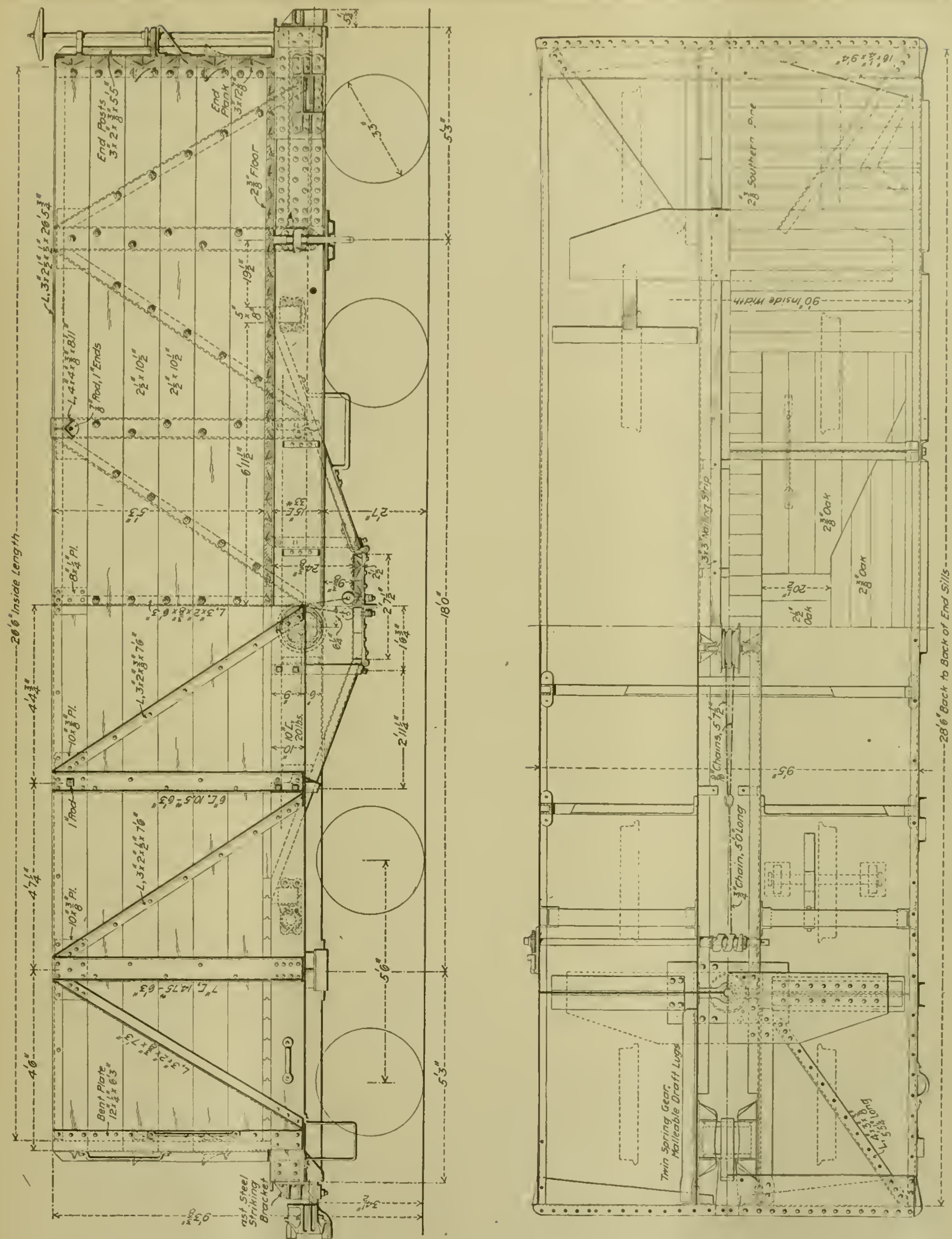
HALF TRANSVERSE SECTIONS.



END SILL AND BOLSTER.

The end sill is a flanged plate which is surmounted by a deck plate flanged up against the end plank of the car. The body bolster is of plates and angles as shown in the detailed engraving. The bolsters are surmounted by long cover plates draft sills of plates spliced to the center sills. In case of damage to the draft gear the draft sills may be renewed without disturbing the center sills.

The coal company required a 40-ton car mounted on the Penn-



PLAN, ELEVATION AND SECTION OF 40-TON STEEL UNDERFRAME COAL CAR.—MIDDLETOWN CAR WORKS.

sylvania standard 50-ton trucks in order to favor the wheels by a reduction of wheel loads. While the reasons for composite construction instead of building the cars entirely of steel cannot be definitely stated a rather significant number of composite cars have been built recently. This seems to indicate a desire to guard against corrosion of equipment which is to be used exclusively in coal service.

These drawings were supplied by Mr. George I. King, vice-president and general manager of the Middletown Car Works.

Another Success of Gasoline Engines.—Crossing the English Channel, doing 25 miles in 1 hour and 7 seconds, in a boat less than 40 ft. long, driven by gasoline engines, is a noteworthy performance. In the recent race the Channel turbine steamer "Queen" was distanced, and the French torpedo boat following the leader had to "open up wide" to keep abreast. The internal combustion motor is doing things on the water as well as on the land which are not being done by steam. It will bear close watching for further developments.

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

EDITORIAL CORRESPONDENCE.

CREWE, England.

At Crewe I found 8,000 men employed, at the time of my visit, in the locomotive department solely. These shops are very large and interesting in many ways, but they have grown, like many shop plants, by accretion. This plant is unique with respect to the amount of manufacturing done, which includes the making of boiler plates, rolling of rails, the making of steel castings and manufacturing of the signal and interlocking apparatus and a variety of other things used on the road. It strikes a visitor as a little strange that a railroad should manufacture its steel plate and rails, because plants for these purposes must necessarily be relatively small and consequently difficult to operate economically and keep up to date. A visit to one of these large English shop plants is exceedingly instructive and emphasizes the importance of studying shop conditions and shop progress with a view of keeping up to standards set by industrial establishments.

At Crewe I found (and it was the only place in my travels) locked doors between shops. The purpose is to prevent unnecessary wanderings of the men, but it must be a very great inconvenience to the officials and those who must necessarily go from one shop to another, and gives an unpleasant impression of espionage.

The amount of milling done in the leading English shops is surprising. No new planers are bought for Crewe, and the old ones are used up as fast as possible. A large tool room is nearly exclusively given up for making cutters for milling machines. Main and side rods are milled in piles of four or more on profile milling machines, the cutters following formers. The work is rapidly and well finished, the rods going directly into the erecting shop with no hand finish. I saw, however, a great deal of hand finishing, by draw-filing, in other shops. Valves and driving boxes are made of solid bronze and are finished by special milling tools, making them absolutely interchangeable. The pin holes in valve motion work are lapped out for the pins; this produces very accurate fitting and reduces the work in the erecting shop. Piston rods have no hand work, and rods in repairs are all finished by grinding.

There is a great deal of old machinery here which is very much crowded, and the number of belts in these shops will some day be very greatly reduced. The shops themselves will light up the heavens very beautifully if they happen to take fire on a dark night. The new machinery seems to be remarkably strong and heavy, with no stinting of material. The milling machines are particularly rigid, and I should say that rather more attention is paid to strength and rigidity than to feed and driving mechanism. I found comparatively few boring mills at Crewe in the older shops and a correspondingly increased use of lathes. Piecework is used throughout on repetitive jobs, and the shop work is arranged as nearly as possible on a manufacturing basis. The rather close adherence to routine methods is possible because of the relatively small number of standard locomotives and the very marked efforts in the direction of interchangeability of the principal parts in several different classes of locomotives. One does not find here some four or five different kinds of eccentrics or eccentric straps piled up in front of a machine.

The boiler work at Crewe causes a sigh of admiration, because here are real boiler makers in abundance, and their work is finely fitted and finished. It is safe to say that the men testing these boilers under hydraulic pressure do not require umbrellas or oil-skins—although I did not have the good fortune to see one tested. While labor saving machinery is used to a certain extent, most of the work is done by hand. The staybolt work is done with special care and copper staybolts are used exclusively. Boiler tubes, as a rule, are beaded over only at the back end, and it is quite common to find only a portion at this end so treated. The smokebox ends are usually not beaded at all. A characteristic of boiler shops over here is the use of flanging presses and formers, and in this the drafting room helps the shop by reducing the number of standard sheets requiring flanging. I should say that the American roads could advantageously send a representative over here to study this matter of duplication of parts in boilers and running gear.

English locomotive men have no use for the American bar-frames, and I was attacked on this question everywhere. I fought for the American frame on principle, but—I learned something. The criticism is not on the bar-frame itself so much as on the difficulty of forging, or casting, a frame of this type so that it will be free from initial stresses. I think there is a good deal of prejudice over here in this matter, but these plate frames cannot be examined thoughtfully without reaching the conclusion that they have some excellent points. Plate frames are now cut away so that they do not render the engine inaccessible, and the plates offer the advantage of homogeneity. The strong point of English frames, however, is not in the plate so much as it is in the bracing, which is exceedingly deep and rigid. The frames are themselves deep and amply rigid against vertical stresses. They are made rigid against twisting by three substantial steel castings, which are nearly as effective as the cylinders. One of these is the motion plate supporting the guides and the others are in the form of the belly braces and cross braces at the front end of the firebox. These act as the diagonal braces between two deck bridge girders and seem admirably suited to provide for the exceedingly heavy stresses received by the flanges of the drivers when striking curves. Judging from the answers to my questions, nothing on an English locomotive has ever broken since the time of Stephenson, and nothing ever will break, but I am quite sure that, except in the case of very old locomotives, there is very little trouble here with broken frames.

On this road, as on nearly all others in this country, there are no adjustable parts in the smokebox except the petticoat and stack. The petticoats are usually cast integral with the stack, and, like the practice of the Caledonian Railway, when once adjusted for a new engine no provision is made for subsequent change. Of course, they throw "fire" to some extent, but not as much as we would expect.

The Crewe shops are on a longitudinal track basis, which is the usual rule over here.

The painting of new engines requires two weeks, but is not renewed for about six years. Fifteen months is the usual period between general repairs. This road builds all its new engines and usually builds about 70 per year for renewals.

On the London & Northwestern the engine men both report from one to one and a half hours before their engine is to go out. They attend to taking coal and water, oiling and inspecting, before the run. They also stay with the engine a half-hour after getting in from a run, and make a very careful inspection, being held responsible for reporting the condition of the engine in every respect and for reporting in writing in the work book anything requiring attention. As a rule they remain about the engine when repairs are being made, to see that the work is satisfactorily done. Contrast this sort of interest with that found in connection with the pooling system!

The shop men in England are a comfortable lot. They take life easily and certainly impress the visitor with the idea that they do not intend to work hard; in fact, in going about the shops the men seen appear to be slow and inclined to make their work last as long as possible. The absence of labor-saving "kinks" and devices, such as hoists over the machines, tends toward a great deal of unnecessary manual labor.

English foremen are officials with considerable dignity. I met several Whitworth scholars among them and a number who were technical school graduates. They are personages of considerable importance, and the workmen hold them in apparent awe, which is in marked contrast to the freedom and democracy of an American railroad shop. The foreman here is not "Bill," "Fred," "Charlie" or "Dick." He is Mr. So and So, with a touch of the cap. The works manager of an English road is, as he ought to be, a real official, with his duties confined, as they ought to be, to the shops themselves. English roads do not have the counterpart of our master mechanic with responsibilities of various kinds over shops, roundhouses, engineers and firemen, wrecking crews and all, with too little help and depending upon general foremen for important shops.

British locomotives are usually adapted to hauling light loads. They are well adapted for it, and have been developed on this basis. The time has now come, however, when something new must be done. Trains are becoming heavier, and as passenger equipment improves, as it must along the lines of "corridor" cars, much greater weights will prevail. Furthermore, competition among the various lines will bring this heavier equipment very rapidly and the English locomotive superintendent will soon face a very difficult problem, which amounts to the provision of greatly increased capacity without exceeding the narrow limits of clearances. Across the Channel the same problem was foreseen some years ago, and French roads have studied it and provided for it effectively. This has not escaped the attention of progressive English railroad men, and the Great Western is now studying the De Glehn compound by aid of an engine built by the Société Alsacienne de Constructions Mechanique, from the drawings of the latest 4-4-2 engine of the Northern Railway of France. My understanding of the reason for this purchase of a foreign engine is this: The Great Western has recently produced at Swindon a new design of 4-6-0 passenger engine. It is a beautiful machine and represents the knowledge and experience gained on this road in the construction of single expansion locomotives. In fact, it is the best single expansion locomotive that Mr. Churchward can build within the limits prescribed by the demands of the road. Wishing to know what may be expected from compounding, he bought a De Glehn compound, believing this type to represent the best and most advanced method of componnding. In securing a compound he desired to obtain one which would be comparable in weight with his own design. The results of the comparison will be interesting. It will be necessary, however, to operate the French engine in the French way, or it will not show what it can do. Undoubtedly this will not be overlooked.

The Great Western is not the only road which is making a study of Continental practice. A locomotive superintendent of another prominent road told me that he believed it would soon be necessary to apply the De Glehn principle to his practice in order to keep pace with the demands made upon him by the management. It is worth remarking that this official did not say that he thought compounding would be necessary, but that the De Glehn compounding was needed. He proceeded to explain that, because the work required of a locomotive varies with frequently changing conditions of the road, the design of the locomotive should provide means for adjusting the engine to the conditions, and this, he thought, was best accomplished by the four-cylinder compound with independent valve gears. I was considerably impressed by this frank statement of a man who would not look to a foreign country for ideas in locomotive construction if he could avoid it. He wished me to withhold his name, and went on to say that he had gone as far as he could on present lines. Little was left to be gotten out of boilers or boiler accessories, there was not much to be expected in the way of improvements in valve gear, and he did not believe it possible to greatly improve simple engines unless superheating should prove successful. If it should, he would adopt it, and even then he thought compounding necessary. On drawing him out a little further, he expressed the opinion that it would be necessary to adopt every refinement, within reasonable limits, which would increase the capacity of locomotives by increasing the effectiveness of a pound of steam. He said: "We must not hesitate to complicate our locomotives, and we must do every possible thing to educate and encourage the men who handle the engines, so that they will get the work out of them. We need scientific locomotives and specially educated men to run them. We are now up against a stone wall, and these things we must do."

His words are quoted exactly as possible, and they are worthy of thoughtful consideration in every country where railroad transportation is an important factor. Some instructive and intelligent locomotive designing is to be done in England in the near future.

I may be pardoned for recording these particular notes with considerable pleasure, because the ideas are so closely in accord with my own. G. M. B.

(To be continued.)

PERSONALS.

Mr. Mord Roberts has resigned as superintendent of machinery of the Kansas City Southern Railway.

Mr. C. H. Bowers has been appointed assistant master car builder of the Canadian Pacific lines east of Port Arthur.

Mr. A. Struthers has resigned as master mechanic of the El Paso & Southwestern at Douglas, Arizona.

Mr. W. E. Killen has resigned as superintendent of motive power of the Chicago, Peoria & St. Louis at Jacksonville, Illinois.

Mr. M. D. Stewart has resigned as master mechanic of the Rio Grande, Sierra Madre & Pacific to accept a position as master mechanic on the Chicago, Peoria & Pacific.

Mr. J. W. Oplinger has been appointed superintendent of motive power of the Atlantic Coast Line, with headquarters at Savannah, Ga., to succeed Mr. W. H. Young.

Mr. F. A. Chase, general master mechanic of the Missouri Lines of the Chicago, Burlington & Quincy, has been appointed general mechanical inspector with headquarters at St. Louis, Mo.

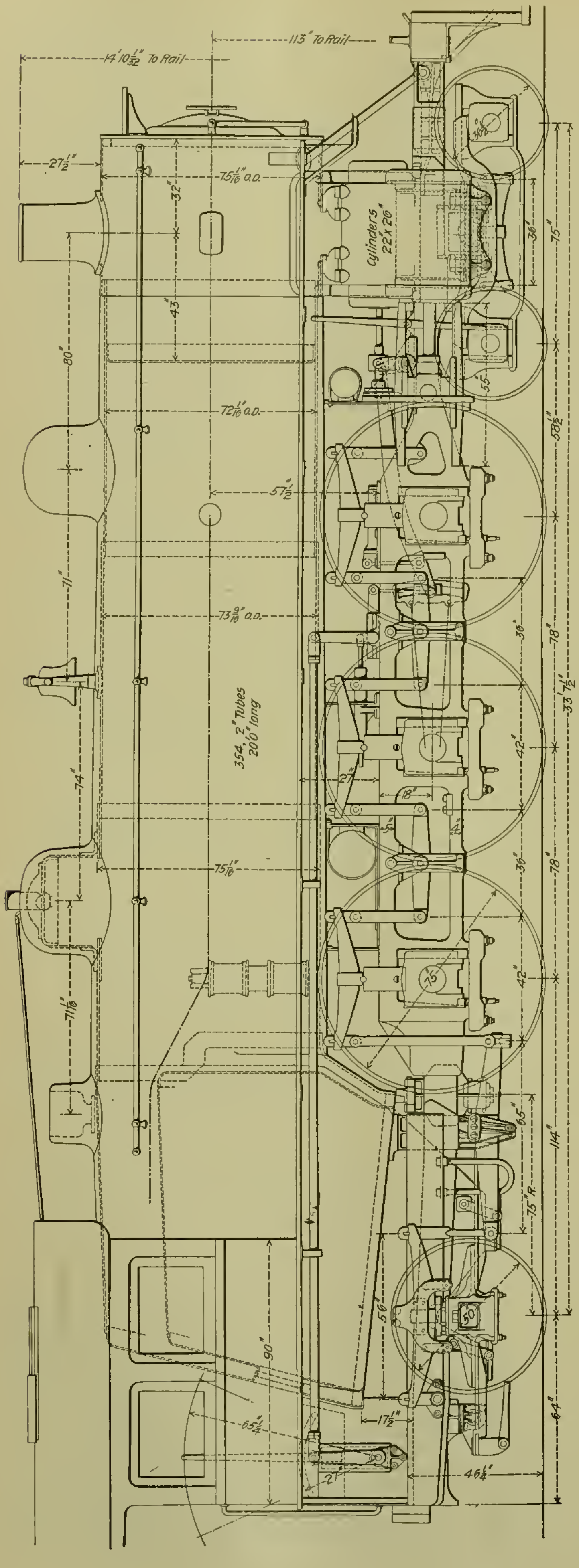
Mr. W. E. Symons, mechanical superintendent of the Gulf Lines of the Atchison, Topeka & Santa Fe, has been appointed superintendent of motive power of the Kansas City Southern, with headquarters at Pittsburg, Kan.

Mr. Thomas Paxton has resigned as master mechanic of the St. Louis, Iron Mountain & Southern to become master mechanic of the El Paso & Southwestern Railway, with headquarters at Douglas, Ariz.

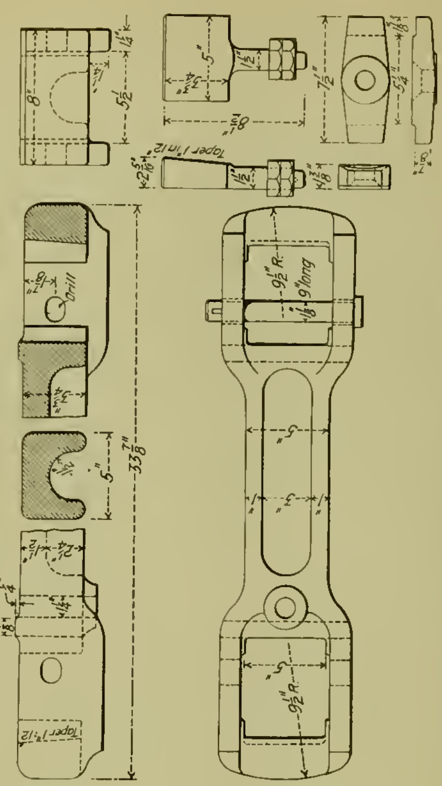
Mr. A. Harrity has resigned as master mechanic of the Atchison, Topeka & Santa Fe at Raton, New Mexico, and has been appointed mechanical superintendent of the Gulf, Colorado & Santa Fe to succeed Mr. W. E. Symons.

Mr. A. B. McHaffie has been appointed master mechanic of the Intercolonial Railway of Canada, with headquarters at Moncton. He is promoted from the position of foreman of the locomotive shops at that point.

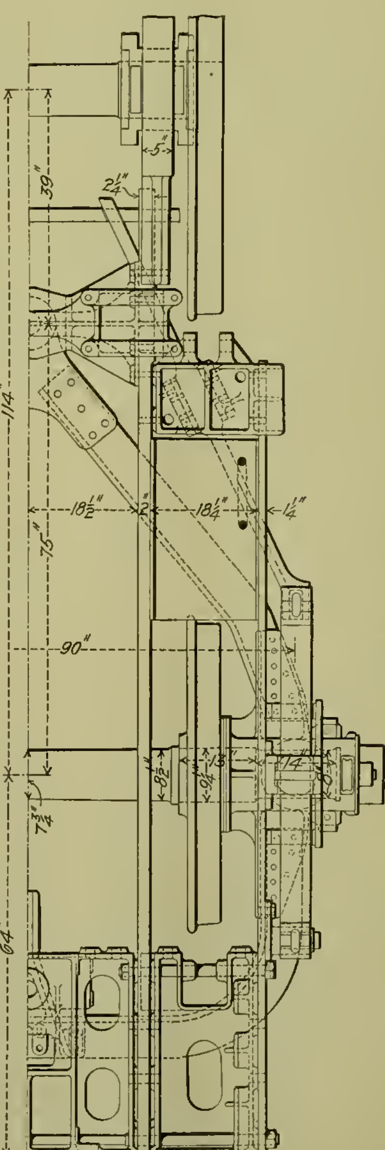
John R. Slack, formerly superintendent of motive power and recently appointed assistant to the general superintendent of the Delaware & Hudson, died in New York, August 1, at the age of 41 years. Mr. Slack was educated at Columbia College and Stevens Institute of Technology. He began railroad work as an apprentice on the New York Central and became mechanical engineer of that road in 1890. In 1898 he went to the Central Railroad of New Jersey as mechanical engineer, and in 1894 was appointed assistant superintendent of motive power of the Delaware & Hudson. In 1902 he was promoted to the head of the department and in March last was appointed assistant to the general superintendent. He will be sadly missed by many whose respect and friendship he gained by his attractive personality.



PASSENGER LOCOMOTIVE.—MICHIGAN CENTRAL RAILROAD.



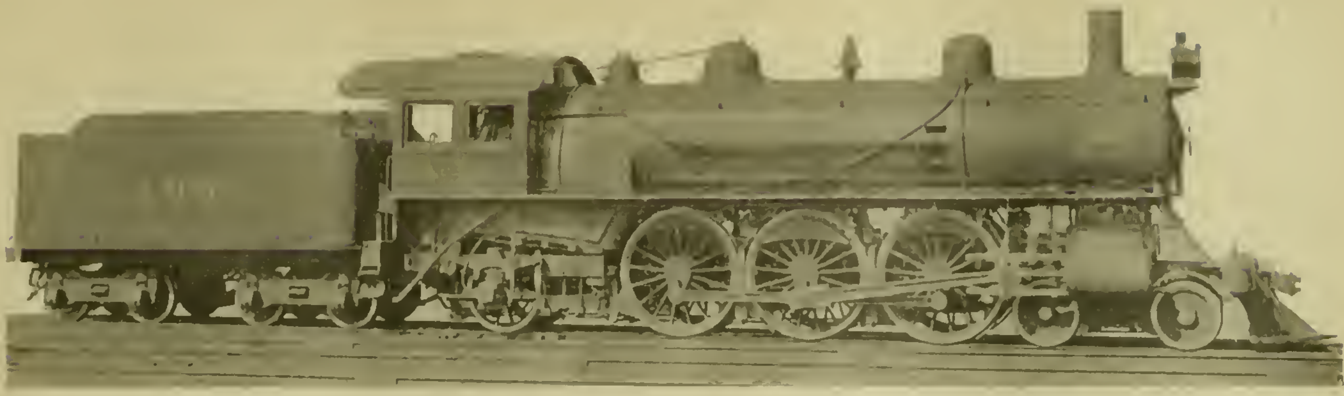
DETAILS OF PEDESTAL BINDER.



PLAN VIEW OF TRAILER TRUCK.

PASSENGER LOCOMOTIVE.—MICHIGAN CENTRAL RAILROAD.

E. D. BRONNER, *Superintendent Motive Power.* AMERICAN LOCOMOTIVE COMPANY, *Builders.*



PASSENGER LOCOMOTIVE, MICHIGAN CENTRAL RAILROAD.

E. D. Bronner, *Superintendent Motive Power* — American Locomotive Company, Schenectady Works, *Builders.*

PASSENGER LOCOMOTIVE, MICHIGAN CENTRAL RAILROAD.

4-6-2 (PACIFIC) TYPE.

The Michigan Central has in service four very powerful six-coupled passenger locomotives from the Schenectady Works of the American Locomotive Company. These engines closely resemble those of the same type for the New York Central, illustrated in this journal in March, 1904, page 87, but they are somewhat heavier. In the accompanying tables the comparison of total weights and heating surfaces of a number of recent large passenger locomotives are given, and also some ratios of the different factors of the new Michigan Central engines:

COMPARISON WITH OTHER LARGE PASSENGER LOCOMOTIVES.

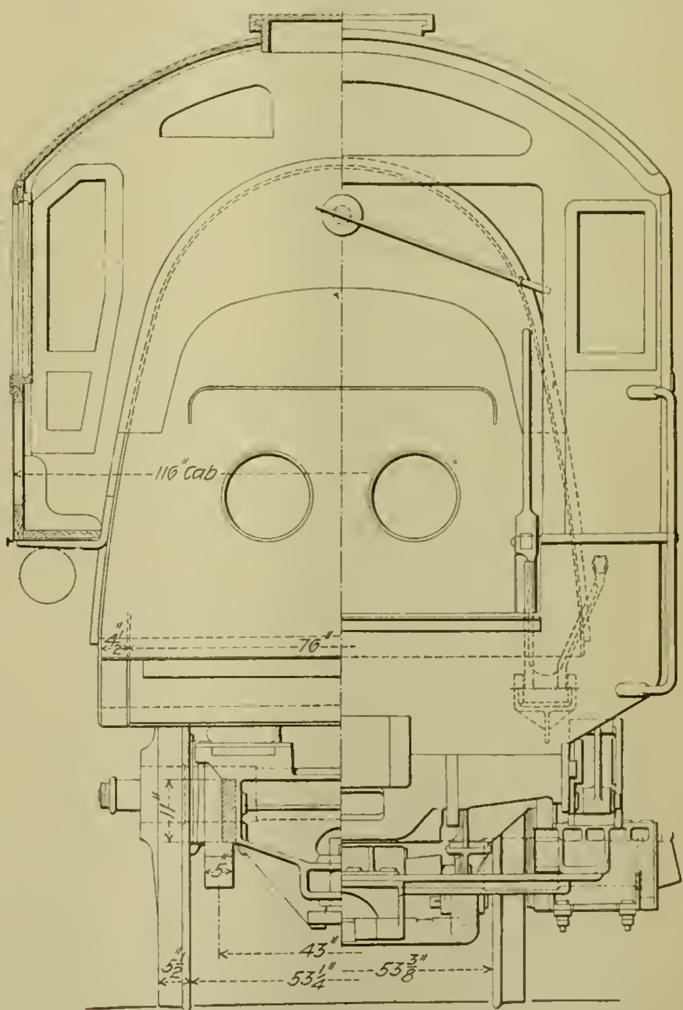
Road.	Engine Number.	Total Weight.	Total Heating Surface.	Total Weight Divided by Heating Surface.
C. & A.	602	221,550	3,053	72.5
M. C.	499	221,000	3,894	56.7
C. & A.	601	219,000	4,078	53.7
N. Y. C.	2,794	218,000	3,757	58.2
El Paso & Southwestern	——	209,500	3,818	54.8
Northern Pacific	284	202,000	3,462	58.3
A., T. & S. F.	1,000	190,000	3,738	50.1
C. & O.	147	187,000	3,533	52.9
L. S. & M. S.	650	174,500	3,343	52.2

RATIOS OF MICHIGAN CENTRAL LOCOMOTIVES.

Heating surface to cylinder volume	= 341
Tractive weight to heating surface	= 36.1
Tractive weight to tractive effort	= 4.93
Tractive effort to heating surface	= 7.31
Heating surface to grate area	= 77.5
Heating surface, percentage of tractive effort	= 13.6
Total weight to heating surface	= 56.7

It is interesting to note the advance in capacity over the recent passenger locomotives of the 4-4-2 type built last year for this road and illustrated in this journal in January, 1903, page 33. The present design is only 550 lbs. lighter in total weight than the heaviest of passenger locomotives which are running on the Chicago & Alton Railroad. In 1902 the Baldwin Locomotive Works built some 2-8-0 passenger engines for the Colorado Midland, with 74-in. boilers. These Michigan Central engines, with 72 1-16-in. boilers, are next to these in having the largest boilers in passenger service. They have long, straight boilers with 354, 2-in. tubes 20 ft. long and having ¾-in. spaces between the tubes. The heating surface is 3,894 sq. ft., which closely approaches that of the Chicago & Alton engine of this type, built a year ago, with the largest heating surface yet given to any passenger locomotive. This boiler has a 4½-in. mud ring on all sides. It has a liberal number of flexible staybolts in the outside rows surrounding the narrow water spaces. A ring of these staybolts, 64 in number, all around each side of the firebox and in the corners, 40 of them in the other rows on the back head and 44 in the throat sheet, are expected to reduce the staybolt breakage.

Special care has been taken to brace the frames with broad, flat braces over the front driving axle, between the second and third driving axles and at the pivot for the trailing axle radius bar. The bottom rails of the frames are tied across the engine at the forward and main driving boxes. There is no splice in the frames except at the rear of the rear driving boxes. Special attention is directed to the new keyed pedestal tie binders for the frame jaws. These permit of strong and yet adjustable construction at these vital points. This binder



HALF REAR ELEVATION AND SECTION.

was developed by Mr. Francis J. Cole of the American Locomotive Company.

These engines have piston valves with inside admission and direct motion. In the plan view the fork connection at the back end of the transmission bar and the double link lifters are shown.

The trailer trucks are similar to those of the recent New

York Central engines of this type. They have, however, a better arrangement for taking out the truck boxes by means of a removable pedestal tie which was not originally provided in the earlier engines. These trucks have angle bar frames and radius bars 75 ins. long, measured on the center line of the engine. In order to connect the rear equalizers with the outside boxes of the trailer truck and the inside driving boxes, the levers are placed at an angle, with the fulcrums under the front firebox supports. These fulcrums form the connection between the main and short outside auxiliary frames at the trailer trucks. A spring seat and 2-in. rollers provide for easy lateral movement of the trailer trucks.

In studying this design the high ratio of tractive weight to tractive effort should be noted. The engine should not be "slippery" under any ordinary condition of rail. It is noteworthy that strength has not been sacrificed in any particular in order to reduce weight.

Mr. E. D. Bronner, superintendent of motive power of the Michigan Central, states that these engines are to haul very heavy trains such as No. 31, which leaves Chicago at 9.00 p. m. and arrives at Buffalo at 7.20 a. m., 535.2 miles in 10 hours, 20 minutes, at an average speed of 51.8 miles per hour. This train usually consists of 16 cars and weighs 600 tons behind the tender. The grades on the Canada division are very light, while on the United States division there are some of 36 ft. to the mile. In this journal for January, 1903, page 33, a remarkable run with this train hauled by the Class K, or 4-4-2-type, locomotives was described. The larger engines, Class L, are expected to handle the train comfortably, whereas the smaller engines are put to the limit of their capacity. In this run there are 15 regular station stops and, taken as a whole, it is very severe service. Readers are referred to the description of the work of the 4-4-2 engines for the particulars of a portion of the remarkable previous performance of one of them.

In the following table the chief dimensions are given:

PASSENGER LOCOMOTIVE, MICHIGAN CENTRAL RAILROAD.
4-6-2-TYPE.

GENERAL DIMENSIONS.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal
Weight in working order	221,000 lbs.
Weight on drivers	140,500 lbs.
Weight engine and tender in working order	343,600 lbs.
Wheel base, driving	13 ft.
Wheel base, rigid	13 ft.
Wheel base, total	33 ft. 7½ ins.
Wheel base, total, engine and tender	60 ft. 5 ins.

CYLINDERS.

Diameter of cylinders	22 ins.
Stroke of piston	26 ins.
Horizontal thickness of piston	6½ ins.
Diameter of piston rod	3¾ ins.
Kind of piston-rod packing	U. S. metallic, with Gibbs vibrating cup

VALVES.

Kind of slide valves	Piston
Greatest travel of slide valves	1¼ ins
Outside lap of slide valves	1 in.
Inside clearance of slide valves	¼ in., ⅛ in.
Lead of valves in full gear	Line and line in full forward motion, one-quarter lead at one-quarter stroke
Kind of valve-stem packing	U. S. metallic

WHEELS, ETC.

Number of driving wheels	6
Diameter of driving wheels outside of tire	75 ins.
Material of driving-wheel centers	Cast steel
Thickness of tire	3½ ins.
Driving-box material	Cast steel
Diameter and length of driving journals	9½ ins. diameter x 12 ins.
Diameter and length of main crankpin journals:	(Main side, 7½ x 4¾ ins.) 7 ins. diameter x 6½ ins.
Diameter and length of side-rod crankpin journals:	Forward and back, 5 ins. diameter x 4½ ins.
Engine-truck journals	6 ins. diameter x 12 ins.
Engine-truck wheels	36 ins.
Trailer wheels, diameter	50 ins.
Trailer journals	8 x 14 ins.

BOILER.

Style	Straight top, radial stay
Outside diameter of first ring	72 1-16 ins.
Working pressure	200 lbs.
Thickness of plates in barrel and outside of firebox	23-32, ¾, ½, 9-16 in.
Firebox, length	96⅛ ins.
Firebox, width	75¼ ins.
Firebox, depth	Front, 79½ ins.; back, 65¾ ins.
Firebox, material	Carbon
Firebox plates, thickness:	Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube sheet, ½ in.
Firebox, water space	Front, 4½ ins.; sides, 4½ ins.; back, 4½ ins.
Firebox, staybolts	Ulster special iron, 1-in. diameter W. S.
Tubes, number	354
Tubes, diameter	2 ins.
Tubes, length over tube sheets	20 ft.
Fire brick, supported on	Water tubes
Heating surface, tubes	3,690.6 sq. ft.
Heating surface, water tubes	23.6 sq. ft.
Heating surface, firebox	180.3 sq. ft.
Heating surface, total	3,894.5 sq. ft.
Grate surface	50.23 sq. ft.
Exhaust pipes	Single
Exhaust nozzles, diameter	5⅜, 5⅝, 5⅞ ins.
Smokestack, inside diameter	18 ins.
Smokestack, top above rail	14 ft. 10 1-32 ins.

TENDER.

Style	Water bottom
Weight, empty	52,600 lbs.
Wheels, number	8
Wheels, diameter	36 ins.
Journals, diameter and length	5½ ins. diameter x 10 ins.
Wheel base	18 ft.
Tender frame	10-in. channels, 11-16-in. web
Tender trucks	Fox pressed steel, floating bolster
Water capacity	6,000 U. S. gals.
Coal capacity	10 tons

PERFORMANCE AND REPAIRS OF "BIG LOCOMOTIVES."

The opinions concerning "Big Locomotives," printed in the June number of this journal, have attracted the attention of many operating officers and it is to be hoped that a reduction in the too general practice of overloading will result.

Several officers were sufficiently interested to make an effort to ascertain the cost of repairs of various classes of locomotives and to investigate the records of "engine failures." These figures are usually not available in the customary methods of keeping accounts and in order to know positively the standing of the large locomotives an analysis was prepared by the officers of the Chicago, St. Paul, Minneapolis & Omaha Railway. Mr. A. W. Trenholm, general manager, has transmitted a statement prepared by Mr. J. J. Ellis, superintendent motive power and machinery, which is reproduced in full with the accompanying diagrams.

A careful study of these diagrams carries the conviction of the necessity for such comparisons in order to determine with intelligence the proper motive power policy of a road. The observations of Mr. Ellis are as follows:

"Are big locomotives satisfactory?" From a motive power standpoint I should say they are not, when the weight greatly exceeds 225,000 lbs. The curves in Fig. 1 indicate that the cost of repairs increases very rapidly with the weight of the locomotive, the increase being greatest in passenger engines. The upper curve of Fig. 2 shows that the cost of coal consumed per thousand ton miles decreases very rapidly with the increased weight of the locomotive up to a certain limit, after which the curve is nearly parallel with the base line; then again slightly rising at engines weighing 275,000 lbs., showing that the limit of weight which gives greatest fuel economy has been exceeded. The same is nearly true as to cost of oil per thousand ton miles shown on the same sheet.

"Are locomotive failures increasing as the size of locomotives increases?" This can be answered by referring to the table of figures showing the engine failures on the Wisconsin Division and Minnesota & Iowa Division for four months, including December, 1903, and the first three months of 1904. It will be observed that on the Wisconsin Division, where the engines employed in road service are about equally divided between light and heavy power, that 91.2 per cent. of all failures during these four months are against the heavy power. On the Minnesota & Iowa Division 23.1 per cent. of the power weighs more than 225,000 lbs. per locomotive and 26.9 per cent. of the failures are due to this class of power. Why there is such a difference in the per cent. of failures chargeable to large locomotives on the Wisconsin and Minnesota & Iowa Divisions, I am unable to say. Whether it is due to the fact that engines are big, or to overloading, is a matter of conjecture.

If the difference between the tonnage hauled and a dynamometer car rating was known for the two divisions, it might throw some light on the subject. A very important part of the first question, from an operating standpoint, is the relative cost per thousand ton miles, for engine and train crews, when working with light and heavy locomotives. A curve should be plotted similar to that of the cost of coal and oil consumed and would be a very valuable addition to this data and something that should be known. We could do this here if we had the cost for train crews—we can, of course, obtain from our records the cost as to engine crews.

"All the information here presented would indicate that from a motive power point of view a maximum limit of weight for

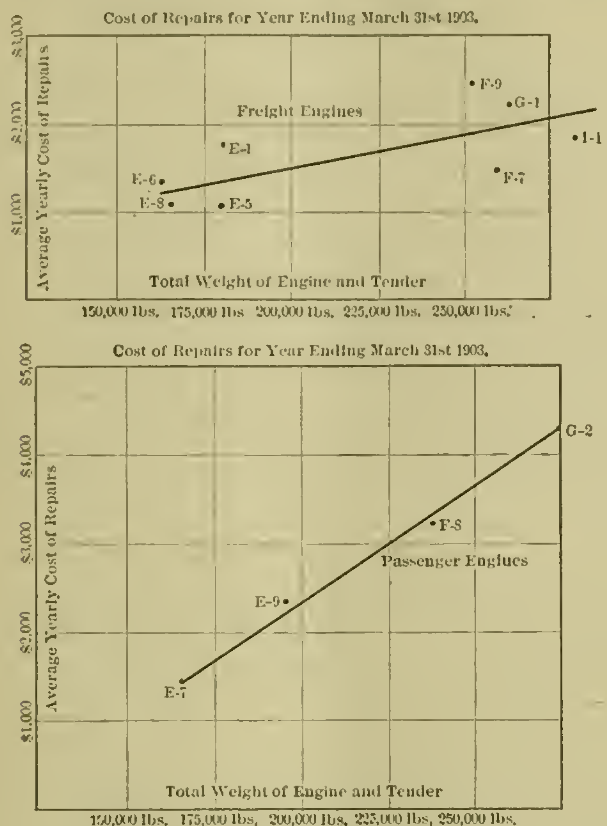


FIG. 1.

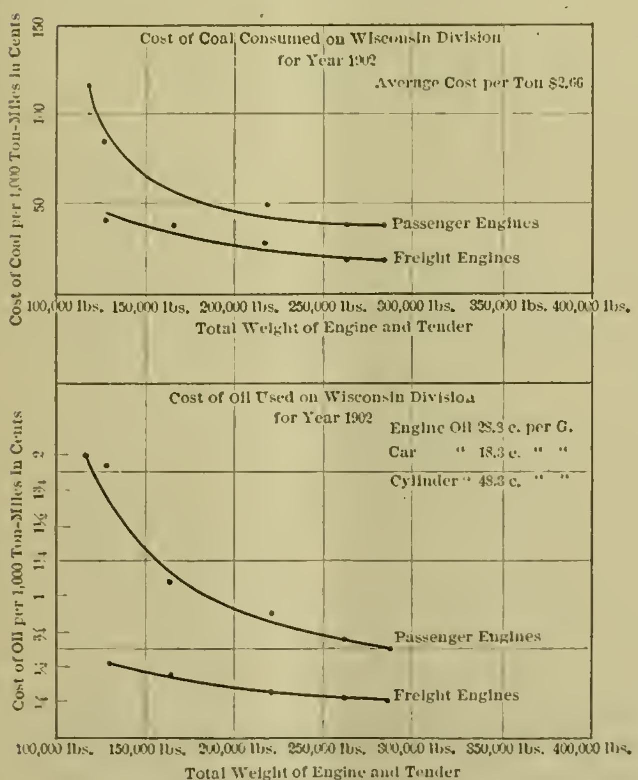


FIG. 2.

locomotives in road service should not far exceed 225,000 lbs., in order to procure the greatest economy in fuel and oil consumption, cost of repairs, and minimize engine failures.

"Please note that Fig. 2 shows the cost of coal and oil for the year 1902. The reason for taking 1902 instead of 1903 is on account of the fact that locomotive statistics compiled in our car service agent's office show the oil consumed in 1902, but does not give the figures for 1903. While we would rather have used 1903 figures, it probably would not change the comparative cost."

AVERAGE YEARLY COST OF REPAIRS.

Class	Type of Engine.	No of Engs in Averge	Aver'g Age	Total Weight Eng. & Tender	Tractive Power	Av'rge Cost of Reprs. per yr.
PASSENGER ENGINES.						
E-7	4-4-0	6	16	166,100	12,920	$1,432.92
E-9	4-6-0	6	13	196,000	16,520	2,310.37
F-8	4-4-0	14	6	238,200	18,040	3,222.00
G-2	4-6-0	3	3	275,050	21,115	4,315.59
FREIGHT ENGINES.						
E-4	4-6-0	5	19	178,600	15,480	1,711.43
E-5	4-4-0	10	21	178,600	13,820	1,041 92
E-6	4-4-0	23	17	164,100	13,820	1,357 50
E-8	4-1-0	10	16	166,100	14,280	1,082.88
F-7	4-6-0	2	7	258,700	22,650	1,493.12
F-9	4-6-0	10	6	251,600	22,320	2,115.33
G-1	4-6-0	13	4	264,000	25,090	2,235.50
I-1	4-6-0	16	2	279,850	29,120	1,877.50

ENGINE FAILURES.

Year	Month	No. Failures Dur. Month	No Road Engs. Assigned to Division	% of Road Engin's ov'r 225,000 on Div.	% of Failures on Eng's over 225,000
WISCONSIN DIVISION.					
1903	Dec.	36	84	51.8	91.7
1904	Jan.	36	83	48.9	88.8
1904	Feb.	18	88	49.7	88.8
1904	Mar.	22	84	49.2	95.5
Averages				49.9	91.2
MINNESOTA AND IOWA DIVISION.					
1903	Dec.	92	70	24.0	23.9
1904	Jan.	62	66	23.9	25.8
1904	Feb.	38	64	20.5	34.2
1904	Mar.	38	64	24.1	23.7
Averages				23.1	26.9

BLUE HEAT IN BOILER PLATES.

Every boilermaker and apprentice who is not posted on the fatal blue heat should at once become familiar with this subject through an actual test, which can be made in the following manner:

Take a piece of steel about 2 ins. wide and about 24 or 30 ins. long, any thickness from say ¼ to ⅜ in. Grind the surface on the emery wheel or grindstone until it becomes bright for a distance of about 10 or 12 ins. on one end, so that you can observe the color when it makes its appearance. Then take it to the blacksmith or flange fire and hold it on top of a clean fire, thus preventing it from becoming smoked up so badly that you cannot see the color. Now move the piece slowly back and forth over the fire and watch it closely until the blue color appears, which will be about the same as is used for tempering a flat chisel for boiler shop use. Then take the piece to the anvil and bend it over double without breaking it if you can. You will find that it will break every time. Take the other end of the same piece, which is perfectly cold, and you can bend it over double without breaking. (The higher the tensile strength the quicker it will break. Soft firebox steel will not break so readily.) This experiment will prove to your satisfaction why many corners have been cracked by heating them just hot enough to produce a blue heat, as the steel will stand far more abuse perfectly cold than it will at a fatal blue heat. If you are working up steel and you see the blue color coming into the steel, stop at once and apply more heat or you may wish you had taken the advice herein given. At a very small cost a little crude oil or gasoline heater can be made and in less than five minutes very heavy material can be made white hot and worked up without any danger of cracking the plates.

Nearly every boilermaker who has followed our advice and made the necessary experiment to familiarize himself with the fatal blue heat will insist on having some sort of a heater in the shop for doing his work properly or he will have sense enough to tell the proprietor that he will not be responsible for the cracking of plates which are heated by placing chunks of red-hot iron on the place to be worked up. This method never heats a plate hot enough to insure working it without danger of cracking, but by using crude oil or gasoline you will never have a break if you stop pounding in time and apply the heat again. It requires but a few minutes to make it white hot again and all danger is thereby avoided.—*Motive Power.*

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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ECONOMICAL TRAIN OPERATION.

An important study of train operation has been undertaken for this journal by Mr. George R. Henderson, and will be presented in several articles beginning in the October number.

The letters from railroad officials on the subject of overloading locomotives which appeared in the June number indicate that the operation of locomotives from what may be termed a commercial standpoint has not been studied, and the purpose of the articles is to indicate the need of establishing a method of analysis of the effect of train loads and speeds upon the economy of operation. The question is, What is the efficient way to load locomotives? It is not treated by Mr. Henderson as merely an engineering problem, but he has applied engineering methods to the solution of a commercial problem involving questions which include motive power and operating factors in an effort to deduce the most effective way of obtaining the greatest returns for the money invested.

It has been common practice in times of heavy business to reduce loads in order to increase the total movement of traffic, and it is desirable to know the speeds and loads which are most efficient under ordinary conditions. This includes such items as fuel and water consumption, engine repairs and wages of engine and train crews, not only in absolute quantities, but as affected by such influences as grades, speeds and loads.

It is apparent at the outset that no fixed rules can be laid down for handling traffic on any and every division, but each piece of road may be studied with reference to its conditions of traffic and its physical characteristics. These articles will define very clearly how such a study may be made for any conditions and will enable railroad officers to make the proper analysis of their conditions so that they may apply the suggestions to their own circumstances in order to conduct transportation economically.

Nothing like this has ever appeared in print and Mr. Henderson's articles promise to be exceedingly valuable.

THE FIRST LAW OF PIECEWORK.

The statements on the subject of piecework, made by Mr. Le Grand Parish, in this issue, are based upon successful experience under specially difficult conditions, and those who are working in this direction will find his suggestions helpful.

One thing stands out prominently in the experience of all who are successful in applying piecework, and this is the most important single item in the article—"The first law of piecework is honesty." Piecework is not safe in the hands of a shrewd schemer, a "sharper" or a man who is after a quickly made "record." Neither is it safe in the hands of one who will put it into effect with the issue of a bulletin notice. The time is past when any but a careful, well prepared and well understood plan will answer. The men must have absolute confidence in the system and in the officials who administer it. With this as a foundation the system must be built up as any business is built up, by carefully studying the conditions and developing a plan to fit them. Honesty of purpose will not alone suffice. The men must be provided with facilities, with material, with suitable conditions for working, and they must be aided by the foremen. All this must be done in such a way as to increase as far as possible the earnings of the men, and the men should understand that piecework is a form of commission on output paid in terms of work actually accomplished. Intensity of output is what the railroad wants. One of them gets it to-day with 150 men at one point where 450 men were employed on less work by the day work plan two years ago. The workers, unskilled laborers, receive double their former wages and the company gains an advantage in increased productivity of its plant, in reduced loss of time of its rolling equipment in the shops and in actually reduced cost of the work itself. The secret is "High wages for increased production."

There is nothing in the whole shop administration problem more promising to both employer and employee than piecework. There is also nothing more thoroughly misunderstood by some people. The writer is told by a piecework expert that in a single month he received formal requests for his schedules from seven different railroads. These were properly promptly refused. It is not likely that anyone asking off-hand for a schedule in order that he may introduce piecework will be careful to consider, for example, the nine bases for comparison of piecework prices stated by Mr. Parish.

Mr. Parish does not state the second law of piecework. If he did he would probably express it somewhat as follows: "Place the problem in the hands of the right man and give him the requisite authority and support."

Such men are greatly needed just now. Some railroads are developing them and some are not. Railroad officers may see how rapid has been the development of such experts in industrial fields. The real question after all is to find the men who can administer piecework and educate both management and men in its principles.

HIGH SPEED TOOL STEEL IN RAILROAD SHOPS.

If busy railroad officers who are at their "wits end" to know how to meet the conditions of decreased rates per ton mile and increased cost of labor and material will carefully ponder the record presented by Mr. Jacobs in this issue, they will discover one of the roads they need to follow, that of the application of commercial principles to railroad service.

Mr. Jacobs treats of shop practice, and when "16 to 1," the familiar slogan, is applied so successfully to the improvement of shop tool output, the record is entitled to keen attention by the highest officials of all our railroads. The Union Pacific has become a leader in this movement toward improved shop methods. On cast iron the improvement in output has been

120 per cent.; on steel 150 per cent., and on wrought iron, 175 per cent., considering actual results and the weight of metal removed in a given time. Union Pacific practice, before the new methods were applied, was probably neither far better nor far worse than that of other roads. It is, therefore, safe to say that other roads present the same opportunities for improvement. If the statements of Mr. Jacobs receive the attention they merit, a wave of improvement of machine and shop output will pass over the entire country, and this will mean much for the railroads and for the men into whose hands this opportunity falls.

Nearly every shop has the new tool steels, and blue chips are commonly seen. This, however, is not sufficient. Machine tools, men, and shop methods require a new kind of attention. In fact, the new steels have revolutionized shop practice all over the world, and the railroads have every reason to become leaders in meeting the changed conditions. If these conditions are met, and if the efforts of machine tool builders to supply suitable special machinery for railroads are suitably encouraged, the railroad mechanical officer will be in position to contribute, as he never has before, to the advancement of transportation, and he will take a high place among the leaders of the times. This officer is ready and willing to undertake his task. The main question lies before the management, the directors and the owners. Shall this opportunity be accepted? It will be accepted, and this journal expected to be kept busy recording the steps in this revolution.

FACTS WANTED CONCERNING TREATED WATER.

Arguments which will enable mechanical officials of railroads to secure from their superiors appropriations for improving the feed water of locomotives are largely sought for. A correspondent in a recent communication said:

"I am greatly interested to read the article by Mr. Landon, chemist of the Erie Railroad, which you published in the August number of the AMERICAN ENGINEER. You cannot present a more important subject than that of 'bad water' for locomotive use. I wish you would secure more articles of this sort giving convincing figures in such a simple way as to make clear to everyone the necessity for dealing with the water problem in a business-like way. Such arguments will help us all in putting this question in the proper light before our general managers. Of course the expense of constructing treating plants looks large, but we should all engage in an additional effort to show that such investments will pay."

This journal will gladly print good arguments of this sort and facts with figures showing the beneficial results actually obtained from treated water will be specially valuable. Those who are using treated water should be able to state their experience and nothing would be more helpful in this educational process than reports of results actually accomplished.

Interesting figures for the performance of the De Glehn compound locomotives are noted in the communication by Mr. Edward L. Coster in this issue. With 1,900 h.p. as a basis, Mr. Coster shows that the locomotive illustrated in the June number of this journal, which is the same as the De Glehn compound on the Pennsylvania, developed one I. H. P. for each 1.38 sq. ft. of total heating surface; 0.73 I. H. P. per square foot of heating surface, and 23.7 I. H. P. per net ton of total weight of locomotive. This indicates that the boiler of this locomotive is exceedingly effective. It is not easy to draw a fair comparison with an American locomotive, but the best performance up to date with a certain exceedingly powerful American engine (not known to be the limit of capacity of that engine) shows a production of one I. H. P. for each 1.74 sq. ft. of total heating surface; 0.57 I. H. P. per square foot of heating surface, and 19.8 I. H. P. per net ton of locomotive. A comparison of these figures, while not conclusive, indicates the advantage in efficiency of the best possible use of the weight of locomotives. The De Glehn compounds are believed to be far in advance of American practice in this respect. It is worth while for American locomotive designers to make a most careful study of Mr. De Glehn's designs.

CORRESPONDENCE.

ADJUSTED TONNAGE RATINGS.

To the Editor:

In the July number, Mr. Vaughan suggests the general application of my formula for adjusted tonnage ratings by simply varying the coefficients in order to fit approximately with the results of various experiments, which can very easily be done. I notice, however, what is apparently a misprint. At the top of page 255 the allowance for grade is given as 2g, in the formula R=(3+2g) W+100C, g representing the per cent. of grade. This evidently should be 20g, as the resistance on a 1 per cent. grade is 20 pounds per ton.

Mr. Vaughan thinks the chart is unnecessary, but the object is to avoid all need for calculations, as some freight trainmen are not over handy with a pencil, and the chart obviates this difficulty.

G. R. HENDERSON.

SUGGESTIONS BY A SPECIAL APPRENTICE.

To the Editor:

It was with considerable interest that I read the paper, by Mr. R. D. Smith, on the Special Apprentice, in your July number. However, as a special apprentice I cannot agree with the suggested changes in the special apprentice course. True, the courses offered by many railroads show room for improvement, but I believe the division of the course into three more highly specialized courses would be a step in the wrong direction.

To consider this subject fairly it might be well to decide what is the ultimate aim of the special apprentice. After a man has spent four years and considerable money, and has safely weathered a technical course at one of the leading universities, and has then put in four more years at the low wages offered the special apprentice it seems to me that a "special" would not be worthy of the name if he did not cherish the ambition of ultimately attaining a higher position than that of a shop foreman. Now, to successfully hold such positions as chief draughtsman, engineer of tests, mechanical engineer, master mechanic, superintendent of motive power, etc., would it not be better to have a general knowledge of locomotive work, car building, and road work, and not to be a specialist in any one of these branches?

To divide the course up as Mr. Smith suggests would perhaps better fit a man to become a shop foreman, but even this might be questioned. In any one of the three suggested courses, you will find the same difficulty as is claimed to exist in the present course, namely: A man does not spend a sufficient time in any one shop to take charge of that shop. By similar reasoning to make a successful shop foreman a special should confine his course to four years in one shop. Such a process would, however, kill the special apprentice course as the technical graduates would all choose the manufacturing industries, where a competent man can readily obtain $60 to $75 a month at the start, which is as much, and in many cases more, than the special apprentice receives in the last six months of a four-year course.

To hold up a position as a shop foreman as the ultimate aim of the special would cause a man to think long and hard before entering railway service, when he can reasonably expect if he shows ability (which is necessary in either case) to be drawing $125 to $150 a month several years before he could become a shop foreman at $100 a month.

The ability to handle men would not be acquired any more readily in a more highly specialized course. A master mechanic may be better able to deal with machinists if he has worked up from a machinist. But, does it follow that he would also be better able to handle car builders and road men because he served his time as a machinist? Would not a course which includes contact with men in all three branches better fit a master mechanic to successfully handle his men?

True, the special apprentice courses as mapped out by many roads could be bettered. As a special I would suggest the following for a four-year course: Locomotive erecting shop, 9 months; roundhouse helper, 6 months; firing, 3 months; coach erecting shop, 6 months; freight car repair track, 3 months; office work with chief clerk, 3 months; laboratory and test work, 6 months; draughting room, 6 months. The last six months could very profitably be spent, as Mr. Smith suggests, along such lines as the master mechanic may intend to promote the special on the completion of his course. As an example, if it is intended to start him as a roundhouse foreman at some small division point, then the last six months should be devoted to general roundhouse work.

In the course that I have mapped out you will undoubtedly notice that I have entirely omitted the customary machine shop, foundry and pattern shop included in most courses. With a basis of the shop work taken in his technical course at the university, I believe that a wide awake special can easily acquire a good working knowledge of these branches while in the other courses, which are essentially all erecting.

In the coach shop and on the repair track a man can by keeping his eyes open get a good general knowledge of the car machine, wood machine, blacksmith and cabinet shops. Likewise, while in the locomotive erecting shop and roundhouse, a man can get the general run of the locomotive, blacksmith, machine, boiler and tank shops. Three months of pool firing together with the roundhouse work should be sufficient to give a man a fairly good idea of road work.

Mr. Smith comes very close to the mark when he says that the railroad company owe it both to themselves and the special to either drop him entirely when he has completed his course or to place him in some responsible position at a reasonable salary. It certainly is not right to keep a man hanging on at his rate of special apprentice pay to do all the emergency jobs that turn up. If the company need a man for such work, then let them pay at least a first-class mechanic's wage. If a man is not worth $90 or $100 a month to the company, after finishing his course, then by all means discharge him. If he is a competent man he can readily find employment outside of the railway service at $100 to $125 a month. The railway supply companies offer a very inviting field and do not hesitate to take a good special, even before he has finished his course.

A Special Apprentice.

SPECIAL APPRENTICESHIP.

To the Editor:

When the subject of special apprenticeship is sufficiently ventilated something may perhaps be done to render railroad work a suitable field for the college man. At present railroads are conducted in such a way as to completely discourage young men to fit themselves by education to fill positions of responsibility. The paper by Mr. R. D. Smith, printed in your July number, indicates that, at least, one official appreciates the fact that something is wrong.

My point of view is that of a man who spent five years in railroad service, after four years at college and had to leave the road in order to secure a salary on which a self-respecting young man could live, and yet at once went to a position with a manufacturing concern where he received proper compensation. I liked railroad work better than anything else, but could not afford to wait for ordinary recognition.

Very little is gained by talking about special apprenticeship, simply because the railroads are not ready for apprentices of any kind. The trouble is deep seated and the motive power departments are wrongly organized or not organized at all. My unsatisfactory experience was due to the fact that the master mechanic under whom I worked was so loaded down with details and had so little adequate assistance of any kind that he could not possibly attend to so small a matter as the cultivation of a knowledge of his subordinates. If such papers as yours would give less space to corners of machine shops and what is put in them, and more space to the fundamental principles of department organization there would be little need for saying anything about special apprenticeship. The trouble lies not with the college men, but with officials who do not know how to use them properly. Many an official holds his position to-day because he has college men about him to help him out of the holes he gets into, because of being merely a "practical" man, and yet they are unable to see that college men may be trusted with responsible positions where technical education is a necessary qualification. They do not have time to study and develop the possibilities of the college graduate.

The real trouble lies in the fact that the motive power departments are not run on a business basis and the officials are not clothed with sufficient authority to operate their departments in such a way as to develop men. And this is why mechanical practices of the most obsolete forms are prevalent in railroad shops. Little encouragement is offered for young men to develop themselves. I do not believe this to be the fault of the mechanical officials, but of the managements for treating the mechanical departments in a way which utterly discourages efforts to advance because patience is worn out by utter disregard of those efforts. The worst feature of the matter is that the officials with whom I have come in contact were themselves discouraged. The remedy lies in reorganizing the department and placing the head of it in a position of importance. He should report to no one short of the president. If this is done there will be an end to the whole special apprentice "problem."

A. B. C.

Editor's Note.—This young man now occupies an important position in charge of about 1,000 men. He has advanced rapidly because of his ability to manage men and it is a pity that he should be lost to railroad service where such ability is so greatly needed.

He presents a warm "roast" of the mechanical department and he seems to have a clear title to his plainly expressed opinions.

PERFORMANCE OF A DE GLEHN COMPOUND LOCOMOTIVE—PARIS-ORLEANS RAILWAY.

To the Editor:

In the course of the extremely interesting article upon the De Glehn compound Atlantic type express locomotives of the Paris-Orleans Railway, which appeared on page 203 of the American Engineer for June last, the following statements occur: "Word has just been received that one of the Paris-Orleans engines, which is exactly like the one illustrated, has just indicated 1,900 h.p. at 70 miles per hour, with 350 tons behind the tender, the drawbar pull at that speed being 7,350 lbs. It must be remembered that this engine weighs only 80 tons." Let us consider what these figures signify, and the conclusions which may be derived therefrom.

In the table of general dimensions accompanying the article above mentioned, the total heating surface of this locomotive is given as 2,616.8 sq. ft.; hence the foregoing performance is equivalent to the development of one indicated horse-power for each 1.38 sq. ft. of heating surface; or 0.73 indicated horse-power per sq. ft. of heating area.

It is also equal to the production of one indicated horse-power for each 84.2 lbs. total weight, or 23.75 indicated horse-power per net ton.

The drawbar stress (presumably at the rear coupler of the tender) being 7,350 lbs., and the velocity 70 miles an hour, the net drawbar horse-power is 1,372, or 72.2 per cent. of the indicated horse-power. Hence, assuming these results to have been attained on level track, the locomotive developed one effective drawbar horse-power for each 1.91 sq. ft. of heating surface, or 0.52 drawbar horse-power per square foot of heating area. This equals the production of one drawbar horse-power for each 116.6 lbs. total weight, or 17.15 drawbar horse-power per net ton. Consequently, we obtain the following relations between power, heating surface, and total weight:

Indicated horse-power = 0.73 (heating surface in sq. ft.).
Indicated horse-power = 23.75 (total weight in tons).
Drawbar horse-power = 0.52 (heating surface in sq. ft.).
Drawbar horse-power = 17.15 (total weight in tons).

Making due allowance for the superiority of the fuel used upon French railways as compared with that usually employed in this country, together with the probability that 1,900 indicated horse-power was sustained but for a comparatively short time, do any records exist showing equal efficiency for an 80-ton American locomotive?

Assuming level track, then, at 70 miles per hour, 1,900 — 1,372 = 528 h.p. were consumed in overcoming the machinery friction, and the rolling, axle, and atmospheric resistances of the locomotive and tender, weighing 146.25 tons in working order; or

$$\frac{528}{146.25} = 3.6 \text{ h.p. per net ton, equivalent to a total resistance of}$$

$$\frac{3.6 \times 375}{70} = 19.3 \text{ lbs. per ton.}$$

The significance of this small loss of energy between the cylinders and the tender coupler will be apparent when it is recalled that during the discussion of M. Edouard Sauvage's paper, "Compound Locomotives in France," at the April, 1904, meeting of the Institution of Mechanical Engineers, Mr. Sisterson, who had charge of the tests made upon the London & Southwestern Railway for the purpose of ascertaining the power necessary to drive light locomotives at various speeds, presented a table showing that in the case of Mr. Dugald Drummond's 4-4-0 type, single-expansion express locomotive No. 706, which has 18½-in. x 26-in. cylinders, driving-wheels 77⅝ ins. in diameter, and weighs with its tender about 100.8

American tons, 912 indicated horse-power were required to propel the engine and tender alone at a velocity of 70 miles an hour; or, approximately $\frac{912}{100.8} = 9.05$ h.p. per net ton, equal to a total resistance of $\frac{9.05 \times 375}{70} = 48.5$ lbs. per ton. Although, as Mr. Sisterson explained, the reliability of these trials was impaired by the unsuitable nature of the road upon which they were made, the locomotive having been started on a slight descending grade and run round a curve on to a level tangent, the results are nevertheless instructive as indicating in a general way the relative resistance at the same speed (70 miles per hour) of the Paris-Orleans and London & South-Western locomotives, which resistance appears to be about in the ratio of 3.6 to 9.05 h.p. per ton of locomotive and tender, respectively, or 19.3 to 48.5 lbs. per ton.

Now, in a certain experiment it was found that, other conditions remaining constant, the employment of an aluminum piston in a motor car engine resulted in an increase in speed of 300 r. p. m., as compared with the maximum possible when a heavier material was used. This fact, while demonstrating the great influence which the weight of the reciprocating parts of an engine exert upon its rotational speed, also apparently disproves the commonly accepted theory that according to the doctrine of the conservation of energy, the energy expended by the steam in accelerating the reciprocating masses during the first half of their travel is restored to the crankpin by the inertia of these parts during the latter half of the stroke.

These considerations suggest the hypothesis that the freedom of running of the De Glehn compound locomotive, and the high ratio of the drawbar to the indicated horse-power (72.2 per cent. in the above example), is largely due to the inherent characteristics of the design whereby, owing to the subdivision of the total work between four crankpins and the consequent reduction in weight of the individual reciprocating parts, together with the almost perfect balancing of the inertia forces developed by the latter, the loss of energy caused by reciprocation is considerably less than in an ordinary two-crank locomotive of equal power. From the experiment with the aluminum piston it appears certain that the acceleration of the reciprocating parts of an engine results in a great loss of energy, but, so far as I am aware, the precise cause of this loss is at present unknown.

Whether it be due to friction, to heat interchange between the steam and the cylinder walls, or to other influences, is for the moment quite immaterial; the important practical fact is that for maximum efficiency the individual reciprocating masses of high-speed engines should be as light and their inertia effects as completely neutralized as possible; both of which ends are attained in the four-cylinder balanced type of compound locomotive.

Edward L. Coster,
Assoc. Am. Soc. M. E.

25 Broad street, New York,
August 13, 1904.

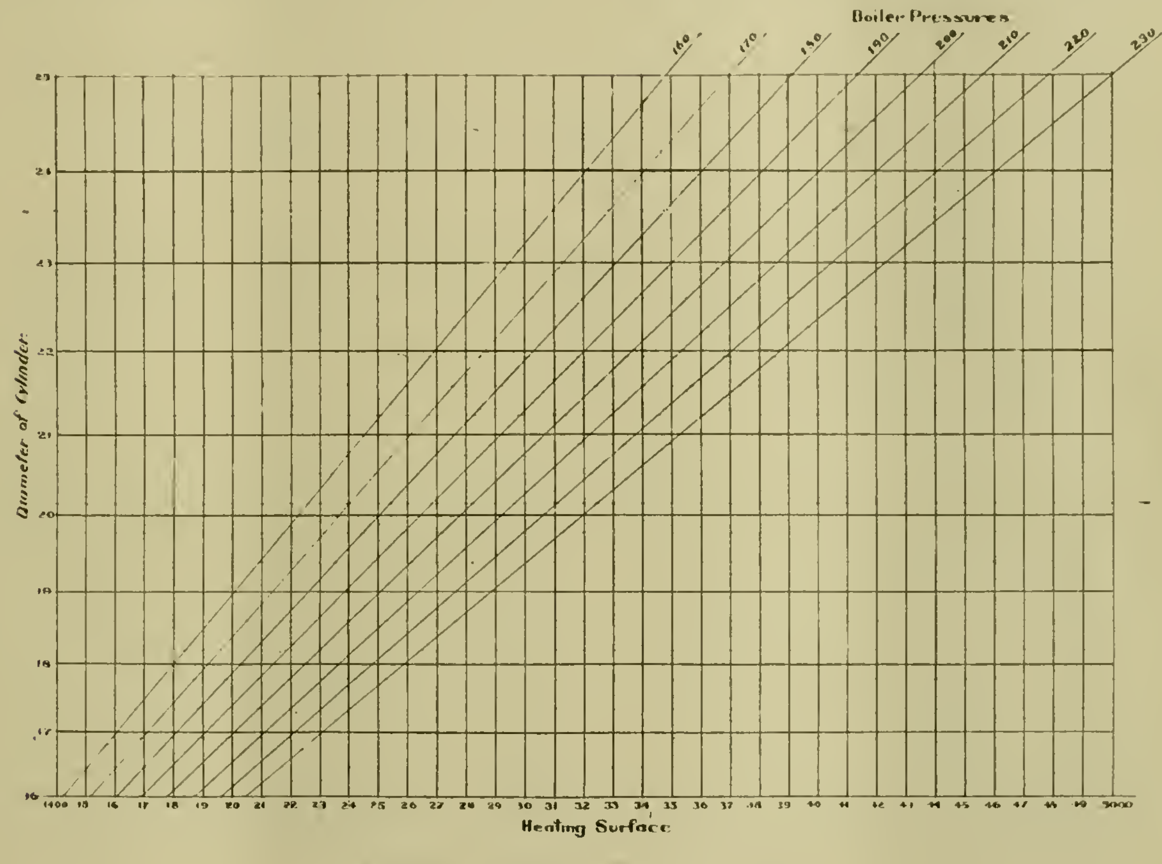
STEAMING CAPACITY OF LOCOMOTIVES.

To the Editor:

The article by Mr. Bentley on steaming capacity of locomotives, published in your issue of July, 1904, has been of much interest to me, especially so far as it pertains to simple engines. The equations given for horse power and maximum horse power and heating surface are useful as well as interesting. I should like, however, to make a few comments on one diagram as printed in connection with the article. In the diagram for heating surface for simple engines the correct figures can only be obtained for an engine having cylinders 25 ins. in diameter, and even if the intersections of the boiler pressure lines on the 16-in. cylinder line had been correctly made, it would still be possible only to obtain a correct heating surface for the 16-in. and 25-in. engines. To make the readings correct for other sizes of cylinders the ordinates of the diagram should vary directly as the square of the diameters, rather than as the diameters of the cylinders. I submit herewith a rough sketch of this diagram, which I think is more nearly correct.

Harry S. Burnham, Chief Draughtsman.

D., M. & N. Ry., Proctor, Minn.



STEAMING CAPACITY OF SIMPLE LOCOMOTIVE.

LOCOMOTIVE FLUE SETTING AND MAINTENANCE.

To the Editor:

In his professional conventions the master mechanic and the master boiler maker give the subject of locomotive flue setting a share of their thoughtful consideration, and much of value to the well being of the locomotive boiler has resulted. When the railroad officer returns to his own road he gives some attention in a general way—spasmodically, perhaps, in some instances—to the care of flues and boilers in service, but in the writer's opinion the subject is not receiving the attention and persistent following up which its direct relation to successful engine performance entitles it.

To be a money-making machine for a railroad company a locomotive must be able to take its rating over the road without failure. In bad water districts the pre-eminent cause of engine failures is leaky flues. So directly does the leaky flue affect the earning power of a railroad company that the writer feels warranted in presenting in some detail this seemingly well worn subject.

The three principal conditions upon which satisfactory service of flues is dependent are:

(a) Proper methods in setting flues; (b) effective safeguards against too sudden and unequal expansion in boiler and flues, and (c) keeping the boiler and flues as free as possible from incrustation and accumulation of loose scale and mud.

It is to the first of these that attention will be chiefly directed. There have been times, perhaps, in the experience of every one having to do with locomotive flues when they would leak in spite of anything that could be done. The methods suggested in this article are not advanced as new discoveries, or as cures for all flue troubles, but they represent practice which service has demonstrated will meet the conditions imposed by bad water in the limestone territory of the Middle West as well as any known methods. The recommended method of flue setting is here presented in tabular form:

TABULAR STATEMENT OF FLUE SETTING METHOD.

BACK END.

OPERATION.	TOOL USED.
Expand Copper Ferrules	Prosser Expander
Drive in Flues	Sledge and pin with collar
Mandrel (lightly)	Taper mandrel pin
Roll	Dudgeon roller by hand
Expand	Prosser expander
Bead and Caulk	Beading tool in air hammer

FRONT END.

OPERATION.	TOOL USED.
Shim with Sheet-iron Strips	
Roll	Dudgeon roller by air
Mandrel	Taper mandrel pin

Each step in the process will be commented upon and reference made to the accompanying illustrations.

Flue Sheet Holes. (Fig. 1.)—Care should be taken that holes in flue sheet be true, smooth and free from burrs and sharp edges. It is desirable that the flue hole have a fillet, especially on the water side, of about 1-32 in. radius. A sharp edge around the hole often cuts the ferrule in two, even cutting into the flue. The diameter of the flue hole should be the same as the outside diameter of the flue.

The Copper Ferrule (Fig. 2.)—For new work this should be not far different from No. 16 B. W. G. In old flue sheets when the flue holes are large it is advisable to use enough heavier ferrules to bring the internal diameter of ferrule when expanded into flue sheet to 1⅞ ins. for a 2-in. flue. The object of the copper ferrule is to provide a yielding medium against which to work the flue and make it tight. Its function is analogous to that of a gasket in a pipe union or the rubber ring in the top of a glass preserve jar. The ferrule should be set into the flue hole flush with the fire side and expanded into place with Prosser expander. (Fig. 3.) To perform its full usefulness, a ferrule should be not less than ¾ in. long; ¾ in. is sufficient, although some authorities prefer ⅞ in. The flue, or safe end, should be No. 10 or No. 11 B. W. G. When flues require frequent working the No. 10 gauge is preferable, having more substance to resist wear and tear. The 2-in. flue should be swaged down to 1⅞ ins. Great care should be taken to give the swage the right length and to have it terminate (Fig. 4) in as abrupt a shoulder as possible. The flue after it is swaged should be annealed and the scale removed from the portion entering the sheet. Grinding this scale off by machine is desirable, but in the absence of a grinder the removal of the scale with a file will answer. The flue when driven into the sheet (Fig. 5) should extend 3-16 in. through the sheet on the fire side.

Mandrelling out the flues in the back flue sheet is the next step (Fig. 6). This is done with a tapered steel pin for the double purpose of securing the flue into the sheet preparatory to rolling and for starting the flue tip flaring out, the first step in the turning of the bead.

Rolling.—The front end of the flues having been shimmed with strips of sheet iron, both the back and front ends are rolled with the Dudgeon roller. With proper appliances the front end may be safely and economically rolled by air. The rolling of the back ends is another matter; these should be rolled by hand, as there is too much at stake to risk the danger of damaging the flues by improper rolling. There is not the safety and uniformity of work in air rolling that obtains in hand rolling by a competent workman.

Expanding (Fig. 7.)—Particular stress should be placed upon this, the most important step in the flue setting process. It is a mistake to regard the bead as the part requiring the most attention. The portion of the flue next to the sheet on the water side is as important as the bead. Care should be taken that the flue shoulder when heavily expanded bears snugly and firmly against the flue sheet. This part of the work, if thoroughly done, will contribute much to making the flue permanently tighter. With proper shape of Prosser expander sections, the projecting portion of the embryo bead can be further turned.

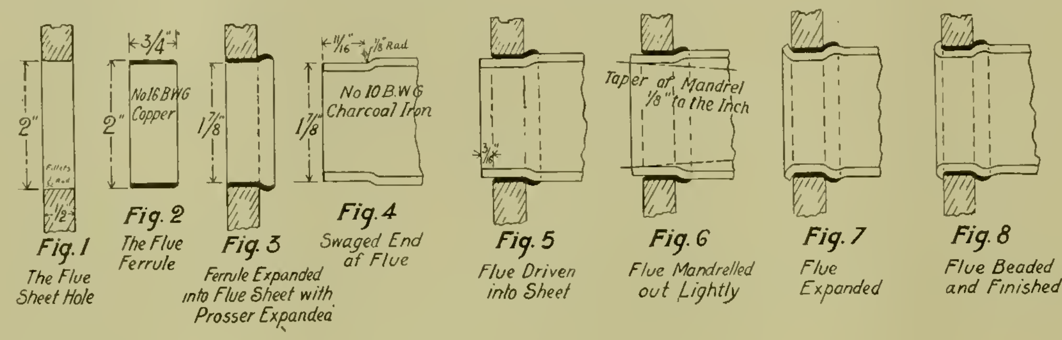


Fig. 1 The Flue Sheet Hole. Fig. 2 The Flue Ferrule. Fig. 3 Ferrule Expanded into Flue Sheet with Prosser Expander. Fig. 4 Swaged End of Flue. Fig. 5 Flue Driven into Sheet. Fig. 6 Flue Mandrelled out Lightly. Fig. 7 Flue Expanded. Fig. 8 Flue Beaded and Finished.

Beading (Fig. 8.)—This may now be done with a beading tool in an air hammer, which, with mandrelling the front end, finishes the flue setting.

On the care and maintenance of flues in service much could profitably be said, but it is impracticable to add more than the following hints in conclusion:

Prevent the extravagant use of the blower, especially when cleaning fires or when grates are partly uncovered. Insist upon the gradual cooling down of a boiler before washing out or changing water. Maintain as near 100 lbs. washout water pressure as possible. Depend chiefly on the caulking tool and Prosser expander to keep flues tight. The mandrel pin may be used with discretion, but the use of the Dudgeon roller in the roundhouse should be practically unknown.

L. L. Smith.

STAYBOLTS.

To the Editor:

The recent increase in the number of articles in current magazines on the subject of staybolts has attracted my attention with unusual interest. Doubtless this much discussed subject, "The cancer of the locomotive," will be fresh in our minds till some genius designs a watertube boiler applicable to the modern locomotive.

The suggestions in the American Engineer for August, 1904, page 311, relative to decreasing the diameter and increasing the length of the staybolts seems to me to be a step in the right direction. The factors to be taken into consideration are three in number, viz.: (1) Direct tensile strength; (2) tensile streugth at temperatures corresponding to boiler pressure, and (3) stress caused by bending.

For tensile stress only, the area to be supported is easily proportioned to the size and strength of the bolt. The tensile strength and percentage of elongation, or, in other words, elasticity, increase with the temperature, as is shown by the diagrams in the American Engineer for July, 1904, page 253; so there is no fear from this source with pressures up to 400 lbs. I do not think the "blue heat" temperature spoken of in this article is "fatal" with modern staybolt iron.

The relation to bolt proportions of stresses caused by bending is shown by the ordinary formula for a cantilever and the change in stress caused by varying the diameter, or length, with a constant deflection, is shown as follows:

Suppose the bolt to be fixed in the outer sheet and the inner end free—

Let d = deflection of the firebox end.
D = dia. at root of thread.
l = length of bolt between sheets.
p = fibre stress due to bending.
E = modulus of elasticity.
e = distance of outer fibre from neutral axis.
P = deflecting force at firebox end.
I = moment of inertia of section at point of max. moment.

Then,

$$d = \frac{Pl^3}{3EI} \ (1), \ Pl = \frac{pI}{e} \ (2), \ d = \frac{pl^2}{3Ee} \ (3).$$

If we wish to find the effect on p of varying l only, reduce formula (3) to the form $(3deE) \frac{1}{p} = l^2$ (4) where d, e, and E are constant.

This shows that the fibre stress in the bolt next to the outer sheet decreases with the square of the increase in length. Therefore the longer the bolt the less will be the stress due to bending; the deflection of the inner end being the same for all lengths.

To find the effect of varying the diameter with a constant length, reduce formula (3) to the form: $\frac{3dE}{2l^2} D = p$, (D = 2e), (5).

Here d, E and l are constant and p varies directly with the diameter, or, in other words, the larger the bolt the greater the stress. Therefore make the bolt as small as possible, consistent with tensile strength.

If with formula No. 3 we use a deflection of .015 in., l = 4 ins., for a nominal 1-in. bolt with 12 threads, we find the stress is carried well beyond the elastic limit of any good iron, and this seems to be a very close limit for deflection.

If the owner of the machine described in the article on page 253 of the July number will make some experiments, using the above formula for plotting curves, with "number of vibrations" in place of p, I think he will find that the longer the bolts of one diameter the greater the number of vibrations, and also the smaller the diameter of the bolt, greater than the minimum limit for tensile strength, the greater will be the number of vibrations.

L. H. Schenck.

CUTTING TEST ON METAL PLANER.

By J. C. Steen.

The cutting test here described was made during the regular progress of the work through the shop. The material was cast iron and the casting weighed 3,000 lbs.

The dimensions of the cuts were so regulated as to bring depth and thickness into measurable quantities, and a number of cuts were made to determine the effect of the form of cut upon the power required. This feature of the test was not altogether satisfactory, as the power required to run the planer light varied somewhat, and a small error is easily made when taking ammeter readings, particularly with a fluctuating current due to a varying load. Whatever the causes were, the results are somewhat at variance with what might have been expected.

The planer on which the test was made is a 48-in. x 16-ft. machine, which was driven during the test by a Northern Electric Company motor, belted to an auxiliary shaft, which in turn was belted to the planer countershaft.

The table is so arranged that the power required may be seen in relation to either cubic inches of metal removed per minute, or pounds of metal removed per hour. The value of C given in the table relates to the constant C in the formula W × C = H. P., where W is the weight of metal removed per hour. C is a constant varying under different conditions.

thickness of cut is meant the amount of feed. This explanation is made because different expressions are frequently used to denote the same thing.

Cuts 1 and 2 show that a relatively less amount of power was taken for 2 than for 1, and the same is true of 5 and 6, referring, of course, to net power. Cuts 8 and 9 might have been expected to show the least amount of power for a given section, but both are slightly higher than 6, which shows the least of all. A small variation might be allowed for by reason of the variation in the driving power, but probably the condition and shape of the cutting tools, as well as variation in the quality of the metal may account for the results being at variance with what might have been expected.

It will be seen that the average of net power constants for 1 and 2, and 3 and 4 are the same, and that those for 5, 6 and 7, and 8, 9 and 10, are quite close; also that the average constants for the gross power from 3 to 10, inclusive, are about the same.

In this test the results for 11 and 12 indicate that the thin cuts took relatively more power than the heavier ones. These

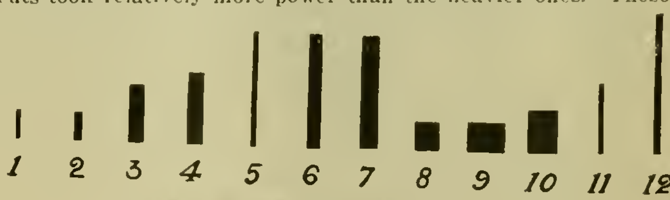


DIAGRAM SHOWING RELATIVE SIZES OF CUTS.

Cut No.	1	2	3	4	5	6	7	8	9	10	11	12
Depth of cut	¼	¼	½	⅝	1	1	1	¼	¼	⅝	⅝	1¼
Thickness of cut	1-32	1-16	⅛	⅛	1-32	3-32	5-32	3-16	5-16	¼	1-32	3-64
Area of cut sq. ins.	.0078	.0156	.0625	.078	.0312	.094	.1562	.047	.078	.094	.0195	.058
Cu. ins. per min.	1.41	2.82	11.25	14.	5.62	16.86	28.1	8.46	14.	16.86	3.51	10.45
Wt. removed per hr.-lbs.	22	44	175	219	88	263	438	132	219	263	55	163
H.p. req'd—gross	5.1	5.4	8.8	9.6	6.6	8.1	11.4	7.3	7.9	9.6	.6	9.6
H.p. req'd—net	.6	.9	4.3	5.1	2.1	3.6	6.9	2.8	3.4	5.1	1.5	5.1
H.p. per cu. in.—gross	3.62	1.91	.78	.68	1.18	.48	.41	.86	.561	.57	1.71	.92
H.p. per cu. in.—net	.42	.32	.38	.36	.37	.214	.24	.33	.24	.302	.43	.49
Value of C—gross h.p.	.23	.122	.05	.042	.076	.0308	.026	.055	.036	.036	.109	.059
Value of C—net h.p.	.027	.020	.024	.023	.024	.0137	.0157	.021	.015	.0194	.027	.031
Av. value C—gr. h.p.	.176 (1–2)		.046 (3–4)		.0442 (5–7)			.042 (8–10)			.084 (11–12)	
Av. value C—net h.p.	.0235		.0235		.0178			.0184			.029	

The average power required for running the motor, shafts and machine pulleys was 3 h.p. with the platen at rest, and 4.5 h.p. with the platen moving in direction of the cut.

Other tests have shown that when cutting cast iron the quality of the metal and shape of the tool have considerable to do with the power required. Some tests have shown that with a given depth of cut the power required increased almost directly in proportion to the thickness, and in other cases the power required increased at a slightly greater rate than the thickness. Again, it has been found that in some cases the minimum amount of power required to remove a given amount of metal was when the depth and thickness of the cut were equal. By depth of cut is meant the height from the planed surface to the rough face of the casting, and by

results should not be taken as conclusive, but are of interest and value as approximations. It may be explained further that the amounts expressed as cubic inches per minute and pounds per hour are not actual, as the time lost by return of platen was not taken into account, but they represent the rate at which metal would have been removed had the cutting been continuous. To obtain a correct record of actual power cost in relation to metal removed, it would be necessary to weigh all chips, and to use a recording ammeter for the amount of energy used throughout the whole cycle of platen movements. Such figures are not so frequently needed as those which deal with the amount of power required to remove a certain assumed amount of metal and to otherwise operate the machine.

HEAVY PASSENGER LOCOMOTIVE.

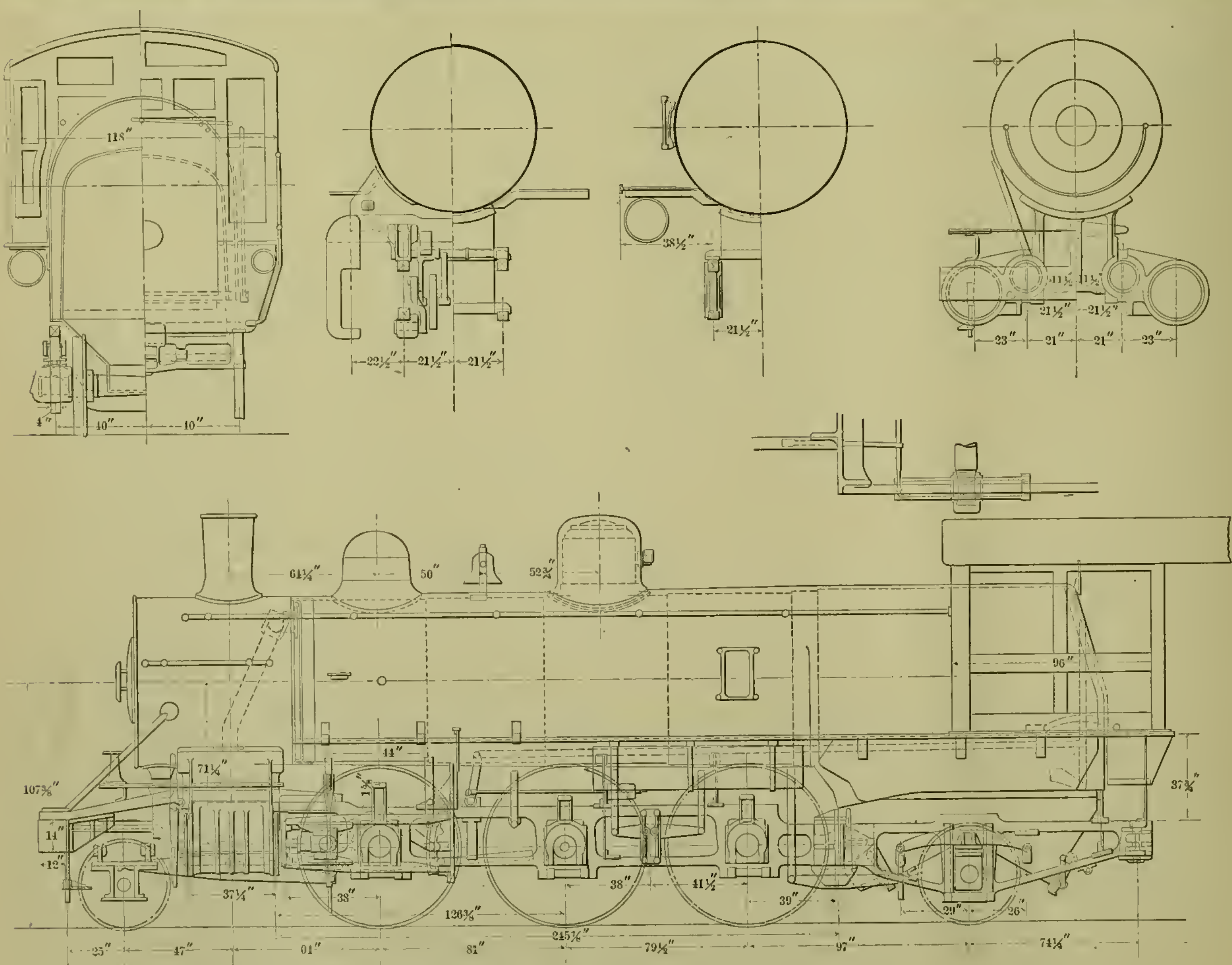
2—6—2 TYPE.

CHICAGO, BURLINGTON & QUINCY RAILWAY.

A new design of Prairie type passenger locomotive has been built for this road by the Baldwin Locomotive Works, and 40 are being put into service. They are single-expansion engines with piston valves and 22-in. by 28-in. cylinders, the tractive effort with 69-in. wheels being 35,000 lbs. These engines have 151,070 lbs. on driving wheels, which is the heaviest weight on 6-coupled wheels in our record. The boiler is straight and has 301 2¼-in. tubes, 19 ft. long, the total heating surface being 3,575 sq. ft. and the grate area 55 sq. ft. This road has had a long and very satisfactory experience with 2-wheel leading trucks, and this construction has not been confined to freight service, but has been followed in the heaviest passenger locomotives with entire success, and on a road which is by no means straight. This is one of the largest and heaviest locomotives of this type in our record, and there seems to be no question of the advantages of the type over the Pacific type with a 4-wheel leading truck. The trailing truck has outside journals and the arrangement for spreading the rear sections of the frames under the firebox, used on several recent Chicago, Burlington & Quincy designs, has been followed in this case. A summary of the leading dimensions of the engine is given in the accompanying table:

CHICAGO, BURLINGTON & QUINCY RAILWAY 2—6—2 TYPE LOCOMOTIVE.

Gauge	4 ft. 8½ ins.
Cylinder	22 ins. x 28 ins.
Valve	Piston
Boiler—Type	Straight
Diameter	70 ins.
Thickness of sheets	¾ ins.



PASSENGER LOCOMOTIVE 2—6—2 (PRAIRIE TYPE).—CHICAGO, BURLINGTON & QUINCY RAILROAD.

F. H. CLARK, *Superintendent of Motive Power.* BALDWIN LOCOMOTIVE WORKS, *Builders*

Working pressure	210 lbs.
Fuel	soft coal
Staying	radial
Firebox—Material	steel
Length	108⅛ ins.
Width	72¼ ins.
Depth	front 72½ ins., back 61⅝ ins.
Thickness of sheets, sides ⅜ in., back ⅜ in., crown ⅜ in., tube ½ in.	
Water space	front 4½ ins., sides 4 ins., back 4 ins.
Tubes—Material	iron
Wire gauge	No. 11
Number 301	diameter 2¼ ins., length 19 ft. 0 ins.
Heating surface—Firebox	190 sq. ft.
Tubes	3,354 sq. ft.
Firebrick tubes	51 sq. ft.
Total	3,575 sq. ft.
Grate area	55 sq. ft.
Driving wheels—Diameter outside	69 ins.

Diameter of center	62 ins.
Journals	main [illegible]½ in. x 12 ins
Engine truck wheels (front)	diameter 37¼ ins.
Journals	6 in. x 10 ins.
Trailing wheels—diameter	42½ ins.
Journals	8 in. x 12 ins.
Wheel base—Driving	13 ft. 4½ in.
Rigid	21 ft 5½ ins.
Total engine	30 ft 8½ ins.
Total engine and tender	55 ft. 8½ ins.
Weight—On driving wheels	151,070 lbs.
On truck, front	23,260 lbs.
On trailing wheels	31,220 lbs.
Total engine	208,070 lbs.
Total engine and tender	360,000 lbs.
Tank—Capacity	8,000
Tender—Wheels, No. 8	diameter 33 ins
Journals	5½ ins. x 10 ins.

POWERFUL TURRET LATHE FOR RAILWAY SHOPS.

A 5-in. by 42-in. automatic chuck turret lathe, the most powerful ever built, has just been shipped by Bardons & Oliver, of Cleveland, Ohio, to the new Montreal shops of the Canadian Pacific Railway.

Fig. 1 shows a general view of this machine, which represents a gradual development of their regular line of turret lathes for bar stock, and is especially designed to meet the exacting requirements of the modern shop with its high speed tool steels. Up to this time it has been customary on turret machines taking as large as 5-in. round bars to use a special type of lathe chuck for gripping the stock. The makers of this machine have adhered to a modified form of the standard automatic chuck, believing from their experience that no other method of holding a bar has ever been devised that will equal in gripping power the so-called spring chuck or collet, providing it is properly designed and constructed. In no other form is the stock gripped equally around the entire circumference and the cutting tools brought so near the spindle bearing.

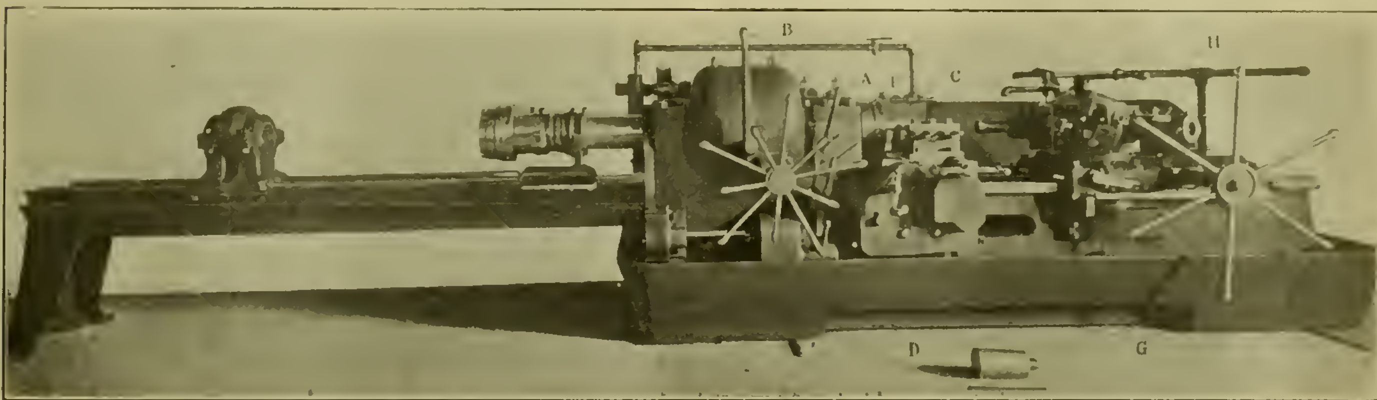


FIG. 1—AUTOMATIC CHUCK TURRET LATHE.—BARDONS & OLIVER.

Another departure from the ordinary practice is in the method of supporting the outer end of the bar. There are two usual methods of doing this, one to place a chuck at the rear end of the spindle, necessitating opening and closing same after each piece is made, and the other to allow the bar to revolve freely in a forked bearing or bushing on the upper end of a light support some distance from the rear end of the head. In this machine a heavy guide is bolted rigidly to the rear end of the head, and extending far enough to reach the end of a 20-ft. bar when in place in the machine. Sliding on this guide is a carrier, revolving in which is a bushing or chuck, with 4 screws spaced evenly around its circumference. By means of this the outer end of the bar can be made to revolve concentrically with the front end and almost perfectly round work can be obtained when using forming tools.

The head, as seen in Fig. 2, is double friction geared, giving 4 spindle speeds without stopping the machine, and if all 3 pulleys of the triple friction countershaft, which is regularly furnished with the machine, are used for "go ahead speeds," 12 spindle speeds can be obtained without stopping the machine. The greatest ratio of gearing is about 20 to 1, while the smallest is about 3 to 1. The cone spindle is driven by a 7-in. belt from a triple friction countershaft, with pulleys 24 ins. in diameter. The machine can be arranged for motor drive if desired.

The cone spindle can be driven direct or through the back gears, the sliding wedge which engages the friction through the fingers being operated by the lever A on the front side of the head. The cone spindle is connected with the main spindle through an intermediate shaft carrying a sleeve gear and pinion meshing into the two large gears on the main spindle. These last two gears are loose on the spindle, and either can be clutched to it as desired by means of the lever B working through a similar friction mechanism to that used on the cone spindle. Babbitt is used for the main spindle and the cone spindle bearings, and the main spindle bearings are oiled through sight feed lubricators located on top of the caps. The front bearing is 8 ins. in diameter by 13 ins. long. The cone spindle has a hole in the centre running almost the entire length, connecting at one end through a stuffing box with a fixed lubricator. Smaller radial holes lead from this central hole to all bearings of the spindle and friction parts, ensuring thorough lubrication, by centrifugal force, from this one source of supply. As this is a fast running shaft, the necessity of some such arrangement as this can be readily understood. The intermediate gear shaft is lubricated in a similar manner, and all gears and rotating parts are fully enclosed.

The stock is held at the front end of the spindle (Fig. 3) by means of a master collet. The false jaws can easily be changed without removing the collet or collet ring from the spindle as the jaw screws extend through large holes in the spindle to a point nearly flush with the outside. A sliding ring covers these holes when the machine is in use. The false jaws are usually serrated to increase their gripping power, and the collet is closed upon the stock by means of the large turnstile on the front of the head which operates the sliding wedge and fingers on the rear end of the spindle. Variation in the size of the bar is provided for by making this wedge with three steps. The collet is adjusted by the nut at the extreme rear end of the spindle, so that the fingers rest on the middle step of the wedge when gripping stock of the correct diameter. If the stock comes a little small the fingers are run up to the large step of the wedge; if a little large they stop at the small step, so that the bar is always securely held.

The feed dog or carrier (Fig. 4), as has already been explained, was designed to serve another purpose besides

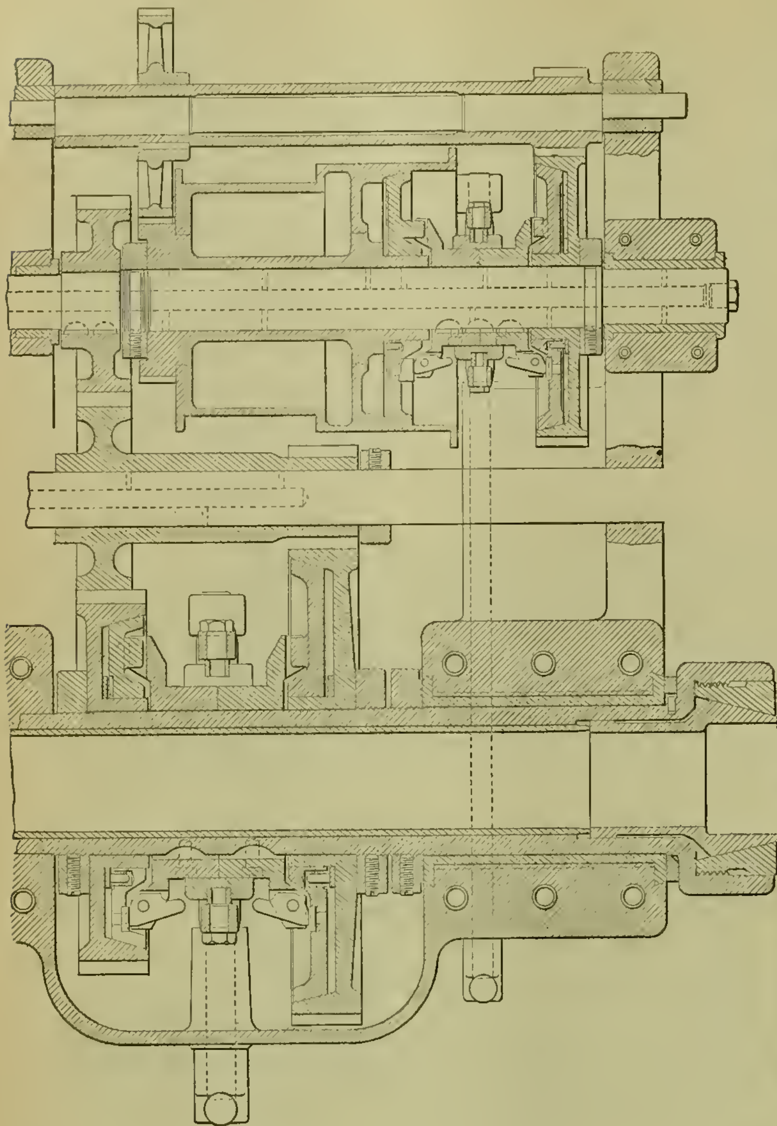


FIG. 2.—SECTION THROUGH HEADSTOCK.

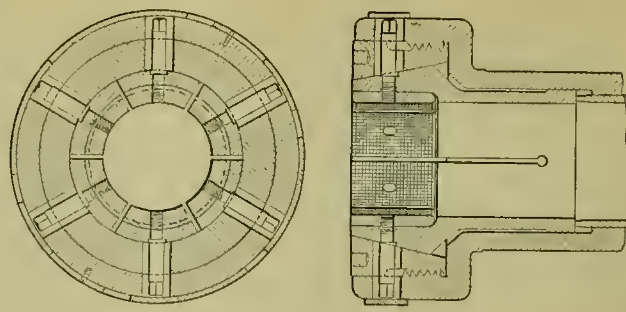


FIG. 3.—MASTER COLLET.

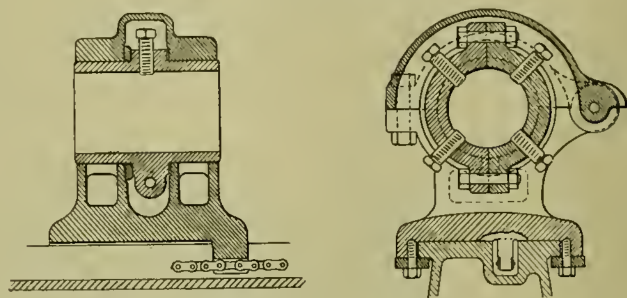


FIG. 4.—FEED DOG OR CARRIER.

FIG. 5.—COMBINED FORMING AND CUTTING-OFF TOOL SLIDES.

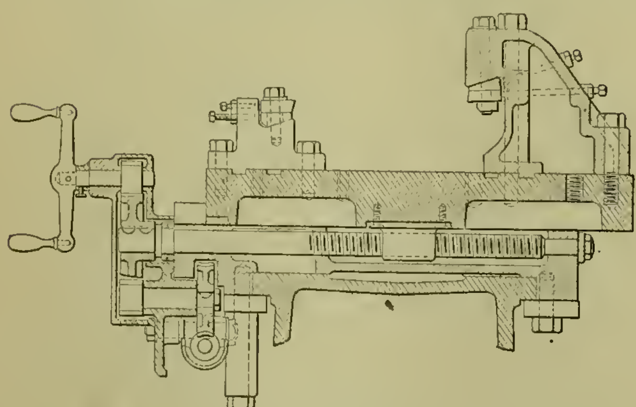


FIG. 6.—FORMING TOOL SLIDE.

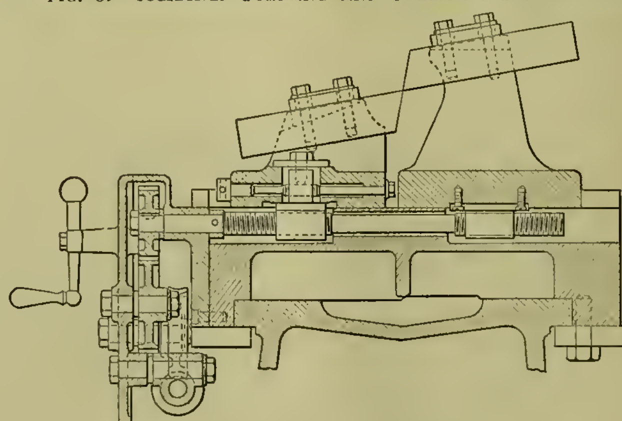


FIG. 7.—CUTTING-OFF TOOL SLIDES.

the mere feeding of the stock. It is in reality a 4-jaw independent chuck by means of which the stock is not only supported at the outer end, but can be made to run concentrically with the spindle at that point, thereby insuring that the finished piece will be round. The feed dog is moved along its bed by means of the smaller turnstile on the front of the head. The shaft of this turnstile passes through the center of the shaft of the turnstile which operates the mechanism for opening and closing the collet. It has been customary to make one turnstile serve both of these purposes, but with this construction, ample power can be had for operating the chuck, while for feeding the stock forward, which requires comparatively little power, a quick motion of indefinite length is obtained. Connection between the smaller turnstile and the feed dog is by means of an endless sprocket chain.

The combined forming tool slide and cutting off tool slides (Fig. 5) is one of the most striking features of the machine, and has been designed for the special purpose of producing as much of the work as possible with wide forming tools fed crosswise against the work rather than with end cuts by the turret tools. Experience obtained in the manufacture of bicycle hubs, projectiles and other irregular-shaped pieces of circular cross section has demonstrated the superiority of this method wherever practicable. The forming slide (shown in section in Fig. 6) is made long and heavy and carries two massive tool blocks, one at the rear for the roughing tool and one at the front for the finishing tool. Tools to form up to 12 or 14 ins. in length can be held in these holders, which are removable so that special attachments can be fitted for other classes of work when desired. The forming tools are adjusted vertically by means of taper wedges which are moved by screws. They are clamped solidly to the holders by bolts passing directly through them and screws are provided for the lateral adjustment of the tools which can be quickly and accurately set with a little practice. The forming slide can be fed by hand or power in either direction. The power feed has four changes by means of the lever C and the reverse is obtained by the lever D. The feed has an automatic release in either direction. In practice the roughing tool is usually fed by power and the finishing tool by hand. A graduated dial on the handle enables work to be formed accurately as to size.

The cutting-off tools are two in number, mounted on separate slides, shown in section in Fig. 7, which have an entirely independent cross feed from the forming tool slide, although they are carried on the same saddle casting, this saddle having a longitudinal adjustment of 3½ ins. The cutting-off tool slides are fed in simultaneously by a right and left hand screw either by hand or by power, the power feed being taken from the same shaft as the power feed to the forming slide, but having separate throw-out. The front cutting-off tool slide has an adjustment so that the tools can be set to cut equally and the cutting-off blades are made of high-speed steel and are of special cross section. Four changes of feed can be obtained by means of the lever C.

The turret and turret slide, while amply large, are not so heavy that they cannot be readily operated by hand. As the most severe duty falls on the forming slide, care has been taken in designing the turret and slide not to make them clumsy and difficult to handle. It travels directly on the bed on flat bearings of ample width and wipers on the front end of the slide keep these bearings clean. A taper gib runs the entire length of one side and provides means for taking up side wear.

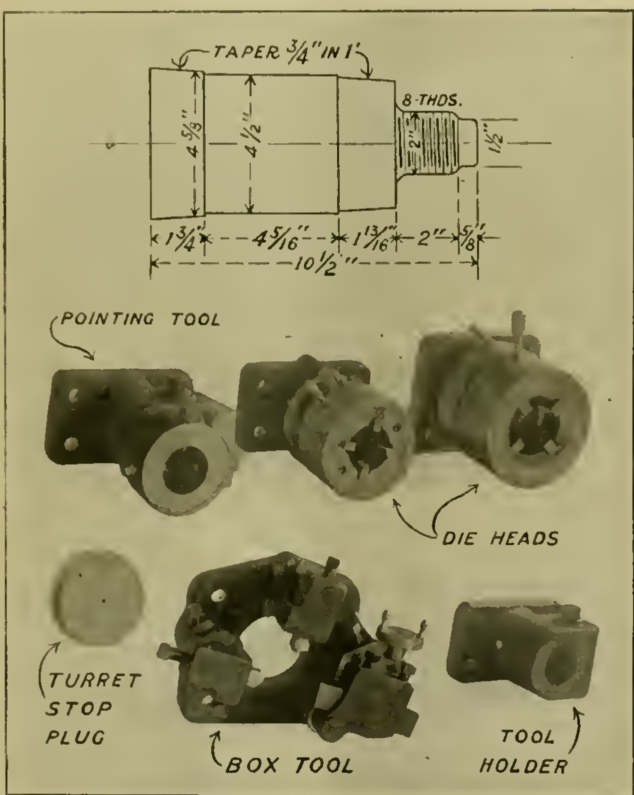


Fig. 8.—Wrist Pin and Tools Used to Machine Threaded End.

The turret is hexagon in form, is 18 ins. in diameter across the flats and an independent stop is provided for each of its faces, these stops having a range of 36 ins., while the total feed to the turret slide is 42 ins. Each face has 8, ⅞-in. tapped holes for the purpose of attaching the various tools. There is a 4½-in. hole in each face and also through the center stud, thus enabling work up to 4¼ ins. in diameter and 42 ins. long to be turned. This diameter can be increased if desired. Power feed to the turret slide is provided, and four changes to this feed can be instantly obtained by means of the lever F shown in Fig. 1. The power feed can be tripped at any point by each of the independent stops, which also serve as dead stops for the hand feed. It can be thrown in or out by hand by means of the lever G. The lock bolt is withdrawn by hand by the lever H and the turret is revolved by hand. Means are provided for locking the lock bolt after it is withdrawn if desired, so that the turret can be revolved

Fig. 9.—Forming Tools Used on Wrist Pin.

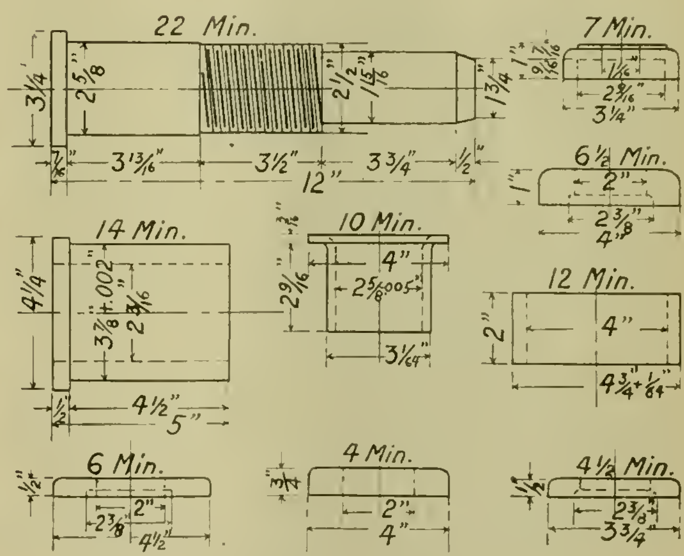


Fig. 10.—Samples of Work Done, with Time Required.

in either direction past one or more holes. The lock bolt is tapered on the upper end and fits into hardened and ground steel bushings in the bottom of the turret and slides in hardened and ground bushings in the turret slide.

The turret has a large projection on the bottom fitting into a corresponding opening in the top of the slide which serves to take the major part of the thrust, but in addition to this a taper bushing is inserted in the center of the turret taking its bearing on the steel turret stud which extends from the under side of the turret slide to the top of the turret. This bushing is adjustable endwise to take up all wear. The turret stud extends through the large washer on the top of the turret, and is threaded on the outer end to receive the binder handle by means of which the turret and slide can be clamped solidly together.

The base of the machine is cast in the form of a pan which has a large reservoir at the back so that there is room for an abundant supply of lubricant without keeping the pan itself filled. A perforated plate over the reservoir keeps the chips from entering, and the lubricant that runs down the front side of the machine is conducted back to it quickly through an opening under the center of the bed. There is also an opening in the top of the bed between the turret slide and the forming slide which allows chips and lubricant to fall directly into the back of the pan. A large sheet steel guard extends almost the entire length of the pan at the rear, giving a large chip capacity, and a smaller guard is provided for the front.

The lubricant is forced to the turret, forming and cutting off tools by means of a rotary pump, fastened to the back gear arm. The pump is driven by a belt from a special countershaft, and has a $1\frac{1}{4}$-in. inlet pipe, the end of which is covered by a strainer for further protection from chips. Two 1-in. outlet pipes are provided, one for the turret tools and one for the cut-off and forming tools, through which a continuous stream of lubricant is pumped while the machine is running. The supply of lubricant is directed and controlled by means of levers conveniently located and connected with 3-way valves. An automatic relief valve furnishes an outlet when the discharge is checked or stopped, and the pump can be stopped entirely if so desired by means of the lever located above the front cap which operates a clutch on the pump shaft.

At each end of the pan lugs are provided by means of which the machine can be readily handled with jacks.

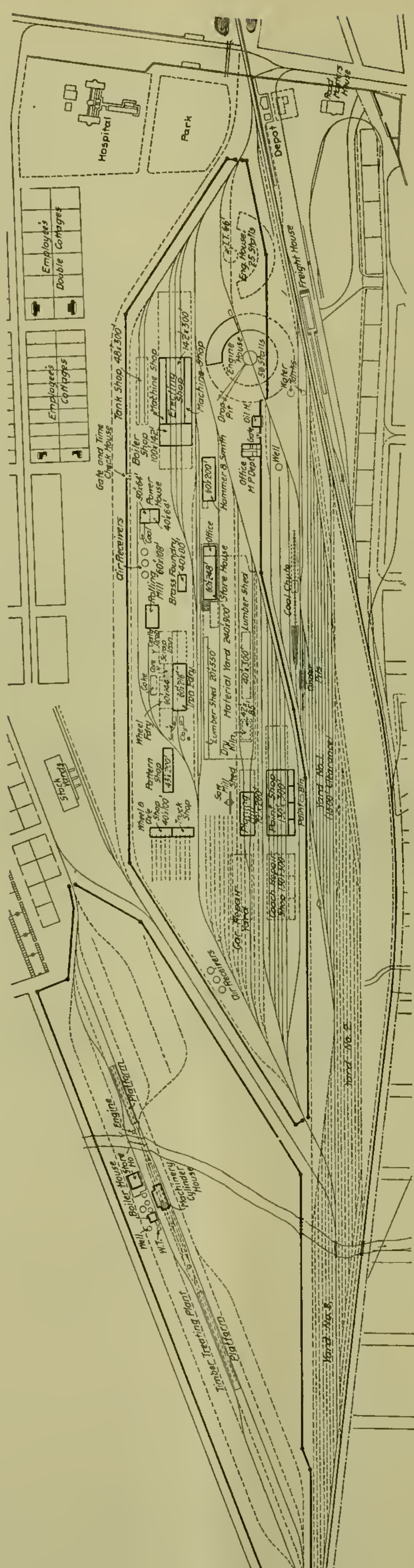
In Fig. 8 is shown a crosshead wrist pin made on this machine from $4\frac{7}{8}$-in. bar stock in 18 minutes. The first operation after chucking was to turn down the small end of the pin from $4\frac{7}{8}$ ins. to 2-in. diameter, and this was done in one cut in 7 minutes by means of the box tool shown in Fig. 8. The cutter is made of high-speed steel and is provided with a releasing mechanism so that the work will not be scored when the tool is being moved back. The back rests, of which there are two, are adjustable in and out so that the work can be backed up at the proper place. The cotter pin end of the wrist pin was turned by means of the pointing tool shown in Fig. 8. This tool is held in the tool holder shown, which is clamped to the face of the turret. By means of these holders tools with shank can be used in the machine. The 2-in. thread is cut by means of a self-opening die head (Fig. 8), which is provided with a roughing and finishing attachment. Only one die head is usually sent with the machine, although two are shown in Fig. 8, one of these being arranged with a sliding holder for use when cutting fine threads. The rest of the wrist pin was machined by the forming tools shown in Fig. 9. These tools are made of high-speed steel, and while the piece was being formed the cutting-off tools were started, thereby saving time. The pieces thus turned out are guaranteed to be within one thousandth of an inch of being round.

Several samples of work done on this machine, with the time it took to finish them, are shown in Fig. 10. This machine is also built to take 6-in. stock, the only change being in the spindle, head parts, automatic chuck and wire feed parts.

AGUAS CALIENTES SHOPS.

MEXICAN CENTRAL RAILROAD.

These shops have been referred to in this journal (see May, 1904, page 181). Because of the climatic conditions the buildings are unique and interesting, they have already been briefly described. The general plan of the plant is illustrated in the accompanying engravings, which indicates completed buildings in solid lines and possible extension in dotted lines. The shop buildings are arranged in a long and somewhat narrow plot enclosed by a 10-ft. adobe wall for protection against thieves. The size of each building is indicated on the drawing. All the shops are arranged on the longitudinal track basis and the plant is characterized by the absence of transfer tables. Buildings for locomotive repairs are grouped at the south end of the enclosure with the roundhouses and oil house nearby. At the other end the car repair department is provided for, with the facilities for storage along the center



GROUND PLAN, AGUAS CALIENTES SHOPS.—MEXICAN CENTRAL RAILWAY.

of the plan. In such a mild climate, most of the heavy supply material is stored out of doors and the storehouse is reserved for small articles and for material requiring special protection from thieves. The power house is at the center of power distribution and the cables are carried on pole lines to the various shops. Two dug wells supply water for the shops and the timber treating plant. A 100,000-gal. steel tank furnishes storage for the shops. A 350,000-gal. reservoir provides a supply to last through the annual dry season.

Of the smaller buildings the hammer and smith shop, 63 by 201 ft., is located near the north end of the erecting macnine and boiler shops. Near it are the rolling mill, iron foundry and planing mill. The end walls and side columns of these buildings are of concrete, the roof trusses are of yellow pine and the roofs and side walls of galvanized iron. These buildings are open to a height of 6 ft. 9 in. from the ground. Old rails are used for framing, to which the galvanized iron is fastened. At the south end of the hammer and smith shop the switch and frog work of the entire road is done. The tool equipment and the motors of this shop are presented in tabular form.

The brass foundry is 40 by 80 ft. and is equipped with 6 Morgan furnaces for melting in crucibles. A Tabor pneumatic molding machine is used for making journal bearings. All the journal bearings for the freight equipment of the entire road are filled here.

The iron foundry is 60 by 216 ft., with a leanto addition for charging platforms, core rooms and storage. The core house is 42 by 54 ft., with two ovens, one 18 by 24 ft. and the other 5 by 24 ft. for small work. Two cupolas, a 10-ton Colliau for general use and a 5-ton McKenzie for emergencies are capable of producing an average output of 10 tons daily. Three Tabor molding machines are used for molding brake shoes and other small work. This department requires a total of 50 h.p.

The rolling mill, used for re-rolling scrap, is a building 60 by 108 ft. and is equipped with a 9-in., three high train driven by a vertical engine. Steam is supplied by two locomotive boilers over heating furnaces. The scrap is made into billets under a 2,500-lb. steam hammer and then rolled into bar iron, round and flat.

An adobe building with brick pilasters, 43 by 200 ft., provides for the pattern shop. A 60-ft. room at the south end is the pattern shop proper, the rest of the building being used for pattern storage. A 10-h.p. motor drives a pattern-makers' lathe, a core box machine, a band saw, surfacer rip saw and grindstone. The glue pots are heated by an electric heater.

Truck, wheel and axle work for freight and passenger cars is done in a building 40 by 200 ft., half of which is devoted to trucks. Light car forgings and bolts are also made in this shop.

The planing mill is 70 by 200 ft. with two longitudinal tracks through it. These connect with the yard at the north end and reach the dry kiln and lumber yard at the south end. This building has a floor of vitrified brick laid on edge in sand. This mill turns out all material for car repairs and also provides for manufacturing such material as handles for picks, hammers, axes, etc., used on the road. Near the mill is a sawmill with a 44-in. circular saw with a log carriage, driven by a 30-h.p. motor belted direct to the saw arbor.

These notes are taken from a complete description prepared by Mr. C. T. Bayless, mechanical engineer of the road.

Large Contracts for Locomotive Repairs.—The Erie Railroad has awarded to the American Locomotive Company a contract for the repairs of 600 locomotives. This is the largest order of this kind, and the terms require the delivery of 30 locomotives per month, after having received general repairs. It is understood that the arrangement is more profitable to the road than to repair the locomotives themselves after the strenuous conditions of last winter, which left the machinery and boilers in need of unusually heavy work. It is possible for the locomotive company to undertake it because of the falling off in the demand for new locomotives at this time

DIRECT-CONNECTED MOTOR-DRIVEN FAN.

A very important improvement in the design of their "A B C" direct-connected motor-driven disc ventilating fan, which makes it much more rigid and compact, has recently been made by the American Blower Co. of Detroit. In place of attaching the motor to the arms of the fan, which in many

MOTOR-DRIVEN DISC FAN.—AMERICAN BLOWER CO.

cases was quite objectionable because of the weight of the overhanging motor, it is now placed on a substantial base as shown in the half tone. Westinghouse series-wound multipolar motors are used, which are furnished with an automatic release switch and a fireproof rheostat.

Engineer Draftsman.—The United States Civil Service Commission announces that the examination for engineer draftsman in the supervising architect's office, announced for August 17, 18 and 19, has been postponed to September 14, 15 and 16, 1904, and will be held to secure eligibles from which to make certification to fill a vacancy in the position of engineer draftsman in the supervising architect's office, at $1,200 per annum, and other similar vacancies as they may occur in that office. Information concerning the examinations and places where they will be held may be had on application to the United States Civil Service Commission, Washington, D. C.

Railroad Accidents in the United States.—The number of persons killed in train accidents during the months of January, February and March, 1904, as shown in reports made by the railroad companies to the Interstate Commerce Commission, under the "accident law" of March 3, 1901, was 221, and of injured 2,797. Accidents of other kinds, including those sustained by employees while at work, and by passengers in getting on or off the cars, etc., bring the total number of casualties up to 919 killed and 12,444 injured. These reports deal only with passengers and employees on duty.

Tractive Resistance on Various Roads.—The tractive resistance on railroads is from 9 to 18 lbs. per ton, on tramways 26 to 33 lbs., on good stone pavement from 44 to 55 lbs., on bad stone pavement from 66 to 78 pounds, on good macadam from 44 to 67 lbs., on bad macadam from 77 to 100 lbs., and on sand roads from 130 to 220 lbs.—*Max Schiemann.*

The Western Transit Company, which is the freight connection of the New York Central & Hudson River Railroad on the Great Lakes, has recently put into commission the new steamer Duluth, the largest package freight vessel on the Great Lakes. It is 401 ft. long, has a 50-ft. beam and 30-ft. depth, with a carrying capacity of 6,000 tons. This makes seven modern steel steamers in the Western Transit Company's fleet, six of which has been added since 1898, it being the company's policy to add a new steamer each year. In addition to these steel steamers, the company has nine iron and wooden ones, and this fleet of sixteen steamers enables the New York Central to give a daily freight service from Buffalo to Milwaukee, Chicago, Duluth and Portage Lake.

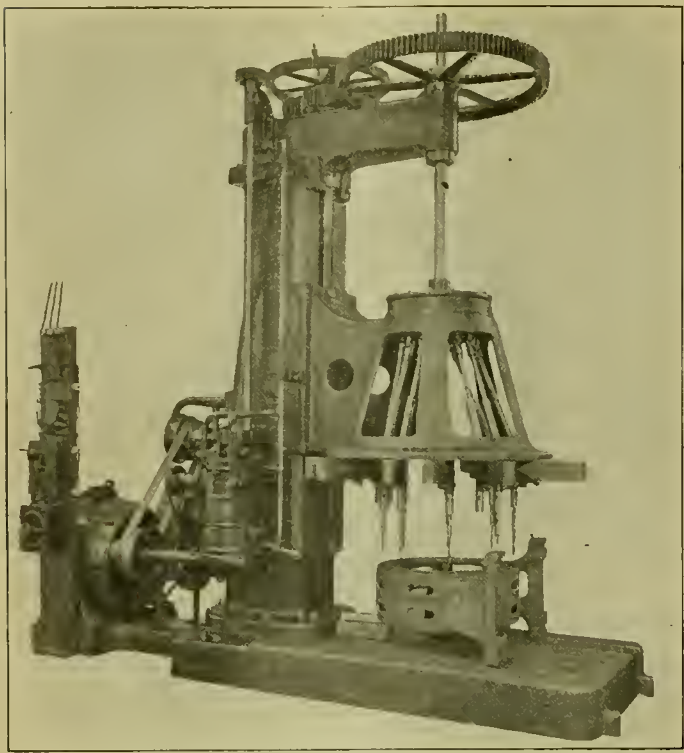


FIG. 1.—MULTIPLE SPINDLE DRILL.—BAUSH MACHINE TOOL COMPANY.

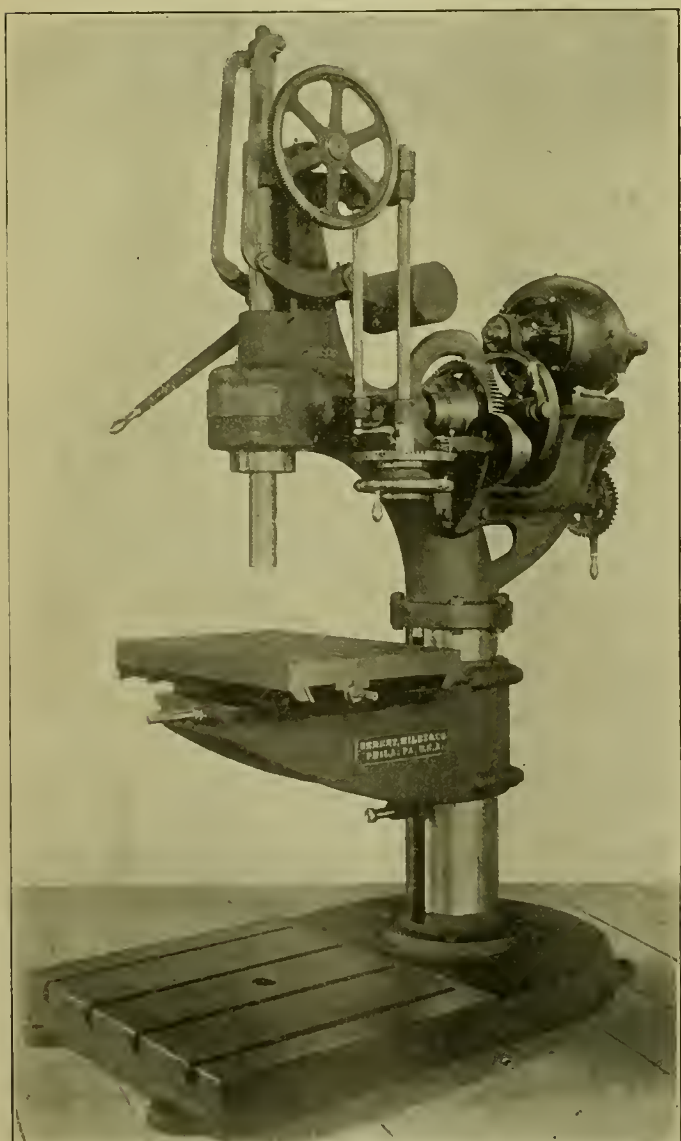


FIG. 3.—NEAT MOTOR APPLICATION TO BEMENT, MILES & CO. DRILL PRESS.

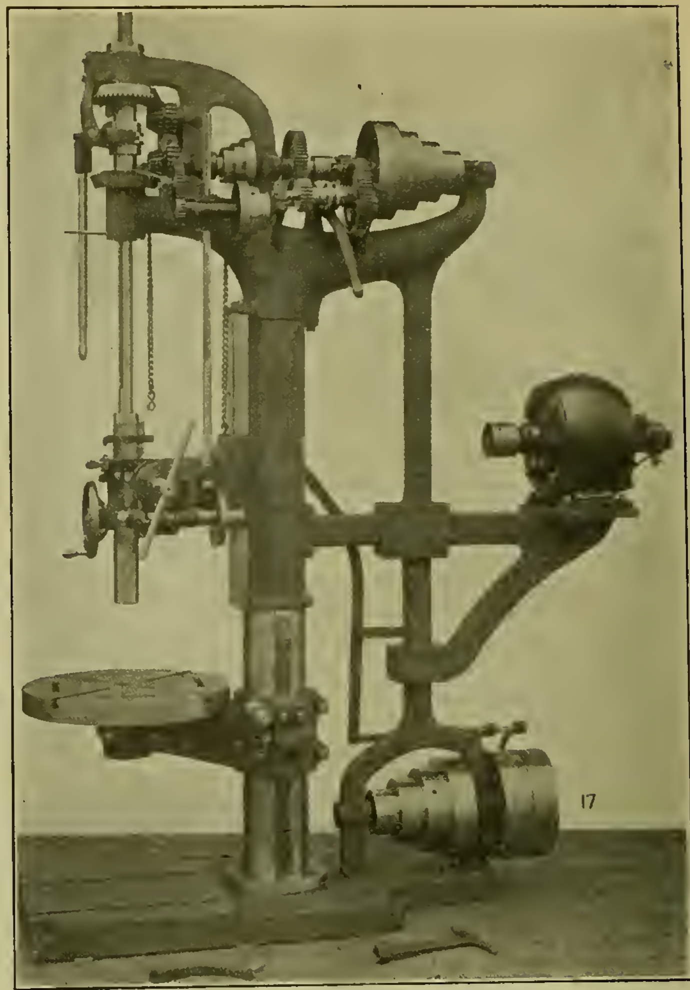


FIG. 2.—STANDARD DRILL PRESS ARRANGED FOR MOTOR DRIVE. CINCINNATI MACHINE TOOL CO.

DRILLING MACHINES.

Fig. 1 illustrates a fourteen-spindle multiple drill built by the Baush Machine Tool Company, Springfield, Mass., and driven by a General Electric Company variable speed 10 h.p., C. K. type motor with a speed range of from 350 to 700 r.p.m. The motor is placed on an extension of the base of the machine and is connected to the driving mechanism by gearing. The machine is designed to drill from one to fourteen 1-in. holes in cast iron with a maximum circle of 36 ins. and a minimum circle of 14 ins. The spindles are adjustable to allow for drilling in groups of square, circular or other forms, using one or more spindles and are also adjustable vertically. The automatic stop and feed permits the head to be operated with great ease and rapidity and relieves the workman of much unnecessary handling. It can also be operated by hand if desired. The machine has a quick return mechanism which can be controlled either automatically or by hand. Its weight is 23,000 lbs. These machines can be made either vertical or horizontal, and the horizontal machine can be made with either single or double head, each of which will carry from one to twenty spindles, ranging from ½ to 1½ ins. in diameter.

Fig. 2 illustrates the neat manner in which the Cincinnati Machine Tool Co. can easily arrange one of their standard drill presses for a motor drive. The motor bracket is of simple design and is clamped to the frame at the rear. The motor shown is a 2 h.p. Northern Electric and is mounted to belt to the tight and loose pulleys. Another interesting feature of this machine is the geared tapping attachment. The lever which hangs parallel to the main spindle operates a double clutch which engages the spindle with either train of gearing, rotating it in either direction, or allowing it to go free if the clutch is in its middle position as shown in the illustration. The clutches can readily be engaged or disengaged while the machine is in motion, thereby allowing the operator to

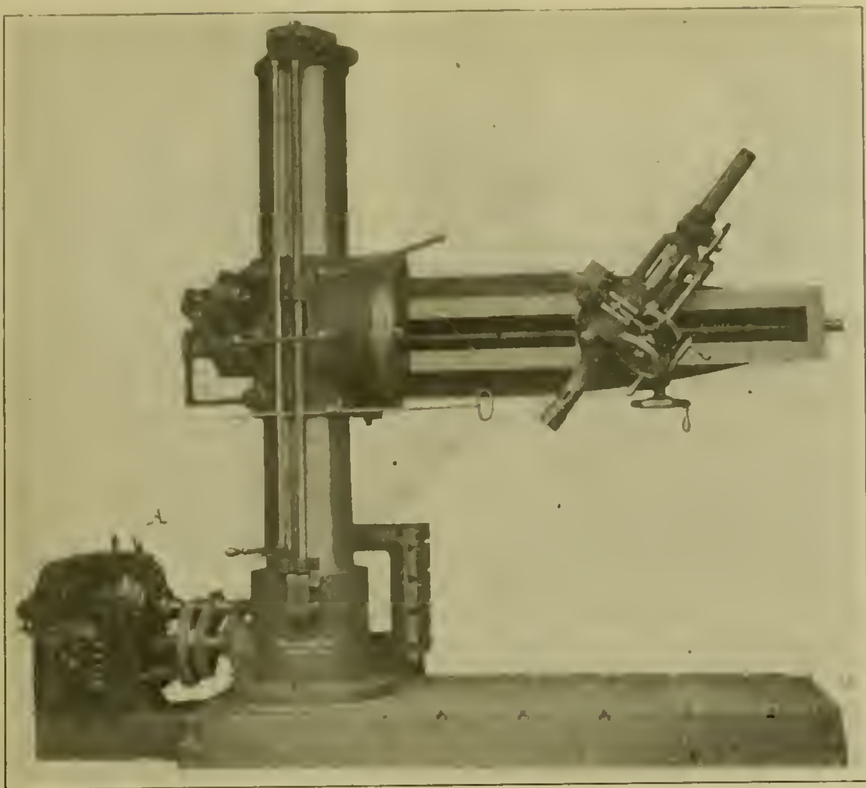


Fig. 4.—Motor-Driven Radial Drill.—Dreses Machine Tool Co.

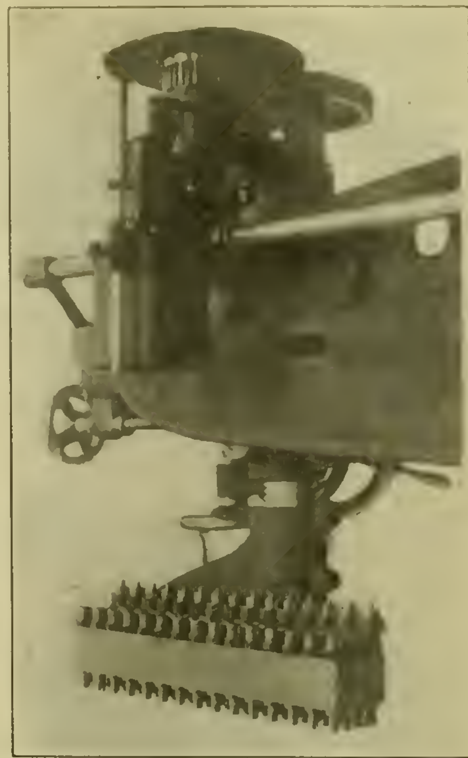


Fig. 7.—Multiple Drilling Device.—Mueller Machine Tool Co.

drill a hole, remove the drill and substitute a tap, and tap the hole without stopping the machine.

Fig. 3 shows a 50-in. vertical drill made by Bement, Miles & Company, and on exhibition at the St. Louis Exposition. Attention is at once attracted to the neat and substantial way in which the motor is applied. The 2½-h.p. Northern Electric motor has a speed range from 350 to 1,750 r.p.m. by speed control, giving in combination with the change gears, spindle speeds from 8½ to 220 r.p.m. The spindle is counterweighted and the bevel gears which drive it run in oil and are enclosed in a dustproof casing. It has power and hand feeds and rapid vertical adjustment by hand lever, and has 18 ins. traverse. The table has compound slides and vertical adjustment by power.

A full universal motor-driven radial drill made by the Dreses Machine Tool Company is shown in Fig. 4. The motor is a 3½-h.p. Jantz & Leist with a 2 to 1 speed variation and is connected to the drill shaft by two friction gears operated by the lever A. The two pinions keyed to the motor shaft are rawhide in order to insure noiseless running. The changes in the motor speed are obtained by shunt resistance, and these in connection with changes obtained by means of the two friction gears operated by lever A and by the regular change gear mechanism on the rear end of the arm afford a wide speed range with a large number of steps.

The adjustable handle rod below the arm starts, stops, engages the back gears, and reverses the spindle quickly for tapping, all while the machine is running and without using the belt shifter. The brake power of the driving friction gears on the rear of the arm can be adjusted so that the spindle will slip at a certain strain; for instance, when the tap strikes the bottom of the hole. The feed is positive and can be varied while the machine is drilling.

Figs. 5 and 6 show an interesting motor application made to a 5-ft. Dreses radial drill furnished to the Pittsburgh & Lake Erie Railroad for their McKees Rocks shops. The motor is a Crocker-Wheeler Company 6½-h.p. vertical and is mounted as shown in Fig. 6. With the belt drive the shaft P (extended) was driven from the cone pulley shaft by means of a pair of bevel gears and motion was transmitted to shaft O by means of gears D and C. With the motor drive the rawhide pinion A on the armature shaft drives gear B and shaft O which in turn transmits motion to the drill gearing. Gears C, D and E drive the elevating screw S by means of a tumbler gearing arrangement. The motor controller is mounted above the motor and is operated by means of the

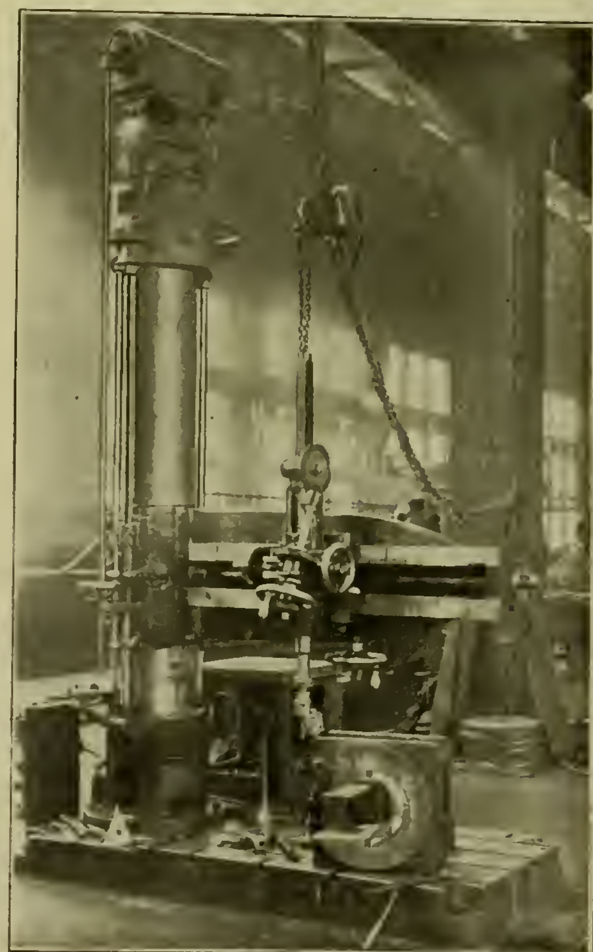


Fig. 5.—Vertical Motor Applied to Dreses Radial Drill.

handwheel on the vertical shaft, which is clearly shown on the half tone, and is connected to the controller shaft by a pair of bevel gears.

The half tone (Fig. 7) shows a new drilling device applied to a radial drill, permitting 60 holes to be drilled at the same time by operating the usual feed levers. The main casting, or head, is clamped to the machine sleeve, which is raised and lowered by means of its rack and pinion.

The radial spindle runs loose in this head, and, by means of teeth cut on the spindle next to the sleeve, drives the sixth gear in the first row of 15 spindles, which mesh together. These spindles have 1½-in. centers, and each of them drives three others in rows at right angles to the first row. Their

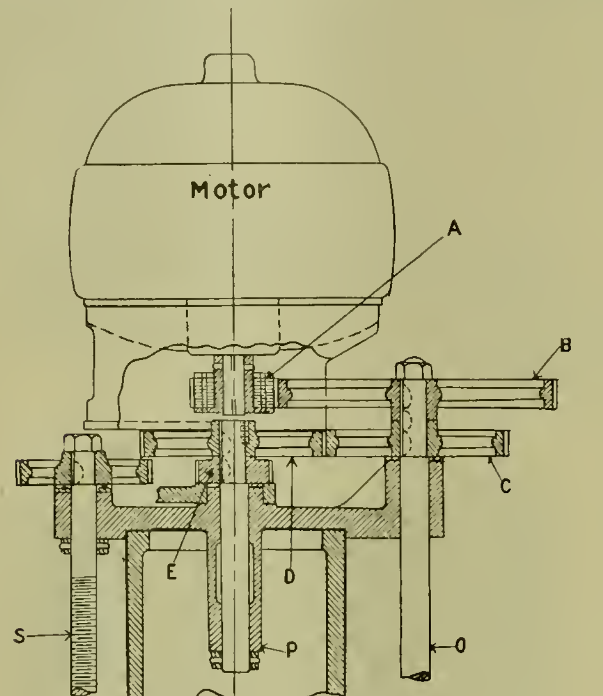


FIG. 6.—DETAILS OF APPLICATION OF VERTICAL MOTOR TO DRESES RADIAL DRILL.

centers are 1⅛ ins. in order to allow the teeth of their gears to pass each other as they run in opposite directions, and 30 right and 30 left hand drills are used to do the drilling. With the aid of a graduated dial on the cross screw and a table having its adjustment at right angles to the radial arm thousands of holes can be drilled with accuracy, down to ¼ in. center distances. The speed of the small drill spindles is about twice that of the main spindle. This device is manufactured by the Mueller Machine Tool Company of Cincinnati, Ohio.

Mr. George R. Henderson has opened an office at 20 West Thirty-fourth street, New York City, as a consulting engineer, with railroad problems as a specialty. His education, training and experience of 25 years' service on such roads as the Pennsylvania, Norfolk & Western, Chicago & Northwestern and Santa Fe, together with his high standing as an engineer, constitute a most excellent preparation for consulting practice, and in view of the important new problems now presented to railroad management, this journal is glad to note that Mr. Henderson has decided upon this course.

CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.

The Master Car and Locomotive Painters' Association will hold its thirty-fifth annual convention at Atlantic City, N. J., September 13 to 16, with headquarters at the Hotel Rudolf. The program of subjects is as follows:

1. Report of committee on tests. J. H. Pitard, Mobile & Ohio, chairman.
2. What improvement have we made in the painting of steel cars in the past year? Robert Shore, Lake Shore & Michigan Southern, chairman.
3. What is the best material and treatment for locomotive front ends? A. R. Lynch, Pittsburg, Cincinnati, Chicago & St. Louis, chairman.
4. What is the best construction of sand blast and method of operating same, in preparing metal for painting? J. H. Kahler, Erie Railroad, chairman.
5. Which is the best method for removing cracked varnish on the interior of passenger cars? Chris. Clark, New York, Chicago & St. Louis, chairman.
6. Essay, "The Treatment of an Ideal Passenger Car from a Painter's View." J. A. Gohen, Cleveland, Cincinnati, Chicago & St. Louis.
7. Passenger car roofs—treatment and attention of same. T. J. Hutchinson, Grand Trunk, chairman.
8. Paint shop, records and accounts. H. M. Butts, New York Central & Hudson River, chairman.
9. What causes the bulging of putty in the nail holes of new work? J. H. Whittington, Chicago & Alton, chairman.

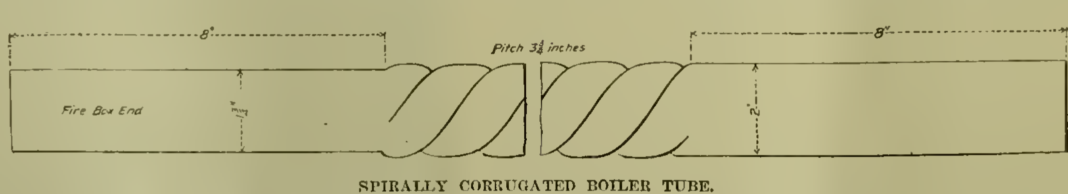
TRAVELING ENGINEERS' ASSOCIATION.

This association will hold its annual convention at the Lexington Hotel, Michigan Boulevard and Twenty-second street, Chicago, September 13. A specially interesting convention is promised.

SPIRALLY CORRUGATED BOILER TUBES.

This tube seems likely to prove very beneficial in reducing "flue troubles" in locomotive boilers. It has been in experimental service for five years with excellent results. The body of the tube is corrugated in spirals of 3¾-in. pitch, the ends being plain for a length of 8 ins. at both tube sheets, these portions being thicker than the body of the tube. Advantages of two kinds are offered by this tube. First, the corrugations render the tube elastic and the expansion and contraction are taken up in the tube itself instead of being transmitted to the tube sheets. Because of the peculiarly severe conditions of locomotive service this is an important matter. By applying tension to a single tube by mechanical means it is demonstrated that the tube may be stretched ⅜ in. in 16 ft. with no permanent set. Second, the spiral corrugations tend to break up the currents of hot gases passing through the tubes, the action being similar to that of "retarders" or the fins of the well known Serve tubes, in abstracting a larger amount of heat from the gases than may be obtained with smooth tubes. This should improve the economical performance of a boiler. It is evident that anything which increases the absorption of heat from the gases not only increases the economy, but reduces the necessity for forcing the fire, the value of which will appear in the form of enlarged exhaust nozzles and a decrease of waste through spark throwing.

Practical tests are believed to show that the corrugations do not collect cinders, that there is a marked saving in fuel, a great improvement with respect to tube leakage and a reduction in the number of sparks thrown. An important reference



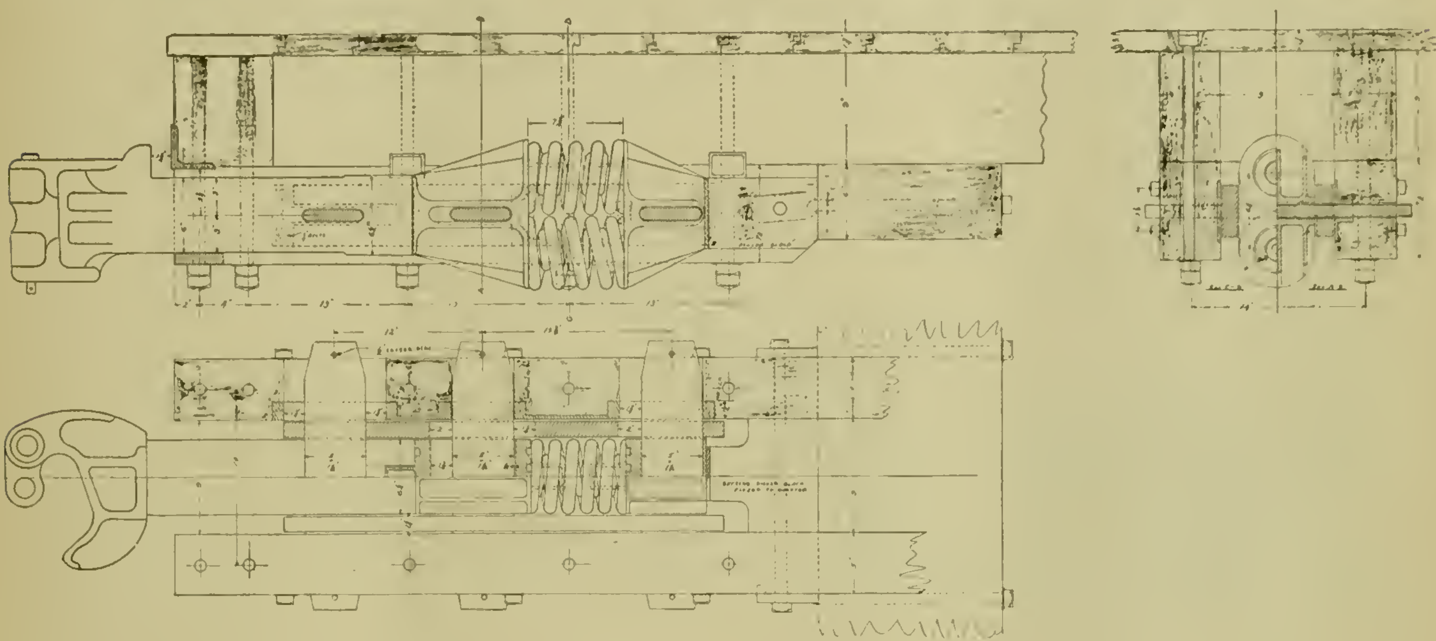
SPIRALLY CORRUGATED BOILER TUBE.

to these tubes may be found on page 85 of the Proceedings of the Master Mechanics' Association for 1903. The following record has been received from a road having these tubes in service for five years:

PERFORMANCE OF ENGINES EQUIPPED WITH CORRUGATED AND PLAIN TUBES.

Engine No.	Tubes	Mileage	Lbs. coal used	Weight train hauled in net tons	Per Mile. Lbs. coal	Per Mile. Tons haul'd	Tons hauled per ton coal used
67	Corrugated	1,200	63,300	1,338	52.75	1.11	42.28
69	Plain.....	1,200	60,800	1,188	50.67	0.99	39.08
							8.18%

The exhibit of these tubes at the recent Saratoga Convention attracted a great deal of interested attention among railroad men who are facing serious flue troubles, and the tubes are now being tried on a number of the most prominent roads. Further information may be obtained from the manufacturers, The New Jersey Tube Co., Newark, N. J.



FARLOW DRAFT GEAR—TWIN SPRING—APPLIED TO WOOD DRAFT SILLS.

THE FARLOW DRAFT GEAR.

This gear was designed to provide the necessary strength and capacity to resist shocks of service in a construction which is easily repaired. Many gears which are satisfactory in every other respects are difficult to repair, and few are so made as to be taken down and replaced by one man. The Farlow draft gear combines a coupler, with the elongated slot; front and rear followers, also slotted; three keys, passing through the slots in the drawbar and followers and also passing through the draft sills or draft castings and two slotted drawbar links, one at each side of the coupler.

The arrangement is illustrated in the accompanying engraving. In addition to the keys for taking buffing shocks, the rear face of the rear follower is broadened to bear against an oak block which is bolted between the draft timbers and bears against the followers at the front end and against the body bolster at the back end, thus adding to the buffing resistance. In buffing, or in pulling, the springs transmit the initial shock to the sills through the links and the three 5-in. keys. These keys are in shear, and bending stresses are avoided. The horn of the coupler strikes when the keys come to a bearing, after which the buffing shocks are transferred to the buffing block bearing against the bolster. The resistance of the keys prevents the springs from being compressed "solid." Because of the keys, which are easily applied and removed, and the slotted draw links, this gear is very easily put up and taken down. It should permit of establishing a low piece-work price for repairs. In fact this convenient construction is a strong point of this gear. There is no yoke to be riveted on or cut off, and no blacksmith work whatever about the gear or its attachments. Strength, however, has not been sacrificed to convenience. In a test made at Purdue University a gear, which was exhibited at the recent Saratoga conventions, withstood 30 blows (beginning at 1 ft. 1 in. and ending at 30 ft. 1 in. drop) and finished in condition for service under a car. At the fourth blow the horn of the coupler struck the end sill.

A twin spring arrangement is illustrated, but the tandem, single spring, or a friction gear may be applied as desired, and any of these forms may be readily applied to old equipment. Other interesting features are the initial compression of the springs by driving in the keys with the taper ends and the fact that the gear will do its work even if a spring is broken and lost in transit. Further information may be had from the Farlow Draft Gear Company, 223 North Calvert Street, Baltimore, Md.

LOCOMOTIVE TESTING PLANT AT ST. LOUIS.

Schedule From Observed Data.

On page 301 of the August number the beginning of the schedule of data taken from Bulletin No. 3 was presented. This list is continued in abstract below because of the value of the schedule itself. The notes will be completed next month. These bulletins may be purchased from the Pennsylvania Railroad:

OBSERVED DATA.

196. Duration of test, hours..........

SPEED.

197. Total revolutions..........
198. Average revolutions per minute..........
199. Equivalent speed in miles per hour..........
200. Equivalent piston speed in feet per minute..........

POSITION OF LEVERS.

201. Reverse lever, notches from front end..........
203. Throttle lever..........

TEMPERATURE, DEGREES FAHRENHEIT.

206. Of smoke-box, by thermometer..........
207. Of smoke-box, by pyrometer..........
208. Of laboratory, dry bulb..........
209. Of laboratory, wet bulb..........
210. Of steam in branch pipe..........
211. Of feed water..........
212. Of fire-box, by pyrometer..........

PRESSURE, POUNDS PER SQUARE INCH.

217. In boiler, average..........
218. In boiler, maximum..........
219. In boiler, minimum..........
220. In branch pipe..........
221. In laboratory, barometric..........

DRAFT, INCHES OF WATER.

222. In smoke-box, front of diaphragm..........
223. In smoke-box, back of diaphragm..........
224. In fire-box..........
225. In ash pan..........

INJECTORS.

Hours in action.

226. Total, right
227. Total, left

QUALITY OF STEAM.

228. In dome
229. In branch pipe
230. Degrees of superheat in branch pipe

COAL, SPARKS AND ASH.

232. Coal fired, kind
233. Coal fired, total, pounds
234. Coal as fired, per cent, of moisture
235. Dry coal fired, total, pounds
236. Combustible, by analysis, total, pounds
237. Ash, by analysis, total, pounds
238. Cinders collected in smoke-box, total, pounds
239. Sparks discharged from stack, total, pounds
240. Cinders and sparks, total, pounds

ANALYSIS OF COAL.

241. Fixed carbon, per cent
242. Volatile matter, per cent
243. Moisture, per cent
244. Ash, per cent
245. Sulphur determined separately, per cent

CALORIFIC VALUE IN B. T. U., PER LB.

248. Of dry coal
249. Of combustible
250. Of cinders and sparks

ANALYSIS OF SMOKE-BOX GASES.

253. Oxygen—O, per cent
254. Carbon monoxide—CO, per cent
255. Carbon dioxide—CO_2, per cent
256. Nitrogen—N, per cent

WATER, IN POUNDS.

259. Delivered to injectors
260. Lost, from boiler
261. Lost, from
262. Lost, from
263. Lost, total
264. Delivered to boiler and presumably evaporated

DYNAMOMETER.

Pull in pounds.

265. Average
266. Maximum
267. Minimum

CUT-OFF, PER CENT. OF STROKE.

268. High pressure cylinder, right, head end
269. High pressure cylinder, right, crank end
270. High pressure cylinder, left, head end
271. High pressure cylinder, left, crank end
272. Low pressure cylinder, right, head end
273. Low pressure cylinder, right, crank end
274. Low pressure cylinder, left, head end
275. Low pressure cylinder, left, crank end

RELEASE, PER CENT. OF STROKE.

276. High pressure cylinder, right, head end
277. High pressure cylinder, right, crank end
278. High pressure cylinder, left, head end
279. High pressure cylinder, left, crank end
280. Low pressure cylinder, right head end
281. Low pressure cylinder, right, crank end
282. Low pressure cylinder, left, head end
283. Low pressure cylinder, left, crank end

BEGINNING OF COMPRESSION, PER CENT OF STROKE.

284. High pressure cylinder, right, head end
285. High pressure cylinder, right, crank end
286. High pressure cylinder, left, head end
287. High pressure cylinder, left, crank end
288. Low pressure cylinder, right, head end
289. Low pressure cylinder, right, crank end
290. Low pressure cylinder, left, head end
291. Low pressure cylinder, left, crank end

PRESSURE FROM INDICATOR CARDS.

Initial pressures, pounds per sq. inch.

292. High pressure cylinder, right, head end
293. High pressure cylinder, right, crank end
294. High pressure cylinder, left, head end
295. High pressure cylinder, left, crank end
296. Low pressure cylinder, right, head end
297. Low pressure cylinder, right, crank end
298. Low pressure cylinder, left, head end
299. Low pressure cylinder, left, crank end

STEAM CHEST PRESSURES, POUNDS PER SQ. IN.

301. High pressure, right side
302. High pressure, left side
303. Low pressure, right side
304. Low pressure, left side

PRESSURES AT CUT-OFF, POUNDS PER SQ. INCH.

306. High pressure cylinder, right, head end
307. High pressure cylinder, right, crank end
308. High pressure cylinder, left, head end
309. High pressure cylinder, left, crank end
310. Low pressure cylinder, right, head end
311. Low pressure cylinder, right, crank end
312. Low pressure cylinder, left, head end
313. Low pressure cylinder, left, crank end

PRESSURES AT RELEASE, POUNDS PER SQ. INCH.

314. High pressure cylinder, right, head end
315. High pressure cylinder, right crank end
316. High pressure cylinder, left, head end
317. High pressure cylinder, left, crank end
318. Low pressure cylinder, right, head end
319. Low pressure cylinder, right, crank end
320. Low pressure, cylinder, left head end
321. Low pressure cylinder, left, crank end

PRESSURES AT BEGINNING OF COMPRESSION, POUNDS PER SQ. INCH.

322. High pressure cylinder, right, head end
323. High pressure cylinder, right crank end
324. High pressure cylinder, left, head end
325. High pressure cylinder, left, crank end
326. Low pressure cylinder, right, head end
327. Low pressure cylinder, right, crank end
328. Low pressure cylinder, left, head end
329. Low pressure cylinder, left, crank end

LEAST BACK PRESSURE, POUNDS PER SQ. INCH.

330. High pressure cylinder, right, head end
331. High pressure cylinder, right, crank end
332. High pressure cylinder, left, head end
333. High pressure cylinder, left, crank end
334. Low pressure cylinder, right, head end
335. Low pressure cylinder, right, crank end
336. Low pressure cylinder, left, head end
337. Low pressure cylinder, left, crank end

SUMMARY OF AVERAGE RESULTS.

Boiler.

338. Dry coal fired, per hour, pounds
339. Dry coal fired, per hour, per sq. ft. of grate surface, pounds

EVAPORATION, POUNDS.

340. Moist steam per hour
341. Dry steam per hour
342. Dry steam per hour, per sq. ft. of heating surface
343. Dry steam per hour, per pound of dry coal

EQUIVALENT EVAPORATION FROM AND AT 212 DEGREES FAHR.

344. Per hour, pounds
345. Per hour per sq. ft. of heating surface, pounds
346. Per pound of coal as fired, pounds
347. Per pound of dry coal, pounds
348. Per pound of combustible, pounds
349. Boiler horse power
350. Efficiency of boiler

SUMMARY OF AVERAGE RESULTS—ENGINE.

MEAN EFFECTIVE PRESSURE, POUNDS PER SQ. INCH.

351. High pressure cylinder, right, head end
352. High pressure cylinder, right, crank end
353. High pressure cylinder, left, head end
354. High pressure cylinder, left, crank end
355. Low pressure cylinder, right, head end
356. Low pressure cylinder, right, crank end
357. Low pressure cylinder, left, head end
358. Low pressure cylinder, left, crank end

RECEIVER.

359. Pressure, right side
360. Pressure, left side

NUMBER OF EXPANSIONS.

361. Right side, head end
362. Right side, crank end
363. Left side, head end
364. Left side, crank end

INDICATED HORSE POWER.

365. High pressure cylinder, right, head end
366. High pressure cylinder, right, crank end
367. High pressure cylinder, left, head end
368. High pressure cylinder, left, crank end
369. Low pressure cylinder, right, head end
370. Low pressure cylinder, right, crank end
371. Low pressure cylinder, left, head end
372. Low pressure cylinder, left, crank end

DIVISION OF POWER.

373. High pressure cylinder, right side
374. High pressure cylinder, left side
375. Low pressure cylinder, right side
376. Low pressure cylinder, left side
377. Right side, total
378. Left side, total
379. Total

PER I. H. P. PER HOUR.

380. Dry coal, pounds
381. Dry steam, pounds
382. B. T. U.

SUMMARY OF AVERAGE RESULTS—LOCOMOTIVE.

383. Dynamometer horsepower
384. Dry coal per D. H. P. per hour, pounds
385. Dry steam per D. H. P. per hour, pounds
386. B. T. U. per D. H. P. per hour, pounds

PER ONE MILLION FOOT POUNDS AT DRAWBAR.

387. Dry coal, pounds
388. Dry steam, pounds
389. B. T. U.
390. I. H. P. per square foot of heating surface
391. I. H. P. per square foot of grate surface
392. D. H. P. per square foot of heating surface
393. D. H. P. per square foot of grate surface
394. Tractive power based on M. E. P., pounds

MACHINE FRICTION OF LOCOMOTIVE IN TERMS OF,

395. Horse power
396. M. E. P., pounds
397. Drawbar pull, pounds

EFFICIENCY.

398. Machine efficiency of locomotive, per cent
399. Efficiency of locomotive, per cent

RATIOS.

400. Total weight of locomotive to maximum I. H. P.
401. Total heating surface to maximum I. H. P.

SUMMARIZED STATEMENT OF AVERAGE RESULTS.

196. Duration of test hours
198. Number of rev. per min.
199. Speed in miles per hour
203. Position of throttle
217. Boiler pressure in pounds per sq. in.
220. Branch pipe pressure in pounds per sq. in.
222. Draft in front of diaphragm, inches of water
265. Drawbar pull, pounds
268 to 271. Approximate cut-off in high pressure cylinder, in per cent. of stroke
338. Dry coal fired per hour, pounds
341. Dry steam used per hour, pounds
344. Equivalent number of pounds of water from and at 212 degrees Fahr. per pound of dry coal
350. Efficiency of boiler
379. Indicated horse power
380. Dry coal per I. H. P. per hour, pounds
381. Dry steam per I. H. P. per hour, pounds
383. Dynamometer horse power
384. Dry coal per D. H. P. per hour, pounds
385. Dry steam per D. H. P. per hour, pounds
395. Frictional horse power
399. Efficiency of locomotive

(The explanatory notes will be concluded next month.)

THE ATLANTIC STEAM SHOVEL.

The 2½-yard steam shovel illustrated in this engraving is a new machine introduced by the Atlantic Equipment Company, of 25 Broad street, New York. It is built by the American Locomotive Company from the designs of A. W. Robinson, M. Am. Soc. C. E. This machine is the result of many years' experience in the design and operation of steam shovels and dredging machines, and it includes all the desirable features of the best modern practice in shovel building. The Atlantic shovel has been designed to cover the following points as compared with others:

1. Simplicity of design with direct strain, and few and strong parts that will not break or easily get out of order. 2. The highest possible speed and power consistent with safe and effective working. 3. Avoidance of wear and breakage of chains and sheaves. 4. Moderate weight. 5. Better and more efficient boiler for easy steaming and economy of fuel. 6. Direct application of power to the dipper. 7. Better angle of lead, giving more digging power with less pull on dipper. 8. One sheave instead of six. 9. Sixty-five to 85 per cent. greater efficiency. 10. High lift. 11. Short boom, thus reducing the strains and permitting faster speed of swinging. 12. The employment throughout of the highest quality of design, materials and workmanship and fully equal to the best locomotive practice.

It has a pull upon the dipper of 38,000 lbs., a clear height of lift of 16 ft. and a capacity of 2½ cu. yds.

The distinguishing feature of this shovel is the direct wire rope hoist. Direct wire rope hoists have been used successfully by Mr. Robinson for some years in large dipper dredges, and his work in this connection is well-known.

The hoisting engines are incorporated in the base of the boom so that the whole hoisting machinery revolves together. The hoisting machinery is unusually compact and at the same time very strong and easy of access. The drum is very short and of large diameter and fits easily between the sides of the boom which constitute the frame. The gearing is of steel and amply strong to stall the engines with full head of steam. The hoisting friction is of novel type, taking up less room than usual and is quick and sensitive and does its work without heating. It is operated by steam so that the operator exerts no effort. The A frame is formed of solid steel bars having solid forged pin-connections at feet and a cast steel head. The A frame is stepped upon the ends of the jack-arm truss in such a way that it forms a continuation of the jack-arms, giving great stability and relieving the car frame from strains. The A frame head is of new design and arranged so that the three strains intersect in a point. This is accomplished in no other shovel and obviates all lateral bending strains which frequently lead to breakage. The A frame can be lowered when required for transportation over the road to 15 ft. (or lower) above the rail. The pin-connections at the foot of the frame permit of this movement and the back guys are shifted forward to a connection provided for the purpose. The raising and lowering of the frame can be done by power.

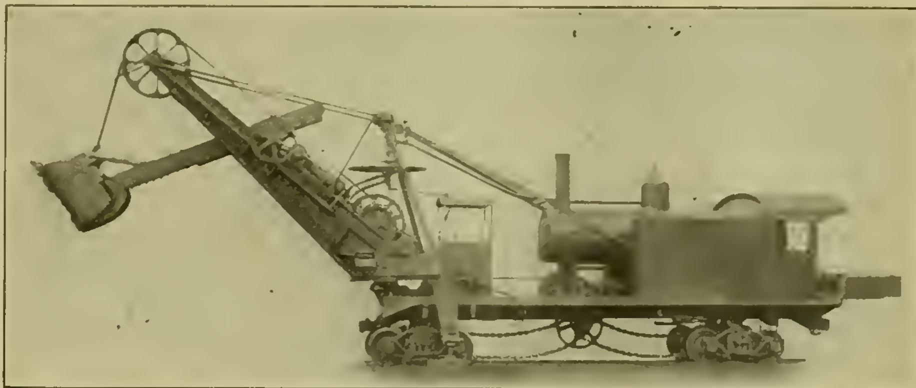
The boom has a straight taper deepest at the inner end. This form is the simplest and most direct that can be devised, giving the greatest strength where it is needed and the least weight at outer end where there is greatest motion.

The turntable is built solid with the boom, being made of stiffened steel plates and a rolled rim. The turntable and boom as a unit have perfect freedom of action, being separate from the revolving collar on the base. In this shovel the hoisting machinery is mounted directly upon the boom so that no guide sheaves are necessary, and the power is applied in the most direct and simple manner and with the least possible loss. A pair of engines with drum and gearing are incorporated into the base of the boom that take up very little room and can pull the required amount on the dipper at a speed of five to six dipper loads per minute, and in which all parts are adequate for continuous heavy work and easily accessible.

The main engines are of locomotive type with outside cylinders. A sheet steel casing is provided for protection. They have solid cast steel frame for both engines in one piece and steel crossheads, with all parts easy of access. Steam is carried by a pipe having a double ball and socket joint on top center, and the exhaust is carried to the smokestack by a pipe through the bottom center. The hoisting drum is of large diameter, grooved for steel wire rope.

Independent thrusting engines are employed to feed the dipper to its work. By their use the cranesman has absolute control of the dipper and can cause it to fill every time while in a proper bank. These engines are solidly built with bedplate in one piece and well bolted to the boom. The gearing is of steel and the engines are reversing by means of central valve. Independent reversible engines are employed for swinging, a duplicate of those on the boom for thrusting, and double-geared to a drum. The drum carries double steel wire ropes on each side, which are connected to the turntable.

In this shovel there is room for a first-class locomotive boiler, and the greatest care is bestowed upon its design and workmanship. It is large enough for a locomotive of twice the cylinder capacity, and is, therefore, easy steaming. It is built for a working pressure of 140 lbs., which more nearly accords with locomotive practice than has been usual on steam shovels, and which conduces to economy as well as speed and power.



THE ATLANTIC STEAM SHOVEL.

The shovel is mounted on two all-steel trucks of diamond pattern specially designed for the purpose and having a large excess of strength over the requirements. The axles are of best hammered iron with M. C. B. standard journal boxes. The bolster is formed of a steel box girder composed of two 9-in. I-beams with steel plate top and bottom. The main arch bars are 6 ins. wide. The rear truck is fitted with hand brakes.

The shovel illustrated is working on the New York Central & Hudson River Railroad and frequently loads 10 cars (100 cu. yds.) in 8 minutes. Another is at work on the site for the new terminal for the Pennsylvania Railroad in New York City. One of these shovels is exhibited by the American Locomotive Company at St. Louis.

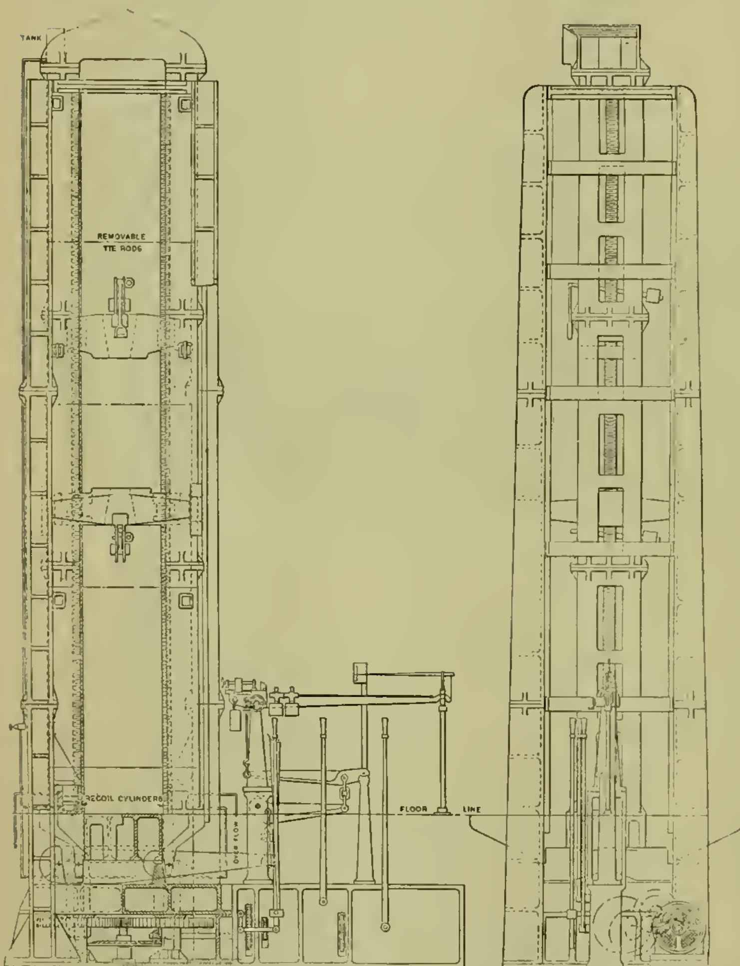
Instruction Car For Motormen.—Because the new subway in New York is to go into service "full blast" at the opening, trainmen and motormen are being trained to their work by aid of an instruction car equipped with the controlling apparatus for power and brakes and facilities for explaining them fully. About 3,000 men will be needed and only those experienced on steam or electric roads are considered. The rates of pay are to be as follows: Experienced motormen, $3 for a day of 10 hours; first year motormen, $2.75; second year motormen (and after), $3. First year conductors, $2.10; second year, $2.25; third year and after, $2.40. Guards, first year, $1.70; second year, $1.80; after second year, $1.95.

RIEHLE 600,000-POUND TESTING MACHINE.

UNIVERSITY OF ILLINOIS.

The State of Illinois has established at the State University at Champaign, an engineering experiment station for the purpose of carrying on engineering investigations along lines somewhat similar to those followed by the various State agricultural experiment stations. This station has recently ordered from Riehle Brothers Testing Machine Company, of Philadelphia, a 600,000-lb. testing machine of the vertical screw type. This machine is intended for general testing purposes. It is made to take columns, long test pieces, beams, and large irregular shapes, reinforced concrete, stone, and brick construction, built-up metal trusses, and a great variety of test pieces. This is the largest vertical screw-testing machine ever built.

In its general features the machine is similar to the Riehle United States standard vertical screw power-testing machine, with a new feature in the form of four columns to guide the pulling head, these columns being firmly secured to the base of the machine, and entirely independent of the weighing mechanism. The machine has two heads, the upper one being supported by cast iron columns, which rest on and are bolted to the weighing table. A tie piece at the extreme top of these columns holds them together at this end. The lower or "pulling" head is driven by two main screws and moves up or down on the screws when they are turned. The top head may be secured at different elevations according to length of specimen to be tested, and is held in place by two keys which pass through slots in the cast iron columns. The parts which transmit the stress from the specimen to the weighing levers rest on the weighing table and are not connected in any way with the parts of the machine which supply the power. The weighing table is supported on eight hardened steel knife edges in the main levers, and they in turn rest on the steels which are fitted in cast iron bearings on the cover plate. The cover plate is supported by two legs on a steel bed plate, which, in turn, rests upon a concrete foundation.



RIEHLE 600,000-POUND TESTING MACHINE.—UNIVERSITY OF ILLINOIS.

The beam of the machine is the Riehle dial screw beam graduated in 10,000-lb. marks and reading to 100 lbs. The two poises are driven by a coarse pitch screw, and the nut takes up wear automatically. One poise can be run out at a time. When it reaches the end of the beam it will release itself and the second poise may be thrown in, or, if desired, both poises can be run out together and the reading on the beam doubled. A needle beam with pointer swinging over a graduated dial is used to magnify the swing of the weighing beam, thus increasing the sensitiveness of the machine.

The pulling head has four projecting arms carrying at their ends flat bearing surfaces, bearing against the faces of four guide columns, which are firmly fastened to the bed plate, legs and cover plate, and extend to the highest point reached by the pulling head in its travel. These guide columns are securely tied together at suitable intervals, and take care of any side thrust coming on the pulling head, such, for example, as occurs when long specimens are compressed. The screws are driven by a train of gears and are made of a special grade of steel and have long guides in the cover plate and on the bed plate. All gears are spur gears, except one pair of bevels, and all gears are cut. By means of friction clutches and positive clutches the pulling head can be driven either up or down.

The machine is driven by a 15-h.p., two-phase, 220-volt induction motor, capable of pulling the machine up to full load at speeds not greater than 1 in. per minute, and up to half load at 2 ins. per minute. It is geared to the machine through one direct and one reversing train of gears, and the starting, stopping and reversing are accomplished by a double friction clutch.

Compression specimens are crushed between two cast iron "tools" with hardened steel plates placed on their faces. These tools could be made with spherical seats if desired. Three transverse tools are provided, one on the pulling head and two on the table. The two on the table have cylindrical bases on which they can rock freely. The table has 16 2-in. tapped holes conveniently placed for inserting bolts to hold specimens or tools. Wedge-shaped openings are made in both the weighing and pulling heads on which hardened steel wedges or "grips" slide. These grips are hung on counterbalanced levers with handles by means of which they can be made to "take hold" of tensile specimens, and as stress is applied the holding power increases. The surface of all grips is roughened by cross cuts. Several sets of grips and several sizes of liners are supplied, so that any specimen within the range of sizes given later can be effectively held. The weighing head may be placed in any one of three positions, as may be required by the length of tensile specimen. In each of these positions it is held by two keys passing through slots in the cast iron columns. The weighing head is moved from one position to another by moving the pulling head till the former is lifted so as to loosen its keys; then, the keys being removed, the pulling head and weighing head together are moved to the desired position; the keys are inserted and pulling head moved down.

In place of the rubber buffer used on smaller sizes of machines, the blow on the knife edges due to recoil when the specimen breaks is minimized by causing the energy of recoil to be partially dissipated in forcing water through a very small aperture. The engraving shows the general arrangement of hydraulic cylinders, piping and needle valve used. The machine and motor are to be placed on a heavy concrete foundation. The principal dimensions are as follows:

Extreme height	36 feet 8 inches
Extreme length, including motor	17 feet
Extreme width	10 feet 8 inches
Height above floor	30 feet 8 inches
Weight	100,000 pounds

The machine will take compression specimens 25 ft. long and less; tensile specimens 22 ft. long, with 20 per cent. elongation in 20 ft. and more for shorter lengths; transverse specimens 10 ft. long by 3 ft. wide and less; tensile tools—grips and liners—to take specimens 6 ins. round or square and less to ¾-

in. round or square; 12-in. by 4-in. flats and less; compression tools 20 ins. square and hardened steel plates 6 ins. square, and transverse tools, 3 ft. wide by 18 ins. high. The speeds of machine at 300 rev. per min. of the driving shaft are:

	Inches per minute.
Speed for setting head	8
Quick speed for testing	2
Fast speed for testing	1
Medium speed for testing	0.4
Slow speed for testing	0.1
Slow speed for crushing test	0.05

Fifteen horse-power will be required to operate this machine, using as a maximum speed 1 in. per minute to full capacity of machine, and 2 ins. per minute to one-half the capacity of the machine.

Commonwealth Steel Company.—Mr. Harry M. Pflager has resigned his position with the American Steel Foundries to accept a position with the Commonwealth Steel Company, of which company he was elected vice-president at the meeting of directors on August 22. Mr. Pflager was for many years mechanical superintendent of the Pullman Company at Chicago. He will direct his attention to the sales department and have his headquarters at the Commonwealth Steel Company offices, in the Bank of Commerce Building, St. Louis.

Mr. F. V. Henshaw, who has for a number of years been active in the management of the engineering department of the Crocker-Wheeler Company, has resigned from that company, and has planned to take a well-earned rest before taking up new work. In addition to a large part of the management of the engineering department, Mr. Henshaw has had entire charge of the estimating and installation work of the above company, and has devoted much study to the broad subject of engineering economies in industrial plants.

BOOKS AND PAMPHLETS.

Types and Details of Bridge Construction. Part I, Arch Spans. Examples of constructed wooden, combination, wrought iron and steel arches for highway and railroad bridges. By Frank W. Skinner, M. Am. Soc. C. E., Associate Editor of *The Engineering Record*. McGraw Publishing Company, 114 Liberty street, New York.

A collection of essential features of special and important work, illustrating variety of design, development of standard practice and methods of erection. It is the purpose of the book to present the development of advanced practice and its standard details, to illustrate the classes of structures adapted to different conditions, show some of the characteristic differences between American and foreign design and illustrate some primitive or obsolete constructions, besides recording important and well known examples, so as to have their principal data easily accessible. The book is divided into four sections: on wood and arch spans, spandrel braced arches, arch trusses, and plate girder arches, and contains 290 pages, is profusely illustrated and arranged and cross-indexed for convenient use.

Boiler Construction. A practical explanation of the best modern methods of boiler construction, from the laying out of the sheets to the completed boiler. By Frank B. Kleinhans. First edition, 1904. Derry-Collard Co., 256 Broadway, New York. Price, $3.00.

As the locomotive type has much in common with the various types of boilers and represents the general class better than any other, and as anyone capable of handling the complicated flanged sheets of a modern locomotive boiler can easily handle the sheets used in other types, the author has deemed it advisable to use it as an example of steam boilers. The construction of the boiler and the various tools used in connection with it are very completely considered in the order in which it goes through the shop, beginning with the laying out of the sheets and following through the various operations until it is placed on the frames, the various fittings, etc., attached and tested, lagged and ready to leave the shop. A section is also devoted to the description, care and repair of boiler shop machines. There are also a number of tables which are useful in connection with boiler construction. It has 421 pages, 334 illustrations and five large plate engravings.

The Coals of Illinois; Their Composition and Analysis. By S. W. Parr, Professor of Applied Chemistry, University of Illinois. 44 pages. Price, 25 cents.

This is No. 7 of the "University Studies," and is by far the most comprehensive work so far undertaken on Illinois coals. One hundred and fifty samples fairly representative of the coal producing area have been studied and the results conveniently arranged in a table for reference. The samples were collected between January and June, 1904, were subjected to the same processes carried on by the same persons; the results, therefore, are more uniform and comparable than any heretofore available. Another striking feature is the introduction here for the first time of a new factor in the proximate analysis of coal, that of "water of composition" as part of the volatile constituent. It is a little startling to see a non-combustible as part of the volatile matter, equaling and often surpassing in amount the sum of the ash and moisture.

Special development has been made also of processes for determining the total carbon, sulphur and coke. Altogether the work is a valuable contribution to our knowledge of bituminous coals in general and Illinois coals in particular.

Electric Generators.—Bulletin No. 9 issued by the Jeffrey Manufacturing Company, Columbus, Ohio, gives instructions for the care and operation of their direct current electric generators.

The Becker-Brainerd Milling Machine Company, of Hyde Park, Mass., in a small pamphlet briefly describe and nicely illustrate the machine tools in their exhibit at the St. Louis Exposition.

Renold Chain. A small booklet, No. 39, issued by the Link-Belt Engineering Company of Philadelphia, describes the construction and operation of this chain and shows a number of applications to machine tools, etc.

Shapers.—Gould & Eberhardt, in a new catalog B very completely describe and illustrate the various shapers and attachments made by them, and present several examples showing the practical utility of their shapers for handling odd and irregular shaped work.

Brill Semi-Convertible Car.—In this pamphlet, issued by the J. G. Brill Company of Philadelphia, Pa., the various semi-convertible systems are compared and the operation and details of the Brill type are very completely described.

Cold Saw Cutting Off Machines.—The Newton Machine Tool Works of Philadelphia, Pa. in catalog No. 39, describe and illustrate the various types of these saws made by them. Several interesting motor applications are shown.

Tools and Supplies.—Catalog No. 105, issued by the Chandler & Farquhar Company, Boston, Mass., shows the various tools and supplies handled by them for machinists, blacksmiths, amateurs and all kinds of metal workers.

Oldsmobile Railroad Inspection Car.—These cars, which are driven by gasoline engines and are designed for use on both steam and electric roads, are very completely described in catalogue No. 112, issued by the Railway Appliances Company, Old Colony Building, Chicago.

Electric Heaters.—The Consolidated Car Heating Company have issued catalogue No. 8, which describes the various types of electric heaters made by them for use in cars, and presents some interesting information on the cost of electric heating. These heaters can also be used for house or office heating.

Economizers.—The B. F. Sturtevant Company, Hyde Park, Mass. have just issued a new catalog which describes in detail the Sturtevant Standard and Pony types of economizers and compares them with other makes. It also treats of the subject of mechanical and natural draft and is of interest to all steam users.

Gisholt Tools.—The Gisholt Machine Tool Company, Madison, Wis., have issued a set of bulletins describing some of their machine tools. With these is a neat binder, so arranged that future bulletins, which will be issued from time to time, can be placed in it and preserved.

Allfree-Hubbell Locomotive.—A pamphlet which thoroughly describes and presents the claims for the adoption of this improvement to the ordinary Stephenson valve gear has just been received. This improved system of steam distribution is being tested on several roads with promise of interesting results. Copies of the catalogue can be obtained from the Locomotive Appliance Company, Chemical Building, St. Louis, Mo.

The Sargent Gas Engine.—The details and operation of this complete expansion gas engine are very attractively described in a pamphlet issued by the Wellman-Seaver-Morgan Company of Cleveland, Ohio. They also announce that they have secured the exclusive right to manufacture and sell this engine.

Jeffrey Water Elevators—A small pamphlet issued by The Jeffrey Manufacturing Company, Columbus, Ohio, illustrates a number of water elevators of the chain bucket type, for horse, steam or gasoline power. They operate in wells or for irrigation or drainage works and will lift muddy as well as clear water.

Grinding Machines.—The Norton Grinding Company, Worcester, Mass., have just sent out a catalog which describes their various grinding machines. One of these is a 18 in. and 30 by 96-in. gap machine designed especially for locomotive work. A number of interesting illustrations are given showing samples of work done on these machines with the time required for finishing them.

Inspirators.—In a small pamphlet the Hancock Inspirator Company, 87 Liberty street, New York, call attention to inspirator type E, which in their latest production. In addition to the description of the inspirator it contains an interesting diagram showing maximum and minimum capacities of feed water with different size nozzles and tubes.

Concrete Construction.—The Engineering Company of America, with offices at 74 Broadway, New York, have just issued an attractive booklet on this subject. It explains what concrete is, mentions its various uses, treats on concrete reinforced with steel, and calls special attention to its superiority as a fire-resisting material and as a protection to steel against corrosion.

The American Locomotive Company has just issued a 44-page pamphlet describing its exhibit at the St. Louis Exposition. This exhibit consists of twelve locomotives, which represent the present tendencies of American design, and which include two pioneer engines, one the four-cylinder balanced-compound, built for the New York Central, and the other the four-cylinder articulated-compound, built for the Baltimore & Ohio.

Balanced Valves.—The American Balanced Valve Company have just issued two very interesting booklets, one on the Jack Wilson balanced high-pressure valve with double admission and double exhaust and the other on the American semi-plug piston valve which is perfectly balanced. The latter describes an extensive test of one of the piston valves extending over a period of thirty-four months. The locomotive in that time ran 91,341 miles and the valves when removed in order to exhibit them at St. Louis were in good condition.

Machine Tool Drive.—The Westinghouse Electric & Manufacturing Company, of Pittsburg, have issued an interesting and attractive 42-page booklet on machine tool drives. The relative advantages of the mechanical drive, the group drive and the individual motor drive are considered at length, and the various electrical systems, including the alternating current and the three and four wire direct-current systems are described and compared. The book is profusely illustrated with half-tones showing motor applications to machine tools.

The Book of the Four Powers.—This book, which is really a work of art, is handsomely illustrated and is published by the department of publicity of the Allis-Chalmers Company under the direction of Mr. Arthur Warren. The four powers are steam, gas, water and electricity and these briefly outline in a characteristic way the scope of the Allis-Chalmers manufactures. This company has six large plants employing 10,000 men and more than 23,000 large freight cars were required to transport last year's output.

Soft Water.—This is the title of an interesting and handsome pamphlet issued by the Kennicott Water Softener Company, Railway Exchange, Chicago, which contains a paper on "Water Softening on the Union Pacific Railroad," by A. K. Shurtleff, assistant engineer of that road. The Union Pacific Railroad has 36 Kennicott water softeners in operation with a total treating capacity of 3,000,000 gallons per day. The paper considers the beneficial results caused by the use of soft water and gives some interesting figures on the cost of treating the water at the various installations.

Transparent Locomotive Chart.—The locomotive transparency with all the parts named which was issued by *Railway and Locomotive Engineering* a number of years ago, will be remembered by all those who were fortunate enough to secure copies. This unique and valuable work has been brought up to date in a new and equally excellent drawing of the same character, illustrating a modern Atlantic type locomotive with piston valves. Every important part is numbered in the drawing and a list of the names appears in the margin. Copies may be had by addressing the Angus Sinclair Company, 174 Broadway, New York; price, 25 cents.

NOTES.

The Walter A. Zelnicker Company of St. Louis have a novel paper weight which they will send to those applying on receipt of nineteen cents to cover postage.

The Continuous Rail Joint Company of America, with offices at Newark, N. J., has many novel features in their exhibit at the St. Louis Exposition that are of interest to railroad men.

The Wellman-Seaver-Morgan Company of Cleveland, Ohio will furnish the Wellman-Street cast steel bolster for 800 Norfolk & Western cars. Two hundred of these cars will be 50-ton hoppers with steel underframes to be built at the Roanoke shops, and 600 will be 40-ton box cars with steel underframes to be built by the American Car & Foundry Company at Huntington, W. Va.

At a meeting of the Board of Directors of the Bullock Electric Manufacturing Company, held on July 30, Mr. W. H. Whiteside, general manager of sales of the Allis-Chalmers Company, was appointed general manager of sales of the Bullock Electric Manufacturing Company, and will have entire charge of the sales department of both the Allis-Chalmers and Bullock organizations.

The B. F. Sturtevant Company, Hyde Park, Mass., have just received an order from Joseph Bancroft & Sons Company of Rockford, Del., for two Sturtevant Standard economizers provided with insulated metallic casing for fronts. The Sturtevant Company is just fitting up an emergency hospital for its employes. It will be thoroughly equipped and will be in charge of a medical student and nurse and a local doctor will attend to all surgical cases.

The Allis-Chalmers Company announces that Mr. Roscoe Cornell has been appointed manager of their branch office which has just been opened up at El Paso, Texas. Mr. Cornell, who had formerly been with the Mine & Smelter Company of Denver, is a graduate of the Michigan College of Mines and is well known as a mining and mechanical engineer. Mr. James W. Lyons has resigned as manager of the power department in order to accept a position as consulting engineer of the Elgin Watch Company and to engage in other consulting work with headquarters at Chicago.

Commonwealth Steel Company.—The controlling interest in this company has been acquired by Mr. Clarence Howard, in which he represents a syndicate. The company is capitalized at $1,000,000 and has a monthly capacity of 3,000 tons of open-hearth cast steel. Under the new management the plant will be devoted chiefly to castings used in railroad equipment. Mr. Howard has been elected president of the company.

Locomotive Appliance Company. — The annual meeting of the stockholders of this company, held in St. Louis August 11, resulted in the election of the following directors: Messrs. W. J. McBride, J. J. McCarthy, F. W. Furry, E. B. Lathrop, J. B. Allfree, C. H. Howard, C. A. Thompson, W. C. Squire, I. C. Hubbell, B. F. Hobart and Dr. G. W. Cale, Jr. This company now has the Allfree-Hubbell locomotive in successful operation on six prominent railroads and the records are reported to be satisfactory in speed, hauling capacity and economy of fuel and repairs.

A Mechanical Engineer, with experience in locomotive construction, shop system, management, organization, the handling of men, and the commercial development of interests requiring general management, is open to engagement. Has wide circle of personal railroad acquaintance. Address, T., care Editor of this journal, 140 Nassau street, New York.

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL

OCTOBER, 1904.

CONTENTS.

ECONOMICAL TRAIN OPERATION.

BY G. R. HENDERSON.

Part I.

In the American Engineer of June last appeared a number of letters from operating officials of important American railroads, which were brought out by an inquiry from this journal as to whether the present large locomotives were being overloaded, and asking what speed in their opinion was best suited for heavy and also light traffic, these terms referring to the quantity and not the quality of the business offered for transportation. The replies were in general declarations against overloading; that is, they opposed loading engines in excess of their "efficient rating," as some termed it; also the suggestion to load engines so that an average speed of 15 miles an hour could be made when the business was heavy and a less speed when the traffic was light, was largely agreed to. But here we find a stumbling block. The term "efficient rating," while no doubt meaning just what it says, is a very indefinite and intangible quantity. In fact, how many railway officials can say just what is the efficient rating of a certain locomotive over a specific division of the road? What is it that makes it efficient or inefficient? Ordinarily the safe and prompt delivery of freight or passengers is considered a mark of efficiency; but is not the latter strictly a relative term? What is prompt delivery for grain or merchandise would not be considered for a stock shipment, which must reach Kansas City or Chicago in time for a certain market. This feature of the business practically defines the necessary speed of stock trains, and also citrous fruits, but for ordinary merchandise, grain, coal or ore, there must be some method of operation which is more efficient than any other schedule that can be proposed. This is what we should term an efficient rating; but even here the efficiency may refer to the cost of operation or to the quantity of material moved, for instance, in a month. It may also occur that the most efficient rating, from a standpoint of cost, will also afford a schedule that will permit the greatest ton-mile movement in a month; or, the two phases of maximum efficiency may not be coincident. As this is one of the most important problems submitted to operating officials, we will endeavor in these articles to make clear how this matter can be studied practically, and the most efficient schedule and rating of an engine over a division discussed, both as regards cost of operation and amount of business handled.

OPERATING CHARGES.

In the first place, we must consider what operating charges are involved in the question under consideration. It is plain that such items as superintendence, maintenance of bridges and buildings, terminal handling of freight, etc., will not be affected in the least by the train loads assigned to the engines; also, that maintenance of track, switching charges, etc., will but slightly reflect changes in the rating of locomotives. The items that are immediately concerned in this problem may be grouped into three classes, viz.: Supplies, repairs and service. The following table gives the percentage of these items of the total operating expenses on an important overland railroad:

		Per cent.
	SUPPLIES.	
a.	Fuel for locomotives	8.20
b.	Water, oil, waste and miscellaneous supplies for locomotives	1.20
c.	Train supplies	1.30
	REPAIRS.	
d.	Repairs and renewals to locomotives	8.00
e.	Repairs and renewals to cars (freight)	5.30
	SERVICE.	
f.	Wages of engineers and firemen	7.00
g.	Wages of train men	4.50
h.	Wages of roundhouse men	1.00
	Total	36.50

In round numbers, about one-third of the operating expenses are directly concerned in the freight train movement. No matter how we make up these trains (within reason, of course) the effect on the other two-thirds of the operating expenses will be very slight, and, for our purpose, can be left out of consideration. It should be borne in mind, however, that an improvement or reduction in these expenses of 3 per cent. would only appear as 1 per cent. gained in the total operating charges; nevertheless, the absolute amounts will be undisturbed, and $50 saved is $50 credit in both cases.

In addition to these operating expenses, the capital involved may be represented by interest charges on the locomotive and caboose, and these added to the expenses "a" to "h" will give the total expense of the movement; these interest charges we will designate by "i." We must now determine how to estimate the actual value of the several charges "a" to "i."

a. Fuel for Locomotives.—This is the largest item of expense, and it is also the most difficult to estimate correctly. It is greatly affected by many variables, as the price per ton, the heating value, the grade, the speed and the tonnage hauled, as well as by the proportions and condition of the engine and the skill of the engineer and fireman. The last two items are too indeterminate to consider here; but the others must be studied in their effect upon the economy of fuel. In this analysis the price will be considered as $2 per ton of 2,000 lbs., or $1 per 1,000 lbs., which, probably, is a fair average price in this country, and the grade that of Illinois bituminous, such as was used in some tests made upon the locomotive testing plant of the Chicago & Northwestern Railway several years ago by the author, and upon which tests this argument is based. The engine to be used in slow or general freight should be as heavy as the track and bridges will permit, and for grade work we will select a locomotive of the following general proportions:

CONSOLIDATION LOCOMOTIVE.

Theoretical tractive force	50,000 lbs.
Available tractive force	40,000 lbs.
Diameter of drivers	56 ins.
Area of grate	40 sq. ft.
Weight of engine and tender	150 tons

If we consider that the fireman is able to supply the coal as fast as it is possible to burn it on the grate—that is, at a rate of 200 lbs. per square foot per hour—we find that the engine will consume 200 × 40 = 8,000 lbs. of coal an hour. It is unlikely that an ordinary man could keep up this rate of stoking for a great number of consecutive hours; but in order to obtain the maximum work out of our locomotive we will consider that it is possible to fire at that rate. The maximum available tractive force—that is, at the circumference of the drivers—is 40,000 lbs.; but, as the speed exceeds 10 miles an hour, the boiler will not supply steam enough to follow full stroke, and the lever must be "hooked up" or an earlier cut-off produced. This cut-off must be shortened continually, as the speed increases, reducing the available tractive force, as shown by the line A-B in Fig. 1, where the ordinates represent available tractive force (A. T. F.) and the abscissae speed in miles per hour and revolutions per minute, as designated.

The line A-B is also marked "8,000 lbs. coal per hour," as it represents the maximum capacity of the engine, as governed by the quantity of fuel burned upon the grate. The concentric line marked "6,400 lbs. coal" shows the corresponding speeds and tractive forces for a rate of combustion 0.8 as great as the maximum; so also the lines designated by 4,800, 3,200 and 1,600 lbs. coal show the same data for burning rates of 0.6, 0.4 and 0.2 of the maximum, these curves having been based upon the results of the engine tests above referred to.

If we divide the total coal burned per hour by the speed in miles per hour, we obtain the rate per mile; this has been done and is shown by the dotted lines marked 100, etc., to 800 lbs. per mile. The two sets of line provide us with the means of estimating the quantity of coal burned per mile or per hour for any combination of speed and tractive effort possible within the capacity of the engine; any point selected between these lines is to be interpolated. For example: At 20 miles per hour the maximum available tractice force will be 26,000 lbs., and the coal consumption 8,000 lbs. per hour, or 400 lbs. per mile. At the same speed, but with a tractive force of only 20,000 lbs., the consumption would be 4,800 lbs. an hour or 240 lbs. per mile (as seen by interpolating between the dotted lines). Also with 26,000 lbs. A. T. F. at 16 miles an hour, the rate would be 5,300 lbs. per hour or 330 lbs. per mile.

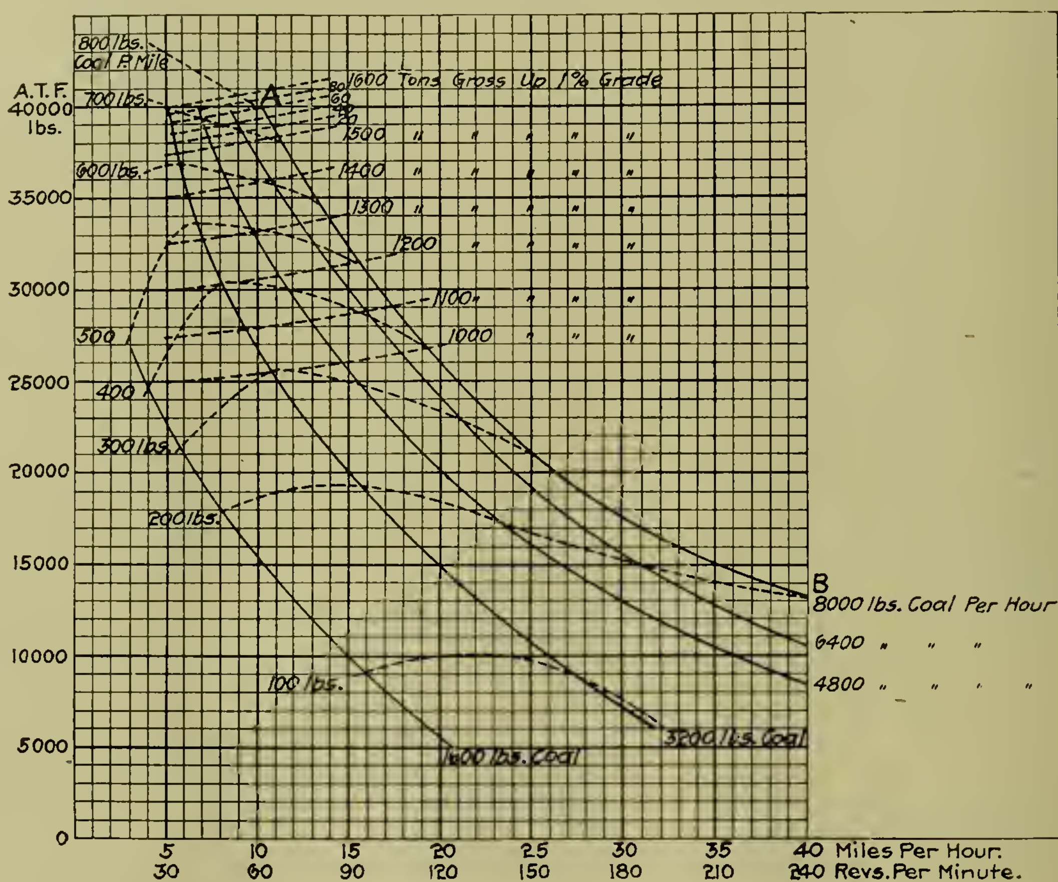


FIG. 1.—COAL CONSUMPTION OF CONSOLIDATION LOCOMOTIVE.—(150 TONS WEIGHT.)

As we can now determine the fuel consumption for any tractive force and speed, we are at once put in possession of the consumption for various speeds, grades and loadings, as the tractive force depends upon these items. If we suppose that the controlling grade is 1 per cent., or 52.8 ft. per mile, we can construct on the same diagram (Fig. 1) additional curves, which will show the tractive force necessary to move various loads at different speeds. Thus a gross weight of train of 1,600 tons at 5 miles an hour up a 1 per cent. grade will require 1,600 × (20 + 5) = 40,000 lbs. A. T. F., and at 10 miles an hour, 1,600 × (20 + 5.5) = 40,800 lbs. A. T. F. We can therefore lay off the broken line marked "1,600 tons gross up 1 per cent. grade." The rest of the broken lines have been constructed in a similar manner, by calculating the total resistance under the different conditions.

From this combination we are able to read off directly the amount of coal required per mile or hour for various weights of train at the different speeds upon the 1 per cent. grade selected as the limit. Of course any other series of curves could be studied. From Fig. 1 we learn that a train of 1,600 tons gross weight could not be drawn up a 1 per cent. grade faster than 5 miles an hour with an expenditure in fuel of 700 lbs. per mile, while a train weighing 1,570 tons (only 30 tons less) could be taken up at 10 miles an hour, but with a coal consumption of 800 lbs. per mile. If we wished to make a speed of 20 miles per hour, our train must be reduced to about 960 tons gross weight, under which conditions 400 lbs. of coal will be burned per mile. It will be noticed that the dotted lines have generally their highest point on the 3,200 lbs. per hour line, which corresponds to a coal combustion of 80 lbs. per sq. ft. of grate per hour, and for any given weight of train, this rate of combustion per hour will indicate the minimum rate of coal per mile. Thus, a 1,500-ton train will use the smallest amount of coal in a given distance on a 1 per cent. grade, when run at about 5½ miles per hour, and a 1,200 ton train when operated at 9 miles an hour. This figure shows at once by simple inspection the "coal efficiency" of different train loads and speeds, but as we have stated, that is only a part of the problem.

b. Water, oil, waste and miscellaneous supplies for locomotives.—We saw in our statement of operating expenses that little over 1 per cent. of the total is consumed by these items, so that they may generally be grouped together without sensible error. While the water used will depend upon the tractive power exerted, the other supplies will be governed almost entirely by the mileage alone, and as water is generally a low-priced commodity, we can figure these supplies as a whole upon a mileage basis. Examination of reports of various railroads indicates that 1.5 cents per engine mile can be taken to cover these items, though in any special case it should be selected to cover the existing conditions, as should all of these hypothetical items. If the water needs treatment, the value should be increased, and if the cost of such treatment be high, it may even be advisable to consider this item separately, and in a similar manner to that of the fuel. As a rule, however, water seldom costs over 5 cents per 1,000 gallons, and as a gallon of water requires, roughly speaking, a pound of coal for its evaporation, at this rate the cost would be only 5 per cent. of that of the coal, and it is very unlikely that it would average anything like that figure for a long division in a country fairly well watered. For this reason we have taken the cost of the engine supplies, with the exception of coal, at 1.5 cents per mile, but where necessary on account of hauling water or from other considerations which raise the cost to an abnormal figure, it may be considered separately, and as a percentage of the cost of fuel.

c. Train Supplies.—This cost will depend partly upon the number of cars in the train, though a large portion will be an absolute charge per train mile. As it is not likely under normal conditions of operation that there would be any very great fluctuations of train loading, we will assume this charge also at 1.5 cents per mile, which we believe is a fair figure for freight trains in this country.

d. Repairs and Renewals to Locomotives.—This item has usually been considered upon an engine mileage basis only, but in recent times the ton mileage basis has come to be favorably considered. It is no doubt true that a combination of both the engine and ton mileage would be the correct method for an accurate analysis of this item, but even then the ordinary variation in cost of repairs is so great between identical engines that it hardly seems worth while to work up an elaborate formula for this purpose. It is also true that a load of 1,000 tons on a 1 per cent. grade is about as severe on an engine as 2,000 tons on a ½ per cent. grade, yet in the first case the ton miles credited to the engine would be only half as great as in the second case, which demonstrates that a unit which considered the actual work done, such as the product of the tractive force and the distance, would be very much nearer the truth; but this unit would also be difficult of practical realization. After due consideration we have concluded that a rate of 8 cents per 1,000 ton miles net would cover repairs and renewals, and while it may be considered by some as too high a figure per engine mile, it must be borne in mind that renewals are also to be included in this amount.

e. Repairs and Renewals to Freight Cars.—This item could probably be omitted from consideration in connection with this subject, as it is supposed that there is a definite amount of traffic to be handled, and consequently a certain amount of car mileage must be made, but in order to estimate our train charges completely, a value will be assigned to it in this discussion. One half cent a car mile is probably a fair average for cost of repairs, and as the average weight of loaded cars is about 33 tons, we have $0.5 \div 33 = .015$ cent per ton mile or 15 cents per 1,000 ton miles, which is the same unit that we have used for locomotive repairs. This is almost double the rate of repairs to the locomotive on the ton mile basis, whereas the percentage of operating expenses was less for cars than for locomotives, but this was taken from the total charges and included light engine mileage, switching, etc., so that a close agreement between the two could not be expected.

f. Wages of Engineers and Firemen.—Owing to the different schedules of pay in existence at various points, this item must be selected in accordance with the rules in force on the division under consideration. In most cases engine men are paid the standard rate for a 100-mile run, even if a smaller distance be covered, so that if a run were 70 or 80 miles long, the pay would be the same as for 100 miles. Special arrangements cover "turn-around" points. In addition to this, some high-grade divisions allow constructive mileage of an arbitrary amount, over and above the real mileage made.

If the run be over 100 miles the men are paid usually for the additional mileage at the same rate. Delays on the road or slow runs are also subject to an extra allowance as overtime, the ordinary regulation being that if the average speed is less than 10 miles an hour between terminals, the pay shall be at the rate of 10 miles an hour. This irregular schedule has a peculiar effect upon the efficiency of a time schedule from a standpoint of wages. Thus a run less than 100 miles results in an excessive cost per mile, and a speed slower than 10 miles an hour produces the same result. If the distance traversed be over 100 miles and the average speed in excess of 10 miles an hour, the rate of pay per mile will be uniform.

In order to proceed with our study the schedule of a prominent Western road is adopted, viz.: Engineers, $4.25 and firemen, $2.75 for 100 miles or less; for runs over 100 miles, 4¼ and 2¾ cents per mile. Overtime to be allowed when the time between terminals is greater than the miles divided by 10 and at the rate of 10 miles an hour or 42.5 and 27.5 cents per hour respectively. In computing overtime, 29 minutes overtime will not be allowed; 30 minutes or more will be considered as one hour; after the first hour of overtime, one mile will be allowed for every 6 minutes additional time made.

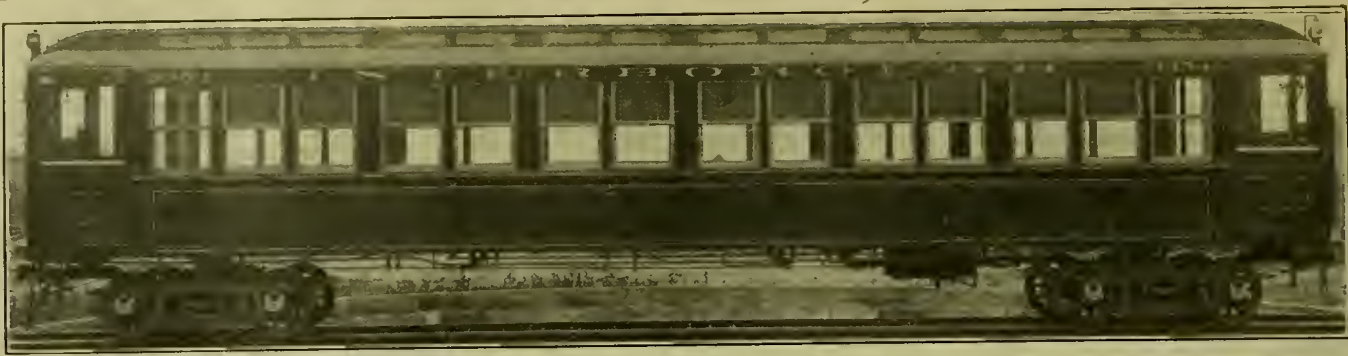
g. Wages of Trainmen.—The road just referred to provides the following wages for trainmen: Freight conductors, $89.70 per month, for 2,600 miles in 26 days; for excess mileage the same rate obtains, viz., 3.45 cents a mile. Overtime is allowed whenever the speed is less than 10 miles an hour, and is computed at the rate of 1 mile for each 6 minutes overtime. Freight brakemen receive $59.80 per month of 2,600 miles in 26 days, or 2.3 cents per mile for excess mileage, overtime being allowed same as for conductors. Thus we find that runs of less than 100 miles in a day or average speeds of less than 10 miles an hour cause excessive charges for service and cannot be considered efficient from a standpoint of wages either as regards the engine crew or the train crew.

h. Wages of Roundhouse Men.—The cost of turning locomotives is practically independent either of the mileage or ton-mileage performed. It includes the cost of cleaning fire and ash-pan, hostling, wiping and firing up. The boiler washing does depend upon the mileage to some extent, but only in a general way. Thus if the water were bad the boiler would be washed out after every trip, whether the division be 100 or 150 miles in length. There are also running repairs to be made every trip or so, such as closing rod brasses, cleaning air brake, grinding check valves, etc., and we propose to cover these charges by allowing $2 for each time that the engine is housed. While this figure may seem high, it represents about the cost of caring for large engines in the Middle West and we do not think that the amount is unreasonable for the size of engine selected for this discussion. If a territory is being computed where labor conditions suggest a reduced figure, it of course should be changed accordingly.

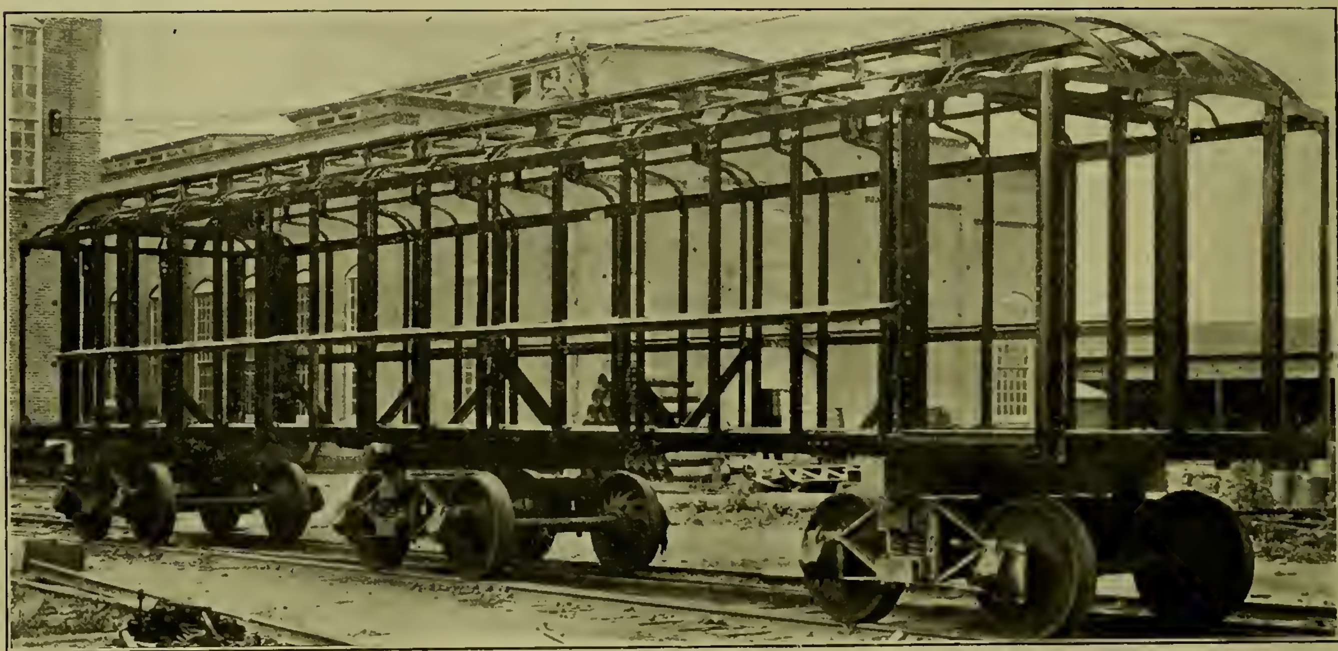
i. Interest Charges.—Interest is not generally considered an operating charge in railroad accounts, but it certainly has an effect upon economical train movement. Locomotives are usually purchased from a fund provided by the sale of stock or bonds, upon which interest is paid, and therefore it is perfectly reasonable to include this account in our study. The same applies to the cabooses or way-cars. Such an engine as we are considering would, with its caboose, represent perhaps an invested capital of $18,000. At 5 per cent. this would mean an interest charge of $900 a year or $\frac{900.00}{360 \times 24} = 10$ cents an hour, and this charge goes on whether the locomotive is working, standing in the roundhouse or on the side track, or is in the shop undergoing repairs. We know that engines are often valued at $10, $20 or perhaps $50 a day for rental purposes; that, however, is an entirely different matter.

(*To be continued.*)

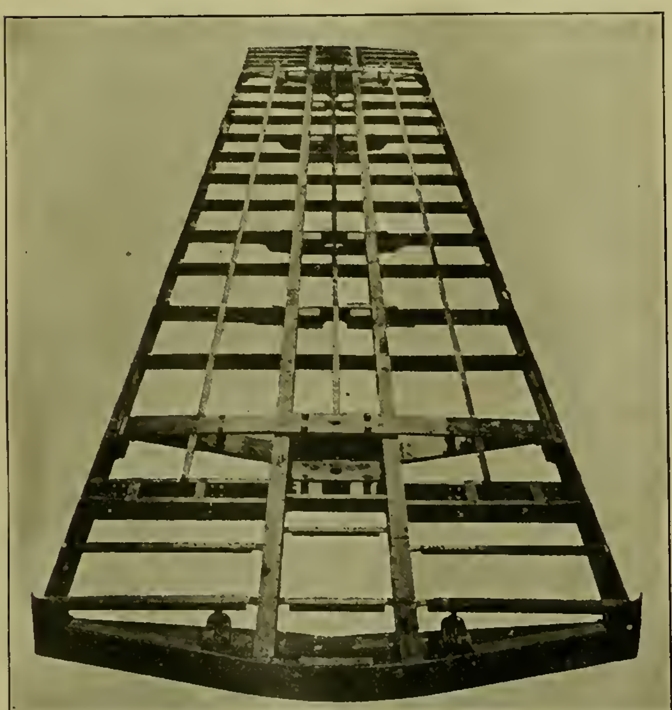
American Success in Machine Tools.—Visiting English mechanical engineers attending the recent convention in Chicago were impressed with one reason for the success of American machine tool builders. It was the fact that many of the builders concentrate their energy and attention upon one form of machine tool and thus are able to carry it to a high state of development. This also favorably affects manufacturing, because in the reproduction of a large number of similar designs the builders can afford to provide facilities which otherwise would not pay for themselves. The advantages of specialization impressed our foreign friends.



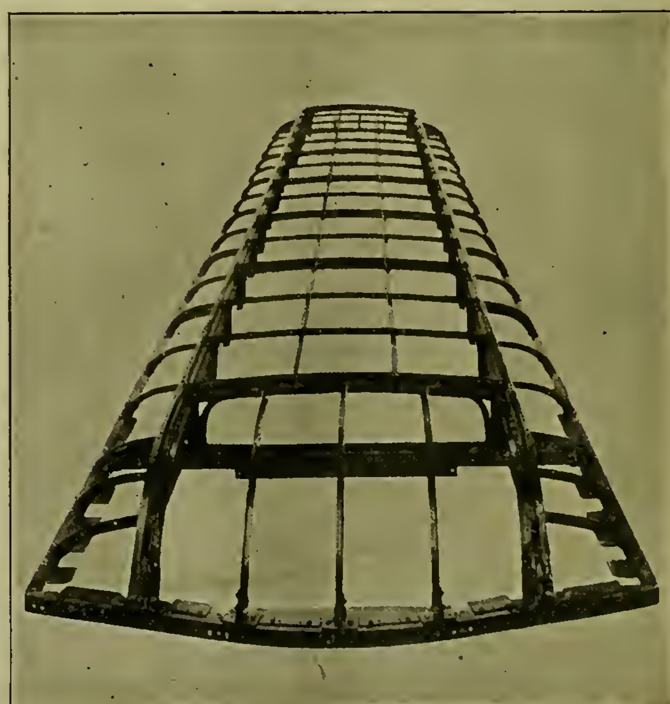
SIDE VIEW OF FINISHED CAR SHOWING ATTRACTIVE APPEARANCE.



FRAMING BEFORE SIDE PLATE IS APPLIED.

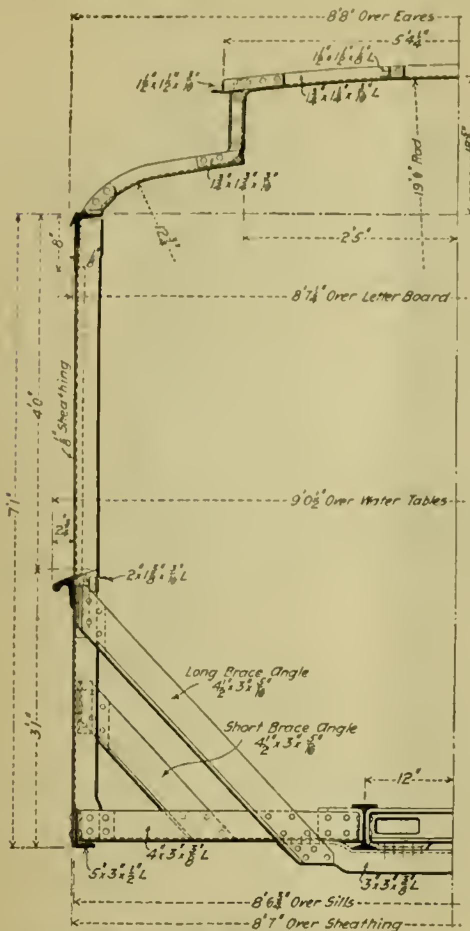


FLOOR FRAMING.



ROOF FRAMING.

FIREPROOF CARS.—NEW YORK SUBWAY.



CROSS SECTION THROUGH FRAMING.

END VIEW.


VIEWS SHOWING THREE STAGES OF FLOOR CONSTRUCTION.

FIREPROOF CARS—NEW YORK SUBWAY.

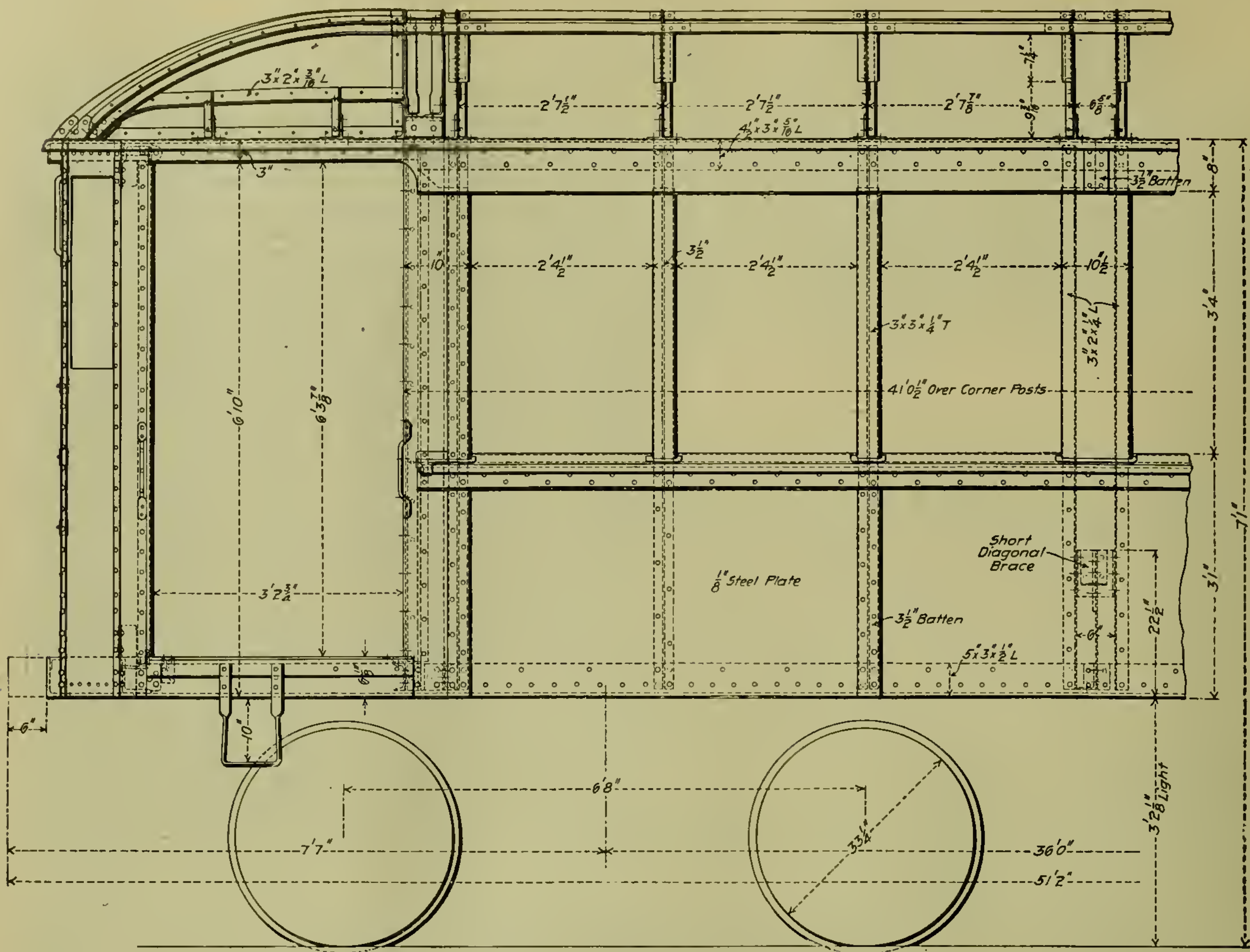
These are the first steel passenger cars ever built. There was no precedent for their construction and the boldness of the design and the responsibility assumed in constructing 300 cars from the first drawings are to be commended. An examination of the cars with a comprehension of the difficulties, including the short time allowed for the design and construction, compels admiration of the work as an engineering undertaking.

It is not difficult to build a passenger car of metal if there are no restrictions of weight and clearance. The problem worked out by Mr. George Gibbs, consulting engineer of the Interborough Rapid Transit Railway, as illustrated in these engravings, however, meets most difficult limitations of both clearance and weight.

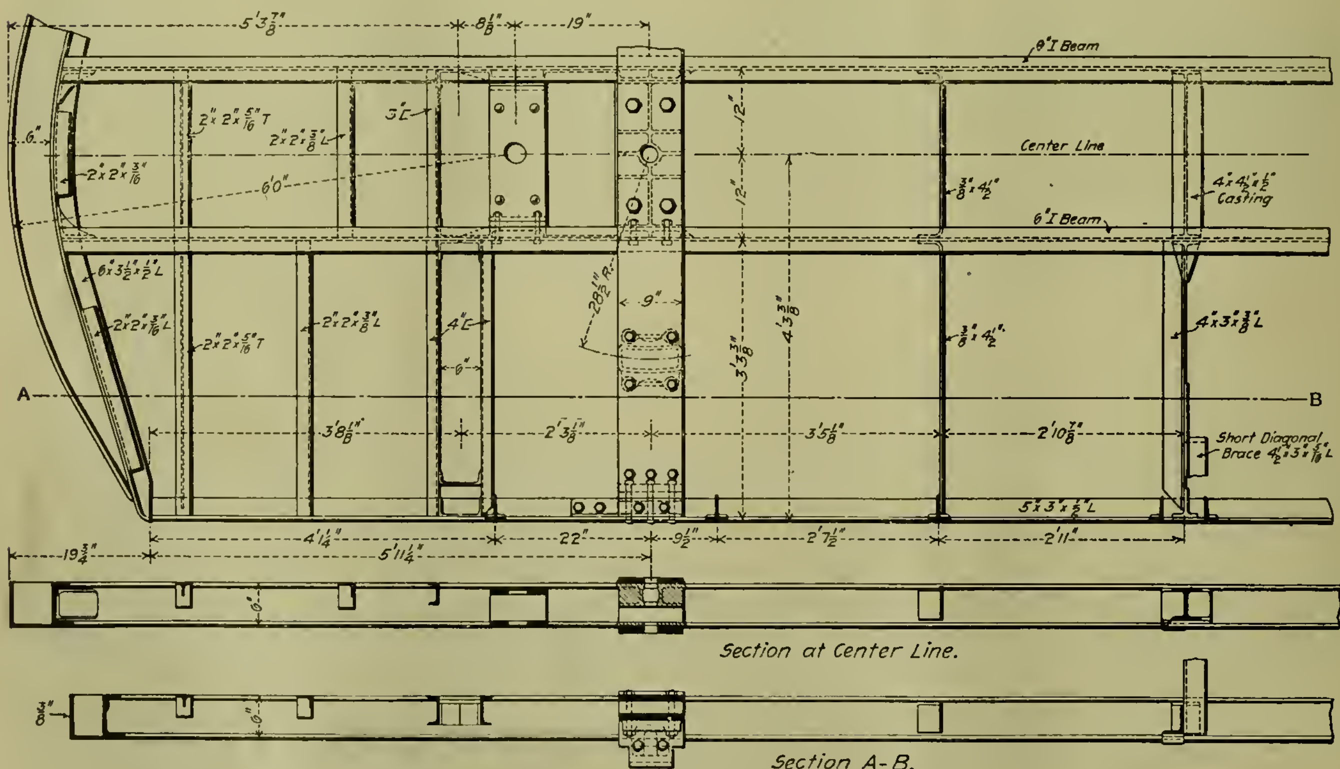
Fireproof construction, low tunnel clearances, a weight not exceeding that of present wooden cars, and stiff, strong construction, which would operate noiselessly, and be satisfactory in cold and hot weather, constituted the problem. Because of the low roof of the subway, it was absolutely necessary to use the minimum possible depth of floor. Because the car must be light the lack of floor depth could not be met by increasing the number of longitudinal sills. Therefore, side girders were used to carry the load. These girders are of ⅛-in. plate, with special bulb angles in the form of belt rails forming the upper flange, while the angle side sills form the lower flange. One of the engravings shows the framing, without the side plate girders, supported on three trucks. Without the plates in place the framing deflects considerably.

Mr. Gibbs guaranteed to produce a steel car without exceeding the weight of the wooden cars, which were illustrated in this journal in March, 1903, page 95. He has practically done so, but found it necessary to depart from the framing of the sample fireproof car illustrated in March, 1904, page 106. That car carried the load chiefly by its floor. The present design has a light superstructure resting in a structure similar to that of a gondola car, with plate side girders carrying the load. From the floor the load is carried to the side by means of cross bearers and diagonal trusses, and incidentally these braces support the side girders laterally, in which direction they are weakest. No truss rods are used, but, obviously, they may be applied if necessary or desirable. One of these cars was loaded with a full standing load and showed a deflection of 1/32-in. at the centers of the sides, showing great stiffness.

Some wood, about 680 lbs., has been used in these cars, because of a delay in securing other material. This wood is all "fireproofed," and in 100 additional cars recently ordered most of it is to be replaced by aluminum castings. It was necessary

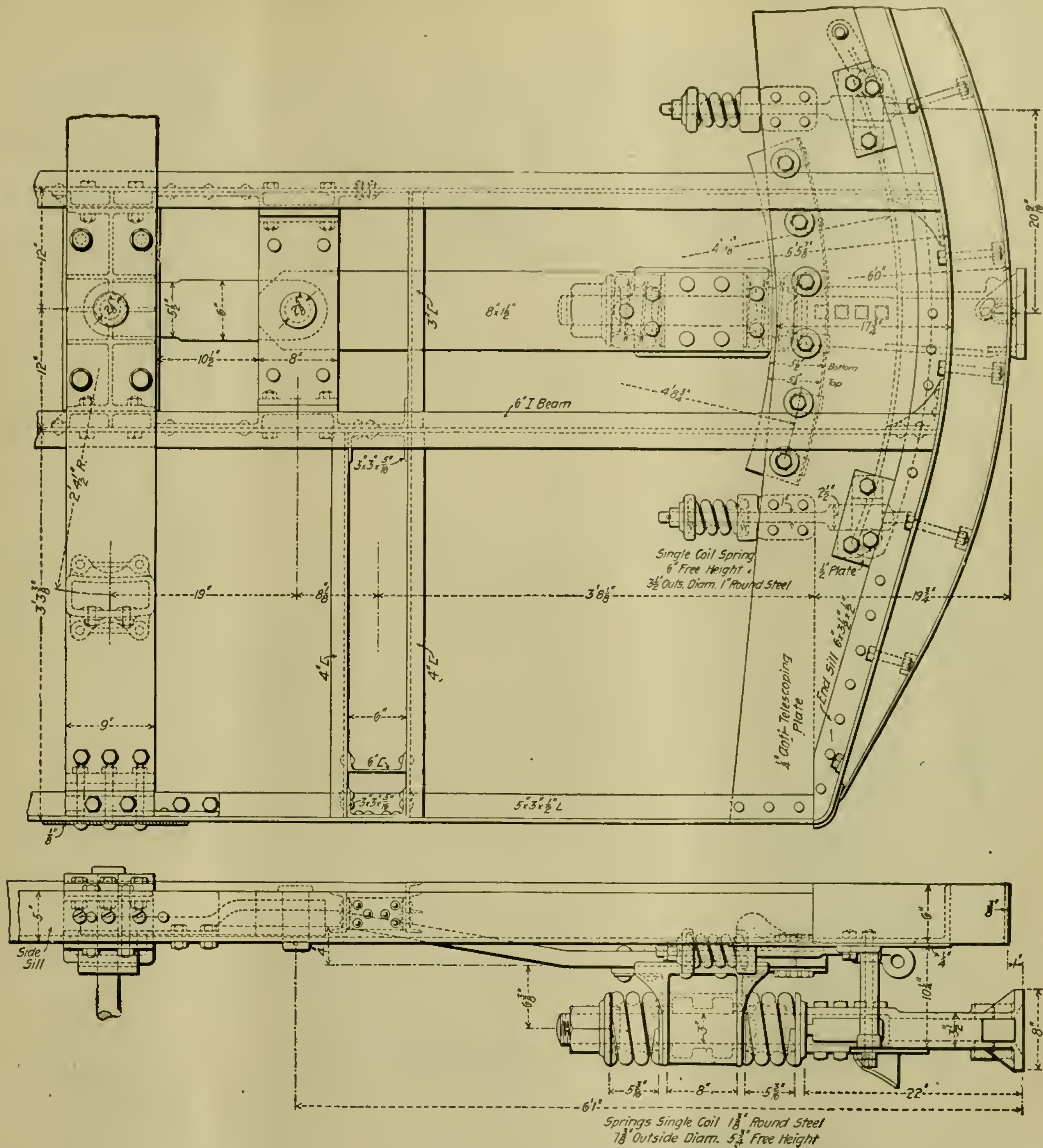


SIDE AND END CONSTRUCTION.

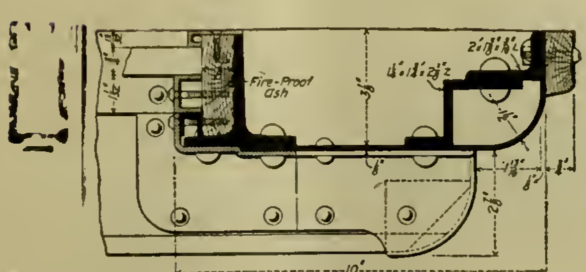


UNDERFRAMING SHOWING BOLSTER AND DRAFT BOLSTER.

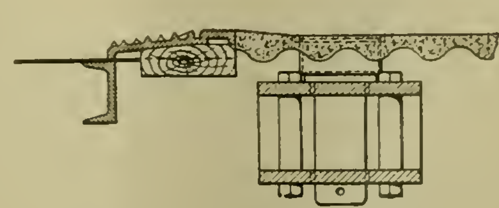
FIREPROOF CARS.—NEW YORK SUBWAY.



DRAFT RIGGING AND PLATFORM FRAMING.

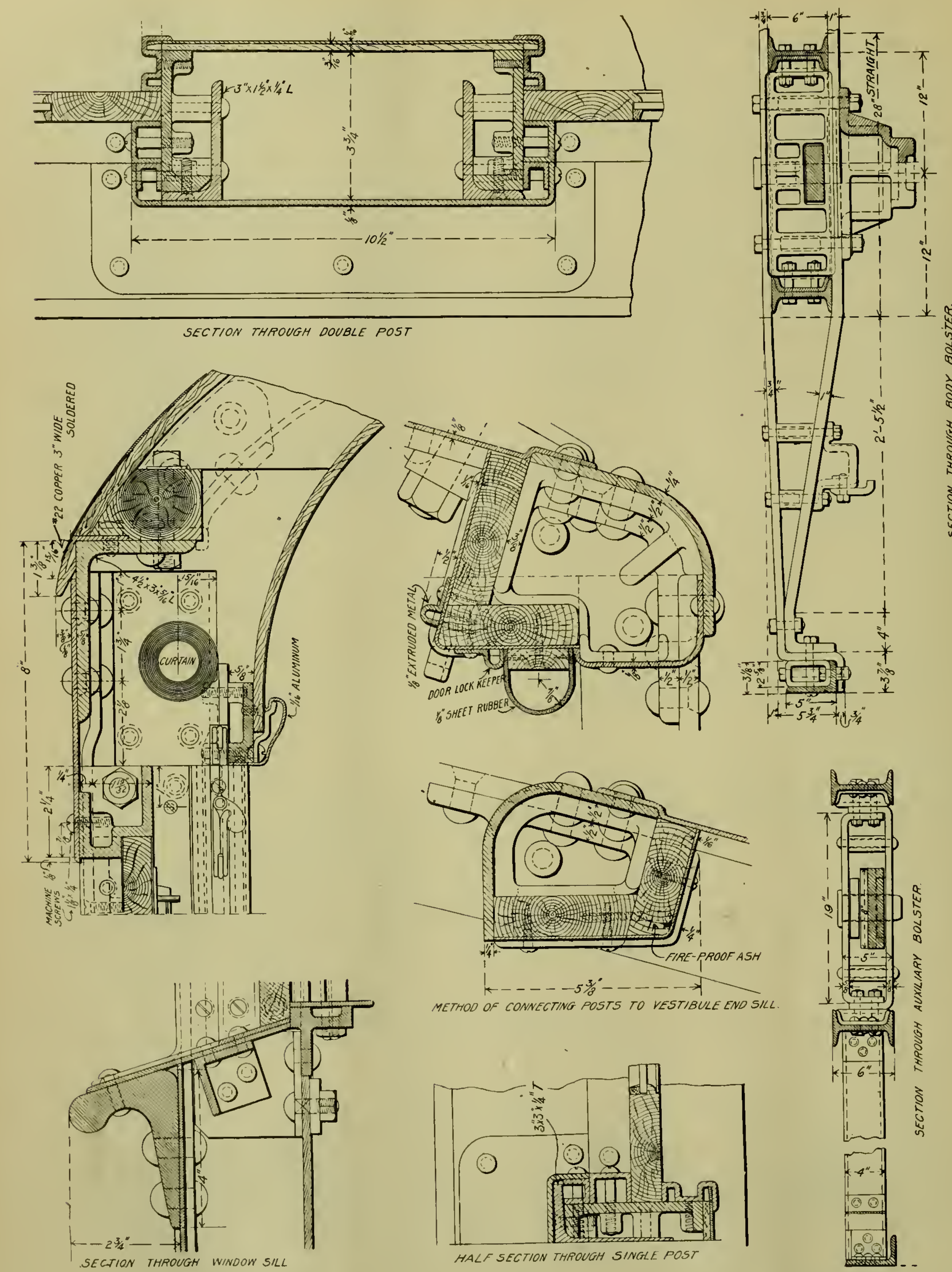


BODY CORNER POST.



SECTION THROUGH FLOORING AND THRESHOLD.

FIREPROOF CARS.—NEW YORK SUBWAY.



DETAILS OF BOLSTERS, POSTS, WINDOW SILL, ETC.
FIREPROOF CARS.—NEW YORK SUBWAY.

to use lining which would deaden sound and resist the transmission of heat, and it was desirable to use metallic interior finish for its moral effect on passengers in case of a panic in which a fire might be feared. As wide a departure as possible from the appearance of a wooden car was sought. Aluminum was decided upon because of its lightness and permanence of finish, and about 900 lbs. of this metal is used in each car. This saved about 1,800 lbs. in weight over construction requiring copper or steel.

The weight of one of the new car bodies is 34,000 lbs. The motor truck weighs 12,240 lbs., and the trailer truck 8,400 lbs. These metal cars are all equipped with motors, each car having one motor truck with two 200 h.p. motors, which are either Westinghouse No. 86 or General Electric No. 64. Local trains are to have 5 cars, 3 of which will be motor cars. Express trains will have 8 cars, 5 of which are motor cars. The equipment will consist of 300 of these new fireproof motor cars and 500 of the wooden cars as illustrated in March, 1903, the general proportion of motors to trailers being as 3 to 2. All the cars are adapted to run either on the elevated or subway lines, and are known as "interchangeable" equipment. The wooden motor cars are gradually to be changed to trailers.

GENERAL DIMENSIONS.

Length over body corner posts	41 ft. ½ in.
Length over buffers	51 ft. 2 ins.
Length over draw bars	51 ft. 5 ins.
Width over side sills	8 ft. 6¾ ins.
Width over side plates	8 ft. 7 ins.
Width over sheathing	8 ft. 7 ins.
Width over eaves of upper deck	5 ft. 7¼ ins.
Width over eaves of lower deck	8 ft. 8 ins.
Width over window sills	9 ft. ½ in.
Width over batteries	8 ft. 7¼ ins.
Width over platform floor	8 ft. 10 ins.
Height under face of sill to top of plate	7 ft. 1 in.
Height under face of center sill to top of roof	8 ft. 9⅞ ins.
Height of rail to top of truck center plate	2 ft. 6 ins.
Height of rail to under face of side sill	3 ft. 2⅛ ins.
Height of rail to top of roof (car light)	12 ft. 0 in.

LIST OF PRINCIPAL STEEL MEMBERS.

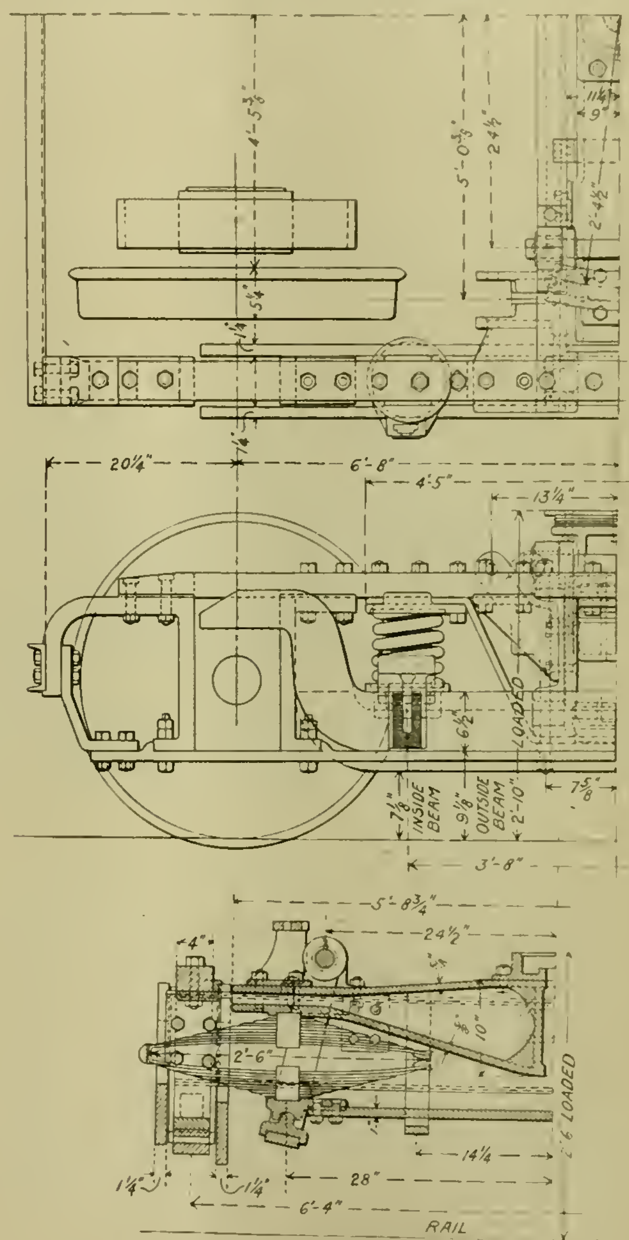
Side sill angles	5 x 3 x ½ in., 12.8 lbs.
Platform end sill angles	6 x 3½ x ½ in., 15.3 lbs.
Side plate angles	4½ x 3 x 5-16 in., 7.7 lbs.
Carline angles	1¾ x 1¼ x 3-16 in., 1.8 lbs.
Purlin angles	1¼ x 1½ x ⅛ in., 13 lbs.
Cross truss, horizontal angles	4 x 3 x ⅜ in., 8.5 lbs.
Cross truss, diagonal	4½ x 3 x 5-16 in., 7.7 lbs.
Window sill angles	1½ x 1½ x 3-16 in., 1.8 lbs.
Wainscot furring angle	2 x 1⅜ x 3-16 in., 2.1 lbs.
Upper deck eaves angle	½ x 1½ x 3-16 in., 1.8 lbs.
Floor support angles	1¼ x 1½ x ⅜ in., 3.4 lbs.
Floor support angles	1¼ x 1¼ x 3-16 in., 1.5 lbs.
Belt rails (bulb angles)	4½ x 2¾ in., special
Center sill T beams	6 ins., 17.25 lbs.
Body end sill channels	4 x 1 21-32 in., 6.25 lbs.
Body end sill channels	3 x 1 39-64 in., 6.0 lbs.
Body end post channels	6 x 1.92 in., 8.0 lbs.
Single post T	3 x 3 x ¼ in., special
Cross truss T	4 x 4 in., 10.9 lbs.
Platform floor T	2 x 2 x ⅜ in., 4.4 lbs.

The side sills are steel angles, the center sills, I beams and the platform end sills, steel angles. The longitudinal sills are continuous the full length of the car, and are secured to the platform and sill by cast steel brackets and a steel anti-telescoping plate under the sills and riveted to them. The body end sills are steel channels, secured by brackets to the side and center sills. The buffer beam is white oak. The body bolsters and short draw bar bolsters are clearly shown in the detail engravings. This portion of the design has been carefully developed through experience with cars now running on the New York elevated lines.

The flooring constituted a specially difficult problem. Its construction in three stages is illustrated from photographs. It begins with galvanized corrugated sheet iron of No. 22 B. & S. gauge, laid across the longitudinal sills and secured to floor angles by rivets. Clips are provided in the corrugated plates to hold the "monolith" fireproof floor, which is finished smooth on top. "Monolith" is a composition extensively used by the Pullman Company, made in proportions of 5½ gals. "monolith," ¾ lb. raw sienna, 1/5 lb. burnt umber, 1/5 lb. Tuscan red, and 37½ lbs. "monolith" cement, all mixed with sufficient hardwood sawdust to give the material the consistency of mortar. This flooring is covered with ash strips for a wearing surface. The platform floors, of ¼-in. steel plate, are covered with rubber matting, cemented, and also secured by large-headed bolts.

The outside roof is of "composite" board covered with canvas, and painted. It is fitted with copper flushing at the eaves. This is secured to carline fillers of fireproofed ash, which are bolted to the carlines. Composite board lining is secured to the under sides of these carline fillers, and to the composite board the final aluminum head-lining is cemented. The aluminum has a scratch brush finish, giving it a frosted appearance. The aluminum moulding for the center light wires finishes over the joints in the plates of the head lining. Composite board is a paper pulp made into a very light and strong material, which will not burn and has the properties of deadening sound and resisting heat conduction.

In the sections showing the window posts the latest development of the design is illustrated. This employs no wood except that of the window sash itself. Both single and double posts are shown. A T is used for the single post, with alum-



MOTOR TRUCK.—NEW YORK SUBWAY CARS.

inum castings fitting the flanges, forming spacing between the sash and furnishing window stops and filling pieces. Outside, the posts finish with pressed steel in channel form, and inside the car the post finish is ⅛-in. aluminum plate over 3/16-in. composite board. A similar construction is used in the double posts, where two angles take the place of the T. In the first cars of the present order the window post construction involved fireproofed wood fillers, which have now given place to the aluminum castings. All interior mouldings and casings for the light wires are of aluminum.

Pressed steel and angles are used for the frames of the transverse seats, and the supports of the longitudinal seats are brackets from the sides of the car and the heater panels. The seats themselves are of rattan on frames of pressed steel. The lower window sashes are stationary and the upper sashes drop when it is necessary to open the windows. The end doors are double, and the side doors of the vestibules are of the Gibbs sliding pattern. Cabs for the motormen are formed by the end doors of the vestibules, which may be swung to enclose the controller and brake devices, placed in another position to form a compartment for the motorman, or made to close the passage between the cars. Each car has 26 10 c.p. incandescent lamps arranged in three rows with 10 lamps on each side and 6 in the center of the roof. With the reflection from the frosted surface of the aluminum headlining the lighting is exceedingly effective. Each car seats 52 persons in 36 longitudinal and 16 cross seats.

MOTOR TRUCKS.

In the following table the chief dimensions of the motor trucks are given:

MOTOR TRUCKS.

Gauge of track	4 ft. 8½ ins.
Distance between backs of wheel flanges	4 ft. 5¾ ins.
Height of center plate above rail with car body loaded with 15,000 lbs.	30 ins.
Wheel base	6 ft. 8 ins.
Weight of truck complete without motors	12,240 lbs.
Weight of one motor on transom	3,000 lbs.
Tongue of one motor on truck transom	3,000 lbs.
Side frames, wrought iron, forged	2½ x 4 ins.
End frames 5-in. channel section	11.5 lbs. per ft.
Pedestals	wrought iron forged
Center transom 10-in. channel section	30 lbs. per ft.
Truck bolster	cast steel
Equalizing bars, wrought iron	1¼ x 6½ ins.
Center plate	cast steel
Spring plank, wrought iron	1 x 3 ins.
Bolster springs, elliptic	30 ins.
Equalizer springs, outside dimensions	4⅞ x 7½ ins.
Wheels, cast steel, spoke center, steel tired	3¾ ins.
Tires, M. C. B. tread	2⅝ x 5¼ ins.
Axles, journals	5 x 9 ins.
Axles, diameter at center	6½ ins.
Journal boxes	malleable iron

These trucks have wrought iron side frames, machined on four sides; the end frames are steel channels, as are also the transoms, the construction being shown in the drawings. The bolsters are of cast steel, with separate center plates and side bearings, and are hung on links. Steel castings are used for the motor suspension, for brake hanger brackets, spring caps, spring seats and brake lever guides. Pennsylvania Railroad specifications are required for the axles. The trailer trucks have wrought iron frames and sandwich bolsters.

These motor trucks are very heavy and strong; they are, in fact, the heaviest and most powerful thus far used under such equipment. The engraving illustrates the construction, but does not show the motors, neither does it convey any idea of the compactness of the design as a whole. In order to facilitate the removal of wheels the outer pedestal is arranged to be easily removed. These trucks have been most carefully designed, as the very large size of the axles will indicate.

These cars are fitted with Westinghouse automatic air brakes throughout, and the motor cars are fitted with Westinghouse motor compressors and electric pump governors, in accordance with the standard of the Interborough Rapid Transit Company. The brake cylinders and auxiliary reservoirs are of the combined type, but differ from those ordinarily employed on steam railway cars in that the auxiliary is arranged so that the triple valve is mounted on the side instead of the end. The brake cylinders are also fitted with the American automatic slack adjuster of the attached type. Each motor car is provided with the Westinghouse multiple electric pump governor valve, a new device that does away with the necessity for balance wire and jumper connections through the train in order to make all the pump governors cut in at the same time for the purpose of equalizing and distributing the load on the motor compressors through the train. With this equipment but one hose connection is made between the cars, in addition to the train pipe which is always used.

SIX-COUPLED PASSENGER LOCOMOTIVE.

BOSTON & MAINE RAILROAD.

The Boston & Maine has received new passenger locomotives of the 4—6—0 type from the Schenectady works of the American Locomotive Company, which have been giving excellent satisfaction during the rush of business to the seashore and mountains of the past summer. They have moderately wide fireboxes, and the chief interest in the design centers in the fact that this is the first example of the use of wide grates over 72-in. wheels by these builders. By bending the mud ring, a fairly deep throat sheet is obtained. These engines have piston valves with inside admission and direct valve motion. While the boiler appears to be high, its center is but 9 ft. 5 ins. above the rails, the diameter of the first ring being 66⅜ ins. In this journal for October, 1900, page 312, a wide firebox engine on the Lehigh Valley having this wheel arrangement was illustrated, the driving wheels being also 72 ins. in diameter. In this case the center of the boiler was 9 ft. 2 ins. above the rails. In the following table the most important dimensions of the Boston & Maine locomotives are presented:

GENERAL DIMENSIONS.

Gauge	4 ft. 8½ ins.
Fuel	bituminous coal
Weight in working order	171,000 lbs.
Weight on drivers	130,000 lbs.
Weight engine and tender in working order	282,400 lbs.
Wheel base, driving	15 ft. 10 ins.
Wheel base, rigid	15 ft. 10 ins.
Wheel base, total	26 ft. 10 ins.
Wheel base, total engine and tender	54 ft. 6⅞ ins.

CYLINDERS.

Diameter of cylinders	20 ins.
Stroke of piston	26 ins.
Horizontal thickness of piston	5½ ins.
Diameter of piston rod	3½ ins.
Kind of piston packing	cast steel
Kind of piston rod packing	U. S. Metallic

VALVES.

Kind of slide valves	piston type
Greatest travel of slide valves	5½ ins.
Outside lap of slide valves	1 in.
Inside clearance of slide valves	⅛ in.
Lead of valves in full gear, line and line in full gear ¼ inch lead at 6 ins. cut off For'd motion	
Kind of valve stem packing	U. S. Metallic

WHEELS, ETC.

Number of driving wheels	6
Diameter of driving wheels outside of tire	72 ins.
Material of driving wheel, centers	cast steel
Thickness of tire	3 ins.
Driving box material	cast steel
Diameter and length of driving journals	9 ins. dia. by 12 ins.
Diameter and length of crank pin journals	6 ins. dia. by 6½ ins.
Diameter and length of main crank pin journals, (main side, 6¾ ins. by 4¾ ins.), F & B 4½ ins. dia. by 4 ins.	
Engine truck, kind	swing motion
Engine truck; journals	6 ins. dia. by 10 ins.
Diameter of engine truck wheels	33 ins.

BOILER.

Style	extended wagon top, radial stay
Outside diameter of first ring	66⅜ ins.
Working pressure	200 lbs.
Thickness of plates in barrel and outside of firebox, 11-16 in. 23-32 in. ¾ in., ½ in., 9-16 in.	
Fire box, length	102¼ ins.
Fire box, width	65¼ ins.
Fire box, depth	front, 72 13-32 ins., back, 51 5-32 ins.
Fire box plates, thickness, sides, ⅜ in., back, ⅜ in., crown ⅜ in., tube sheet ½ in.	
Fire box, water space	4 ins. front, 4 ins. sides, 4 ins. back
Fire box, crown staying	radial
Fire box, stay bolts	Ulster special iron
Tubes, number	336
Tubes, diameter	2 ins.
Tubes, length over tube sheets	15½ ft.
Fire brick, supported on	water tubes
Heating surface, tubes	2631.6 sq. ft.
Heating surface, water tubes	27.3 sq. ft.
Heating surface, fire box	159.6 sq. ft.
Heating surface, total	2818.5 sq. ft.
Grate surface	44 sq. ft.
Grate, style	rocking, in 4 sections
Ash pan, style	sectional, steel plate
Exhaust pipes	single
Exhaust nozzles	4¾ ins., 4⅞ ins. and 5 ins. diameter
Smoke stack, inside diameter	16 ins.
Smoke stack, top above rail	14 ft. 3 11-16 ins.

TENDER.

Style	water bottom
Weight, empty	48,800 lbs.
Wheels, number	8
Wheels, diameter	36 ins.
Journals, diameter and length	5 ins. diameter by 9 ins.
Wheel base	17 ft. 4 ins.
Tender frame	4-10-in. channels
Tender trucks	Fox pressed steel, floating bolster type
Water capacity	5,000 U. S. gallons
Coal capacity	10 tons

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

Editorial Correspondence.

Oxford, England.

To give a fair impression of the shop practice of a foreign railway from such brief visits as I was able to make is not altogether easy. I did not see all the shops, but found a contrast between the best and the worst quite as marked as we have at home.

The railroad shops of England do not present many features which we would wish to adopt. Many of them are old and are full of time-honored machinery, with some good machine tools. The shafting speed appears to be low, but those who conducted the writer about usually did not know the speeds. Concentration of an enormous amount of work in a single shop plant is the rule, and this leads to an aggregation, growing by accretion, scattered over a large area, and exceedingly difficult to supervise. No one seems to worry about shop matters, and in but a single case could the output of the shop be stated without having the figures looked up. A plant sufficient for completely maintaining 3,000 locomotives, building, say, 75 per year, and doing a vast amount of manufacturing, presents a problem which no railroad on our side of the water would dare undertake.

Altoona presents a very great contrast to most of the large plants here. As shops increase in size it becomes very difficult to provide facilities for handling material. Here the locomotive parts, except the boilers, are all light, and while cranes are sometimes provided for wheeling engines and for placing them in the erecting shops, they are not used as we use them for transporting heavy parts.

Piecework is quite common in England. Upon asking whether prices are not sometimes changed, the astonishing reply was: "Oh, yes; we change the prices whenever the men make 1⅓ times their day rates." This fully explained the "navy yard" pace of the shop men. The speed limit is set by the employers, and it is no wonder that repairs are extravagantly expensive, as figures, which I hope to secure permission to print, will show.

The extensive development of the use of milling machines at Crewe has been mentioned in these notes, and is worth mentioning again. So many milling cutters are used as to require a good sized tool room force to make and maintain the cutters. It has already been stated that no new planers are bought for these shops. Planers are decidedly taking a back seat in favor of milling machines. I must again mention the piles of main and side rods milled on profile milling machines by aid of formers. Main rods for Joy valve gear are made with a boss at the center, formed by means of a separate piece bolted on top of the former. Valves are finished complete by special milling cutters. These also cut the grooves at the top of the valves for the valve packing. By keeping these cutters up to standard gauges absolute interchangeability of valves is secured. Side and main rods are completely finished at Crewe by milling machines, and they are ready for the engines. Oil cups on rod ends are made rectangular in section the full width of the rods, and are finished outside by the milling cutters. Crank axles have for years been cut out of the solid by rotary planers, which are really milling machines with discs about 24 ins. in diameter having inserted teeth.

This portion of the correspondence is being written on a fast train on one of the best railroads in Scotland. The "carriage" shakes and trembles enough to entitle the writer to absolution for all the deficiencies of the letter. If those who have nothing but unqualified praise for British track would put it to the test of writing upon a pad held on the knee they would come nearer telling the truth about it. I say, and say again, that English track is not as good as our best. The cars are apt to have a quick side motion.

Attempts to ascertain cutting speeds of tire lathes and other machines were not satisfactory. One thing quite noticeable is the heavy character of the new English machinery seen in various shops. There seems to be plenty of metal about them. While some progress has been made in the application of electric power transmission, there is nothing approaching our best examples of this. At Swindon the new machine shop is electrically-driven, and the generators are driven by three Westinghouse gas engines, the gas being made at the works, and is used throughout for lighting. Gas is frequently used for furnaces. At Crewe gas producers are distributed about the works, and furnaces are fired with gas, made from bituminous coal.

Very few boring mills are used here, though their value is beginning to be appreciated, and there is no question of the superiority of our lathes to those in common use. Wheel lathes are rather light, and it is evident that they will not stand heavy feeds and fast cutting without chattering. Crank axles take up an enormous lot of room in English shops. It is by no means unusual to see a string of eight or ten big lathes working on them and occupying the full length of one side of a long machine shop.

Only in the case of the new shop at Swindon are the machines in anything like as close proximity to the erecting shop as in our recent practice. In the older shops there is almost always a brick wall between the machines and the engines, with an occasional gangway between. With longitudinal tracks in such shops, and these at close centers, it is not convenient to handle material.

Good boilermakers must be plentiful here, for the work in the boiler shops merits admiration. Careful fitting with all holes drilled is the rule. Flanging is invariably done by hydraulic presses and the boilers are designed specially for the use of dies. The relations betweeen the shops and the drafting room are direct and everywhere clearly apparent. One boiler design is made to serve several standard classes of engines. This has been carried out to an admirable extent on the Great Western. Some beautiful work in copper fireboxes with copper stay bolts was seen at Crewe. In riveting staybolts at Crewe a pneumatic hammer is used. It is held in a conical casing in such a way as to give a smooth conical head, being guided as it revolved about the rivet. With this machine all the heads are as perfectly uniform as if headed in a die. The

SIX-COUPLED PASSENGER LOCOMOTIVE.—BOSTON & MAINE RAILROAD.—4—6—0 TYPE.—WIDE FIREBOX OVER 72-IN. DRIVING WHEELS.

finished firebox was a feast for the eyes. The front ends of tubes are not beaded over as we bead them, but are left after expanding. At Crewe steel ferrules are used at the firebox ends. Leaky tubes are not a serious source of trouble here. Most of the engines are not worked hard enough to make anything leak, but the engines which are worked hard are most carefully fixed to prevent cold air from reaching the tube ends, as explained in commenting upon the new Caledonian 4—6—0 engines.

An admirable provision is made for the maintenance of rolling stock by setting aside each year a definite amount in a fund which is available for this work, and is increased from time to time with the increase in the amount and capacity of equipment. This practically provides a depreciation fund for keeping the rolling stock up to a uniform condition of efficiency.

G. M. B.

(To be continued.)

NEW LOCOMOTIVE AND CAR SHOPS.

McKees Rocks, Pa.—Pittsburg & Lake Erie Railroad.

BLACKSMITH SHOP EQUIPMENT.

The construction of the blacksmith shop building was considered in the January issue of this journal, page 24. The arrangement of the equipment, shown in Fig. 1, was very carefully worked out by the master blacksmith, Mr. A. W. McCaslin. The double forges extend along one side of the shop, with their centers about 15 ft. apart and about 15 ft. from the wall, and are placed at an angle of 45 degs. with the side wall. Double forges placed thus are economical as concerns floor space, and are adapted to all classes of work except for locomotive frames (which are handled at the large fires on the other side of the shop), and for furnace work. The foreman sitting at his desk in the office, which is liberally supplied with glass windows, can see practically everything that is being done in the shop.

of the shop is used for storing dies and material. The material racks for bar stock are painted different colors to facilitate keeping the various grades of material in their proper places. A trolley with an air hoist is provided for unloading heavy material. A No. 10 Sturtevant steel pressure blower, with a pulley on one side only driven by a 45 h.p. motor, and the water-closets are placed above the wash and locker room. The main blast pipe passes overhead from the fan and vertical pipes branch off to the forges. The large blast pipe is fitted with safety valves near each end to prevent damage in case of an explosion of gases.

The double forges (see Figs. 2 and 3) are of cast iron, are very compact, complete and durable, and while the first cost is somewhat greater than for the ordinary forge, will require no repairs and will last as long as the shop. A cellar, 12 ins. deep, extends under the entire forge, with the end inclined and projecting 2 ft. beyond the end of the forge. About two days' supply of coal is kept in the cavity under the center of the forge, while the coke is kept in the ends which are partitioned off from the center, and are divided by a removable partition at the middle into two parts, one for soft and one for hard coke. This does away with the usual coal and coke boxes, and allows free access to the forge from both the sides and the end. The outer end of the top of the forge is partitioned off to hold the good slack left when tearing down the fire. The space between the backs of the two forges is occupied by the blast valves and by shelves for holding small tools. The hood and the piece which connects it to the blast pipe are of cast iron. The forges were designed and patented by Mr. McCaslin, and are manufactured by the Monessen Foundry and Machine Company, of Monessen, Pa.

The rather high blast pressure of 14 ozs. is used, and the advantage of this can best be explained by quoting from a paper on "The Ideal Blacksmith Shop," read by Mr. McCaslin before the recent Railroad Master Blacksmiths' convention. "The writer, through experience, has determined to his own satisfaction that any volume that will fully supply each forge with

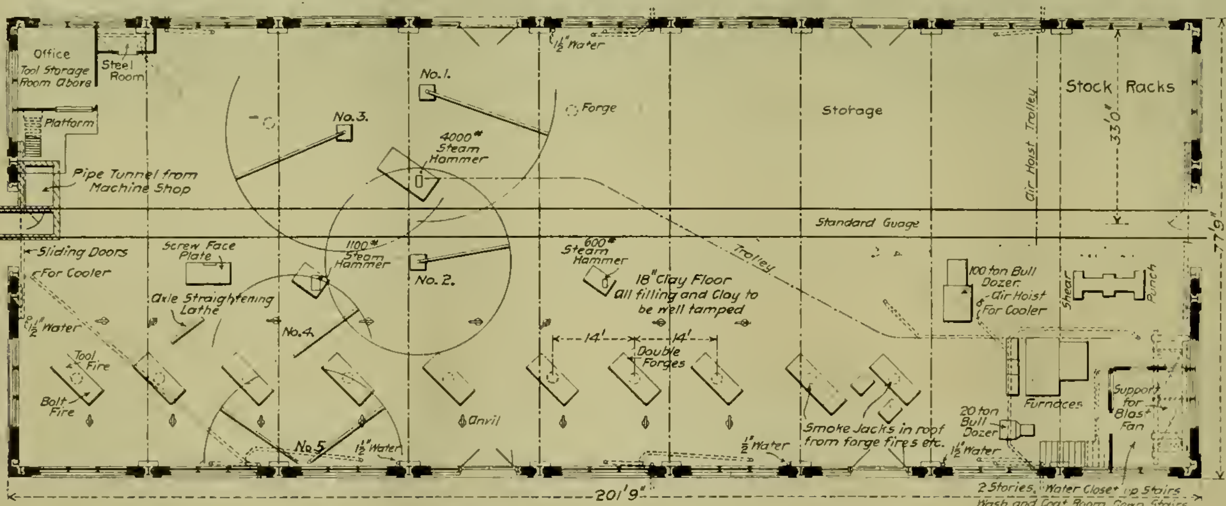


FIG. 1.—BLACKSMITH SHOP LAYOUT.—MCKEES ROCKS SHOPS.

A carefully arranged system of single jib cranes serve the steam hammers, and a double jib crane, No. 5, serves two of the forge fires used for heavy work. Three steam hammers are provided; a 4,000-lb. and a 600-lb., made by the Chambersburg Engineering Company, and a 1,100-lb., made by Bement, Miles & Co. Two large circular fires near cranes Nos. 1 and 3 are used for heating heavy work for the 4,000-lb. hammer. Two small coke furnaces are built in the double forge to the left of the small bull-dozer, and are used to heat small and short work for the bull-dozers. The pneumatic bull-dozers, a 20-ton and a 100-ton, were designed by Mr. McCaslin and built at the shops, and are used for forging anything from a bolt head or handhold to a wrecking chain hook or heavy arch bar. The furnaces between the bull-dozers are used for case-hardening and for heating heavy material, a trolley extending from this point to the large steam hammers. The large punch and shear is a Hilles & Jones No. 4, motor driven. Half of the opposite side

a constant pressure from 14 to 16 ozs. through an upright opening in the tuyere equal in area to 2 or 2½ sq. ins. is about the proper thing for railroad smith shops, not only in volume but in pressure as well. Seven ounces of blast pressure, no matter what the volume, will not heat iron as rapidly as the iron will absorb heat, consequently with that pressure we do not get a maximum output, while with 14 to 16 ozs., regulated to suit conditions and requirements, every heat unit up to the limit of absorption in the iron can be utilized, and the earnings of the employer, also the piece worker, increased, and the worry of the honest day worker through the change from unfavorable to favorable conditions greatly lessened. For ordinary work in the railway smith shop the tuyere should be at least 10 ins. below the top of the forge. With this depth and the fire prepared with fine wet slack well tamped around a stake the fire will, with possibly the throwing out now and then of a small clinker, last from 7 o'clock a. m. until noon, and the slag and clinkers do not drop down and clog it as they will at a less depth; besides, we have a body of fuel below the iron sufficient to produce and continue to produce the necessary heat for the best results, and lessen the demand for a new fire at 9.30 a. m. and 3.30 p. m."

The anvils are placed on portable cast iron stands so that the smith can shift or turn the anvil to suit his work. Continuous wrought iron brackets or supports are placed along the side

FIG. 3.—CAST IRON DOUBLE FORGES.

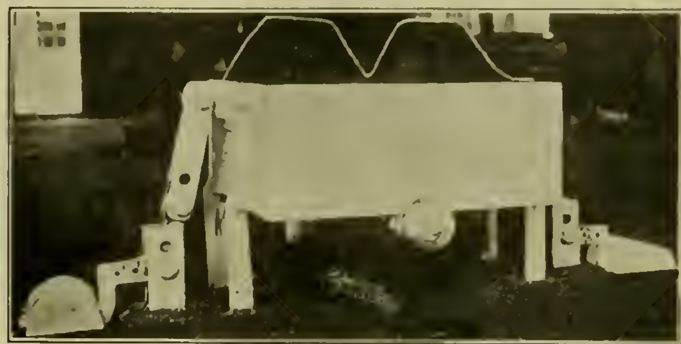


FIG. 4.—DROP FIRE FOR LOCOMOTIVE FRAMES.

FIG. 2.—BLACKSMITH SHOP.—MC KEES ROCKS SHOPS.

wall nearest the forges to hold the tools. The water tubs are made of cast iron, and are let down nearly level with the floor-line. In Fig. 4 is shown a unique forge, designed by Mr. McCaslin, for heating locomotive frames. With an ordinary forge it is necessary to either raise the heavy frame out of the fire or to swing it to one side, and thus disarrange the fire so that it is necessary to build it up again before another heat can be taken. With this special forge it is only necessary to shut off the blast, disconnect the pipe by means of a slip joint and raise the large counterweights, which causes the fire to drop 12 ins., the box being guided by the upright posts, which fit in slides on the ends of the box. This leaves the fire in good condition, ready for another heat.

One very noticeable feature of the shop is the good light and the entire absence of smoke or gas. The stacks from the forges are about 22 ins. in diameter at the hood, extend 12 or 15 ft. above the roof and create such a strong draft that the smoke is all carried off.

This shop does all the smith work for the locomotive department, which is at present repairing about 17 engines per month, and for the car department, which takes care of over 12,000 cars. While it may appear small for this amount of work, yet, due to the way the work is handled and to the labor and time-saving devices which have been introduced, the number of workmen employed has increased very little over what it was ten years ago, although the amount of work has increased several times. The shop is not equipped for making bolts on a large scale.

EFFECTIVE USE OF "THE AMERICAN ENGINEER."

A well known superintendent of motive power sent to the editor of this journal a copy of a letter written by him to four of his subordinate officials, which reads as follows:

"I am mailing you a copy of the American Engineer and Railroad Journal which contains some marked articles which I would like you to read. Please study particularly the article by Mr. Jacobs on page 333, on the subject of High Speed Steel in Railroad Shops. It appears to me that every one else is doing better with high-speed steel than we are, and I think there should be a general speeding up of all our tools where high-speed steel is used.

"The article on page 331, entitled Piece Work, by Mr. L. G. Parish, will also interest you. It contains important suggestions which you should note.

"I would also like to call your attention to the marked article on Blue Heat in Boiler Plates, on page 349. Please arrange to make a test and advise me what results you obtain by following the directions of this article.

"I would like a reply stating your opinions on these subjects as applied to our conditions."

The gentleman referred to has applied many improvements in his department by systematically following this plan of interesting his assistants in the practice of other railroads as described by the technical press, and has led them to develop many adopted as well as original ideas by this method.

PISTON VALVES WITH RELIEF PLATES.

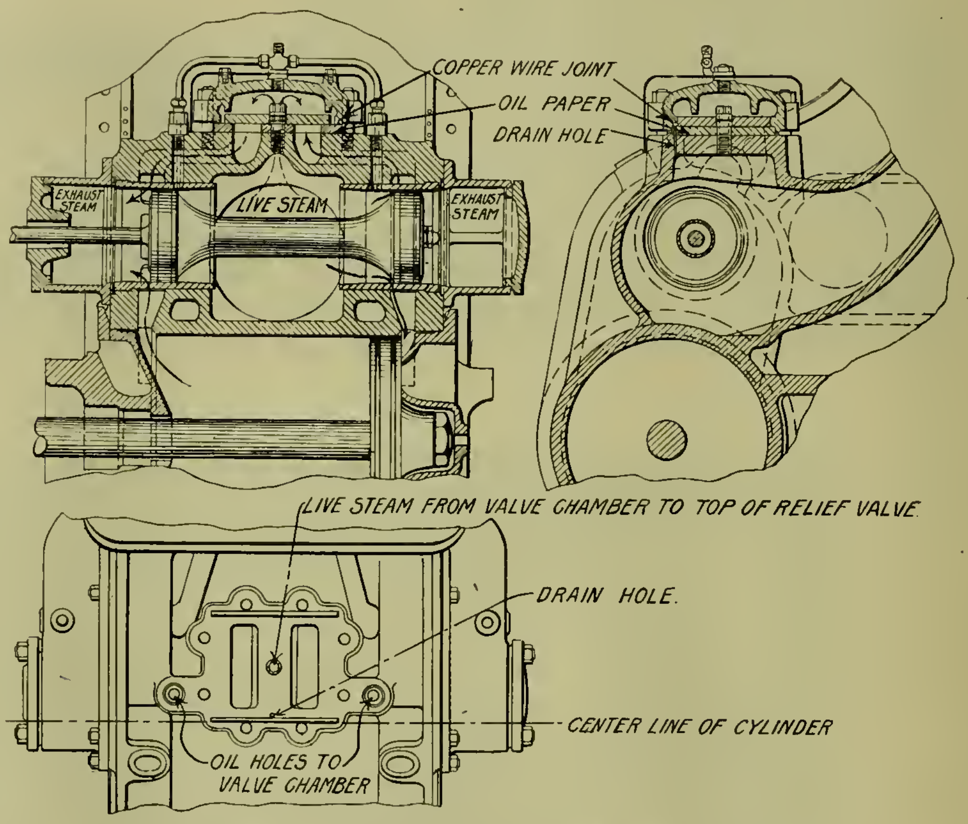
PENNSYLVANIA RAILROAD.

The most recent design of locomotives on the Pennsylvania Railroad is Class B-6, for switching service, and the first of the class was built at Altoona for the Pennsylvania Lines West of Pittsburg. It is the heaviest locomotive for this service carried on six driving wheels, and has 22x24 in. cylinders, 56-in. driving wheels, and weighs 170,000 lbs., or 28,333 lbs. per wheel. The total heating surface is 2,495 sq. ft. The boiler has 325 2-in. tubes, 13 ft. 10 in. long, and the grate area is 41 2-10 sq. ft. The boiler is 74½ in. in diameter at the largest ring. The boiler pressure is 205 lbs. and the tractive effort 36,200 lbs.

The most interesting feature of this engine is the construction of the piston valves, which, while not entirely new, are specially noteworthy because they provide for relief of water and for the compression of drifting, after the manner of the ordinary slide valve. The admission is at the center of the valve, and the eccentrics are reversed.

The construction of this valve and the steam chest is shown in the accompanying diagram, which illustrates all of the parts in position. The valve travels in short bushings, as usual. In the upper part of the steam chest cored passages lead from the steam ports upward, opening under a flat plate, which is set on the ground joint on top of the steam chest. A bonnet covers this plate and prevents leakage of steam to the outside. The steam chest pressure is brought on top of the plate through a hollow stud fastening through the center of the plate. This stud also prevents fore and aft motion of the plate. A separate drain passage at the lower level prevents the accumulation of water in the relief plate chest.

The ports under the plate are 9 x 3 ins. in size, and the lift of the plate is ⅛ in. against stops, which project downward from the bonnet. In drifting this plate is lifted and held away from the seat, owing to the reduced pressure in the space above the valve, this space being in communication with the steam admission passage leading to the cylinder.



PISTON VALVE WITH RELIEF PLATES.—PENNSYLVANIA RAILROAD.

This form of valve was used experimentally by Mr. J. B. Henney when superintendent of motive power of the New York & New England Railroad, Mr. Henney's first drawing being dated August 24, 1888. He used a 5½-in. piston valve, which was applied in a steam chest of a locomotive which formerly had slide valves. In a later experiment he employed two 6½-in. piston valves side by side, and doubtless the experiment would have been more successful had he used larger valves. Mr. Henney used the arrangement of relief plates, from which the construction here illustrated was adopted.

While a switching locomotive does not offer the best test of such a relief arrangement, in drifting, this construction has proven very satisfactory in this service, and is looked upon as a promising improvement over the separate relief valves which are usually employed in connection with piston valves.

TRAVELING ENGINEERS' CONVENTION.

The twelfth annual meeting of the Traveling Engineers' Association was held in Chicago, September 13, with a large attendance, Vice-President J. D. Benjamin presiding. The opening address emphasized the importance of the cost of fuel and lubrication, and engine failures as present live questions. "The Future Engineer" was the subject of a paper by Mr. E. R. Webb. It brought out a general discussion on organization and discipline, leading to the conclusion that engineers and firemen should be hired by the traveling engineer, and that good men can be retained in the service by encouragement, education and improvement of the conditions under which they work. A discussion of progressive examinations of engineers and firemen developed strong support of the examination idea. Water tubes in fireboxes received interested attention. Those having bad waters spoke unfavorably, while others favored them (as supports for brick arches). The discussion led to a resolution to the effect that arch tubes offered an opportunity to improve economy when conditions permitted their use. Mr. Ira C. Hubbell read a paper entitled, "Valve Motion: Its Relation to Steam Economy." The discussion brought out reports of excellent performance of the Alfree-Hubbell valve gear. As an argument for more attention to valve gear, Mr. Hubbell pointed to the expense of $123,000,000 for coal for American railroads for the year ending June 30, 1902. The high-speed brake was discussed by aid of a paper by Mr. L. M. Carlton, which outlined the new problems of braking with increased pressure. Wheel sliding was one of these. A paper on headlights by Mr. A. L. Beardsley brought out favorable opinions of electric headlights. The discussion chiefly concerned the location and care of headlights and the location of the turbines. Among the valuable features of the convention was a paper on the "Baldwin Balanced Compound Locomotives" by Mr. M. Carroll, followed by an interesting address on the same subject by Mr. S. M. Vauclain, which was illustrated by stereopticon slides. Some of the exhibits at this convention are referred to elsewhere in this issue.

COST OF GAS ENGINE POWER.

It is interesting to note the expense of fuel of a horse-power in a gas engine with the fuels ordinariy used:

FUEL COST PER HORSE-POWER FOR 24 HOURS WITH—

Producer gas from coal at $3 per 2,000 lbs. . . . . .3.5 to 5.5 cents
Producer gas from coke at $4 per 2,000 lbs. . . . . .7.5 to 9 cents
Natural gas (800 B. T. U.) at 25 cents per 1,000 ft. . . . . . . .9 cents
Illuminating gas (600 B. T. U.) at 75 cents per 1,000 ft. . . 36 cents
Gasoline, ⅛ gallon per horse-power, at 16 cents per gallon. . 48 cents
Steam from coal at $3 per 2,000 lbs. .9 cents

(From a pamphlet issued by R. D. Wood & Co., Philadelphia, Pa.)

PERSONALS.

Mr. James W. Hill has resigned as master mechanic of the Peoria & Pekin Union Railway, at Peoria, Ill., after 18 years' service in that position.

Mr. E. N. Gower has been appointed superintendent of motive power of the Gainesville Midland Railroad, with headquarters at Gainesville, Ga.

Mr. E. Jones has been appointed master mechanic of the St. Louis, Iron Mountain & Southern, with headquarters at Baring Cross, Ark.

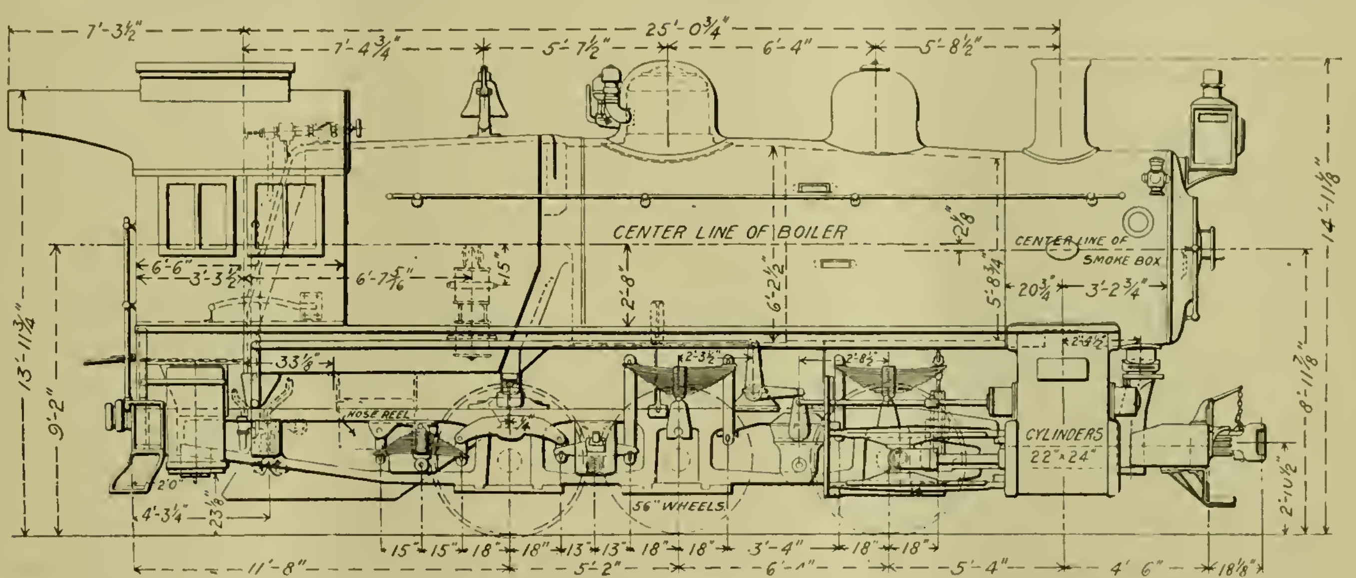
Mr. James Farrell has been appointed acting superintendent of motive power and machinery of the National Railway of Mexico, with headquarters at Laredo, Texas.

Mr. J. N. Borrowdale has been appointed general foreman of the car department of the Illinois Central at Chicago, succeeding Mr. C. D. Pettis, resigned.

Mr. C. B. Cramer, master mechanic of the Charleston shops of the Southern Railway, has been transferred to the shops at Sheffield, Ala., succeeding Mr. G. N. Howson.

Mr. H. T. Herr has resigned as master mechanic of the Norfolk & Western at Roanoke, Va., to accept an appointment as assistant to the vice-president of the Denver & Rio Grande Railroad, with headquarters in Denver, Col. Mr. Herr is assigned to special work in the operating department.

F. D. Adams, veteran master car builder of the Boston & Albany Railroad, died last month at his home in Buffalo at the age of 82 years. His life work was connected with cars, beginning in 1847, when he entered the service of the Norwich Car Company, at Norwich, Conn. In 1853 he went to Buffalo as a contractor in the Buffalo Car Works. His first railroad position was that of master car builder of the Buffalo & Erie in 1859. In 1868 he became superintendent of the Ohio Falls Car Company. In 1870 he went to the Boston & Albany as master car builder, and filled this position until his retirement from active service in 1896. Mr. Adams was a charter member of the Master Car Builders' Association, and was closely associated with it up to last year. He will be greatly missed because of his gentle strength, his faithfulness, and his thorough knowledge of his vocation and his uprightness of character. Mr. Adams performed a marked service for the railroads in the construction and successful operation of very light passenger cars for a period of over 20 years, and yet because of his quiet disposition few knew of this work. It gives an impression of the great progress in transportation to reflect on the fact that Mr. Adams saw the beginnings of railroads in his boyhood.



CLASS B-6 HEAVY SWITCHING ENGINE WITH PISTON VALVES.—PENNSYLVANIA RAILROAD.

Mr. L. P. Ligon has been appointed master mechanic of the eastern division of the Norfolk & Western Railway, with headquarters at Roanoke, Va., to succeed Mr. H. T. Herr, resigned.

Mr. R. W. Burnet has resigned as general foreman of car repairs of the Central Railroad of New Jersey to accept the position of assistant master car builder of the Erie Railroad, with headquarters at Buffalo, N. Y

Mr. L. D. Gillett has been appointed master mechanic of the Pocahontas division of the Norfolk & Western Railway to succeed Mr. L. P. Ligon, and Mr. J. M. Thomas has been appointed general foreman at West Roanoke, Va., to succeed Mr. Gillett.

Mr. C. D. Pettis has resigned as general foreman of the car department of the Illinois Central at Chicago to accept the position of superintendent of the car department of the St. Louis & San Francisco at St. Louis, Mo.

Mr. George W. Seidel has been appointed master mechanic of the Chicago, Rock Island & Pacific Railway, at Horton, Kan. He is succeeded as master mechanic of the Southern Railway at Birmingham, Ala., by Mr. G. N. Howson, transferred from the same road at Sheffield, Ala.

MINIMUM SUBURBAN TRAIN STOPS.

Illinois Central Railroad.

In describing the new suburban service cars on the Illinois Central (American Engineer, September, 1903, page 327) the reduction in the periods of waiting at stations for loading and unloading expected from the side door cars was prominently mentioned. Information recently received from Mr. A. W. Sullivan, assistant second vice-president of the road, indicates that the expectations of the officers have been fully realized. Not only have the cars been operated for a year without costing anything for repairs, but they have furnished absolute protection against personal injury of passengers. The station stops are marvelously short. A recent stop-watch test, made without the knowledge of the trainmen, showed an average of 7.75 seconds for the stops on a heavy run, the minimum being 3 seconds and the maximum 12 seconds.

Even if these cars were very unsatisfactory in other ways, which they are not, this feature of reducing the loss of time at stations for the movement of passengers should entitle the side door principle to the earnest attention of those dealing with crowded suburban service trains.

CORRESPONDENCE.

PACIFIC VS. 2-6-2 TYPE LOCOMOTIVES.

To the Editor:

Your statement in the description of the latest design of 2-6-2 locomotive of the Chicago, Burlington & Quincy Railroad, in your September issue, that "There seems to be no question of the advantages of the type (the 2-6-2) over the Pacific type with a 4-wheel leading truck," appears to the writer to be, both on principle and in view of results in practice, so manifestly correct and well founded that the grounds for the recent comparatively extended adoption of the Pacific type by railroad managers are not easy to see. It is, of course, to be assumed that those who have added locomotives of this type to their equipment have done so for reasons which they found or considered to be good and sufficient ones, and this communication is presented more particularly in the hope of developing an expression of the views of those who advocate the Pacific type, than with a desire to urge the superiority of the 2-6-2.

Whether or not trailing wheels are, in and of themselves, desirable in a road locomotive, need not be here considered, inasmuch as in designs embodying driving wheels of large diameter and a wide firebox, which the logic of facts has demonstrated to be *essentials* in heavy and fast passenger train service, they are absolutely indispensable. Moreover, as they are used, and similarly used, in both the 4-6-2 and the 2-6-2 types, the two are, in this respect, identical, and the question of relative advantage between them depends wholly upon the conditions and requirements obtaining and existing forward of the front driving axle, which are comparatively few and simple. In order to support the weight which overhangs the front driving axle upon a 4-wheel truck, as in the 4-6-2 engine, there must—not necessarily, but upon the accepted lines of American practice—be an increase of wheel base and an increase of boiler length, as compared with the 2-6-2 engine. Is this increase accompanied by a corresponding advantage; if so, in what particulars, and if not, why should it be made?

The 2-6-2 engines of the Lake Shore, class J, and the 4-6-2 engines recently built by the Baldwin Locomotive Works for the Chicago & Alton, may be referred to as fairly representative of the two types under consideration. Assuming the distances from centre of exhaust to centre of front driving axle (67 ins. in the 2-6-2 and 95½ ins. in the 4-6-2) to be the minimum admissible with an 80-in. wheel, we have an increase of wheel base of 28½ ins. in the 4-6-2 engine, and, other things being equal, there would be the same increase of boiler length. While the longer wheel base is of course not, of itself, desirable, it may, for present purposes, be taken as not positively objectionable, and neglected as a factor in the comparison. If the increased boiler length is utilized to provide a corresponding increase of tube heating surface, steam room and weight available by adhesion, it would, in these regards, constitute an element of advantage of the 4-6-2 over the 2-6-2 type, but such possible advantage cannot, in the first place, be made fully available, by reason of what are, or are believed to be, the limitations of practicable tube length, and for this, or for some other reason not apparent, it has not been fully availed of in the Chicago & Alton and other engines of the 4-6-2 type.

The distance from centre of exhaust to front tube sheet is, in the Lake Shore 2-6-2 engine, 36 ins., and might be shorter if desired, being 29 and 30 ins., respectively, in other large engines of the same type. The tubes are 19 ft. long. In the Chicago & Alton engines this distance is 55 ins., and the tubes are 20 ft. long. It will therefore be seen that 19 of the 28½ ins. of extra boiler length are not utilized for steam generating purposes, and act, without apparent advantage and possibly with disadvantage, to increase the volume of an already large smokebox. Briefly stated, the 28½ ins. of increased wheel base of the 4-6-2 engine attains no positive advantage, and two-thirds of the increased boiler length is either useless or unutilized.

If such increase of steaming capacity as is resultant upon the use of 20-ft. tubes is deemed desirable, it can be provided in a 2-6-2 as readily as in a 4-6-2 locomotive and without involving undesirable increase of wheel base, useless expansion of smokebox volume, or variation from standard or existing draught appliances. It is therefore the opinion of the writer not only that all the advantages of the 4-6-2 type are fully attainable in the 2-6-2, but also that the latter, as to the features of shorter wheel base and simpler and less expensive construction, possesses positive advantages over the former.

There remains, or it may perhaps be contended, there should be first considered, the question of the relative merit of a 2 and a 4-wheeled truck, and this is one which cannot be fully discussed within the permissible limits of this communication. As stated in your article on the Chicago, Burlington & Quincy locomotives, "This road has a long and very satisfactory experience with 2-wheel leading trucks," and this statement may be made with equal correctness as to various other roads, particularly the Lake Shore and Philadelphia & Reading. The 2-4-2 engines of the latter road have been operating trains between Philadelphia and Jersey City at exceptionally high speeds for a number of years, and have done so as safely and as satisfactorily as engines having 4-wheel trucks in the same service. In view of the present extended use, at high speeds, of 2-wheel leading trucks, railroad managers cannot reasonably question their safety in, or adaptibility to, service of this character, and their effectiveness at slower speeds has long since been fully demonstrated and universally accepted. Under these circumstances the substitution of the 4-wheel truck, as in the Pacific type, must be warranted, if at all, by its own superior advantages and not by supposed disadvantages of the 2-wheel truck. Neither of these, as it seems to the writer, has been shown to exist.

J. SNOWDEN BELL.

Pittsburgh, Pa., September 6, 1904.

A TECHNICAL SCHOOL GRADUATE OF SEVEN YEARS' EXPERIENCE.

To the Editor:

The communications on the subject of apprenticeship which have appeared in your paper will not be complete without a brief statement of my experience. I was graduated from the Massachusetts Institute of Technology seven years ago. After serving three years as a special apprentice and fulfilling the requirements of the officials as an apprentice, I was given special work of various interesting kinds and made myself generally useful to those officials. After seven years I have become foreman, with less salary than a draftsman of ordinary ability can secure any day. In fact, I am paid $95 per month. It was perhaps a mistake to let this go so long, for I have been discouraged and have made up my mind to do something else. It would not matter that the salary is low if I were given an opportunity to introduce improvements, but this I am unable to accomplish. What would you advise me to do?

D. E. F.

EDITOR'S NOTE.—Get another position, but first make an impression on your superiors which will enable your successor to accomplish something. A technical school graduate having had seven years' experience is worth more than $95 per month, or he is not worth anything. This seems to be a case of the wrong railroad. Life is too short to wait for advancement under such conditions. Our correspondent has little to lose. He should try an aggressive policy to see what that would bring him. He might do worse than be dismissed.

HELP THE MACHINE TOOLS.

To the Editor:

Several times, in recent issues of your paper, statements have been made implying the necessity of using specially designed heavy machine tools in connection with the high-speed tool steels, and in a number of instances you have called attention to particularly heavy cuts that have been taken on certain machines.

It seems to me that, in a railway shop, it is a sign of poor shop practice to have to take such heavy roughing cuts except on certain classes of work, such as turning worn wheel tires, rough turning axles and machining some of the heavier castings and forgings. There is no good reason why the greater percentage of locomotive and car castings and forgings cannot be made very nearly to size so that only a light roughing cut need be taken. The strains on the machine tools and the waste of material will thus be reduced and the cutting speed can be increased.

The use of high-speed tool steels, improved machine tools and better methods of handling the work will undoubtedly greatly increase the shop output and decrease the cost of production, as is very clearly shown in Mr. Jacobs' valuable article on "High-speed Steel in Railroad Shops" in your September issue. In addition, a considerable saving might also be made, in some shops at least, by carefully designing the castings and forgings with a view to reducing the amount of metal to be removed. On some of the larger forgings it may be found cheaper to machine the metal off than to forge it near the finished size, and occasionally it may be found advisable to leave a surplus of metal on irregular castings in order to facilitate molding, or to relieve shrinkage strains, but such cases are not frequent.

Apparently, one road at least has taken some steps along this line, for in the description of the McKees Rocks shops in your September issue it is stated that "most of the forgings and castings are so made that they can be finished by taking a comparatively small roughing cut, and the old machine tools, even though cutting at a considerably higher speed than before, can easily handle this class of work." Reference to the list of the motor-driven machine tools in the machine shop at McKees Rocks will show that more than 60 per cent. of them are old tools, which were designed before the high-speed tool steels came into use, and in view of this fact it is interesting to note that, "although new tool steels and commercial methods are being introduced into this shop as rapidly as possible, yet the old machines are giving good satisfaction in practically all cases."

I do not wish to advocate the use of old and worn out machine tools in our railway shops, for the question of shop output and the cost of production is one of vital importance to the railroads, and they should pay as much attention to it as a large commercial establishment does. At the same time it would appear that with a little care in the designing of castings and forgings old machine tools in good condition could in many cases be fitted up at a small expense so that they could be used to good advantage in a modern railroad machine shop. M. M.

SPECIAL APPRENTICESHIP.

To the Editor:

For some time my interest has been centered on articles appearing in your journal relative to special apprentices, not merely from a personal point of view, but from a knowledge of many young men who have taken up the work and are drifting, as it were. On reading the letter signed "A. B. C." in your September number the expressions of that writer were so nearly the conclusions that I have found from my experience and observation that I want to say "amen" to the conclusions that he has drawn.

Upon completion of my special apprenticeship course I felt capable of earning at least what an ordinary mechanic was paid and expressed a desire to know whether I would receive that rate or not. To make the story short, would say that those in charge, after keeping the question hanging for several weeks, notified me that I would be paid 5 cents less per hour than the rate paid machinists on that system. It was merely a question of leaving the road, for me, but the action taken by the officials does not look business-like or logical. Furthermore, to be advised by the superintendent of motive power to join the machinists' union and then be denied the scale paid members was to me a polite way of saying, "Get out!" I might add that a statement was given me saying that my services had been entirely satisfactory.

To clinch matters, I have been doing machinist's work the past two months at the ——— shops, not merely to prove to myself that I can handle the work satisfactorily, but to gain experience and incidentally earn more than had I remained with the ——— Railroad. Your journal is bound to do a good missionary work and by continual drubbing may turn the tide.

G. H. I.

Editor's Note.—This young man is bright, thoroughly capable and a graduate from the electrical engineering department of one of our large universities. He is bound to win out in the end and we trust that he will not give up the fight as hopeless. Is it any wonder that the railroads are losing some of their brightest young men?

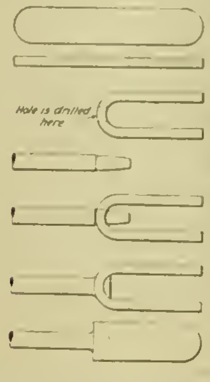
METHOD OF MANUFACTURING BRAKE-RODS AND PUSH-BARS.

To the Editor:

The method of manufacturing brake-rods and push-bars followed by the car department of the Cambria Steel Company is quite different from that of the majority of shops. In the Cambria shop the jaw or end of the brake-rod is made from bar iron which is sheared to the right length, heated and bent into a U-shape. A hole is drilled in this U-shaped piece, at the centre of the bend, about 1-16-in. smaller than the diameter of the brake-rod.

The end of the brake-rod is drawn out slightly, leaving a square shoulder about 1½ ins. from the end. This reduced end of the rod is pushed into the hold drilled in the U-shaped end or jaw, and the two parts are heated to a welding heat. They are then placed in a heading machine, which has some special dies arranged to hold the rod and keep the jaw in the proper position while another part of the die presses against the end of the rod, upsetting the same and welding it to the jaw. The end of the rod projects through far enough so that the excess stock forms a head on the inside of the jaw, which prevents the rod from pulling out of the jaw if the weld is not perfect.

When the jaws have been welded on, the rod is completed by drilling the holes for the brake-lever pins. The writer has no figures concerning the cost of this method of making brake-rods as compared with other methods, but it produces a very good looking brake-rod, with the possible exception that the



jaws are heavy when compared with the rod. This last objection does not hold for the push-bars, and it could probably be removed in the rods by using lighter stock for the jaws. It is said that when rods made in this manner are placed in a testing machine the rods generally break without developing any weakness in the ends where they are welded to the jaws.

O. N. Ferry.

POOLING LOCOMOTIVES—RESULTS OF A CAREFUL STUDY.

Important observations concerning pooling of locomotives are given in a report prepared by Mr. Camille Boell, superintendent of motive power of the French State Railways, to be presented before the International Railway Congress next May. The investigations by the author resulted in the following conclusions:

1. That the pooling system leads to a very perceptible increase in the expense per mile, and, therefore, it ought not to be employed except in case of absolute necessity.

2. That for the purpose of increasing the product of engines it is preferable to have recourse to the system of interposing auxiliary crews, or to the multiple crew system, the evils of which are infinitely less.

3. That the double crew system is particularly to be approved, notably for switching, suburban or shuttle train service, and even for certain classes of through train service for the reason that while affording better utilization of engines than the single crew system it may permit the realization of a slight saving of fuel without appreciable increase in cost of repairs.

4. That with these various systems there may be an advantage from the standpoint of fuel expense to assign to each engineman a particular tender, which, however, gives rise to certain complications in the service, and is not always capable of realization.

5. That the system of three-men crews may, in certain cases be substituted advantageously for that of double crewing.

It may be added, in conclusion, that other systems than that of the single crew have little to commend them for fast express train service, which demands engines in a perfect condition of repair and well understood by the enginemen who handle them.

Under usual conditions the economizer will save 12 to 15 per cent. of the coal bill each year without reducing the temperature of the gases sufficiently to seriously affect the draft. The amount saved would be, under ordinary conditions, about enough to pay for the cost of the economizer in three years. When we consider the fact that the economizer is very durable and costs but little for repairs, it will be seen that as an investment it promises to return an exceedingly large interest. —*Prof. R. C. Carpenter in Power and Transmission.*

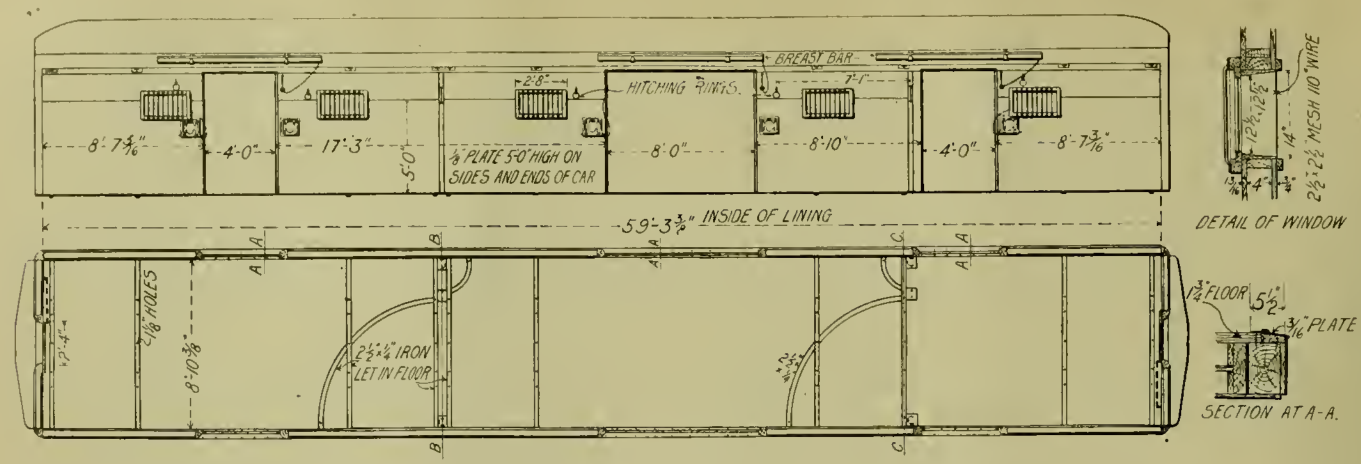


FIG. 1.—60-FOOT HORSE CAR.—CENTRAL RAILROAD OF NEW JERSEY.

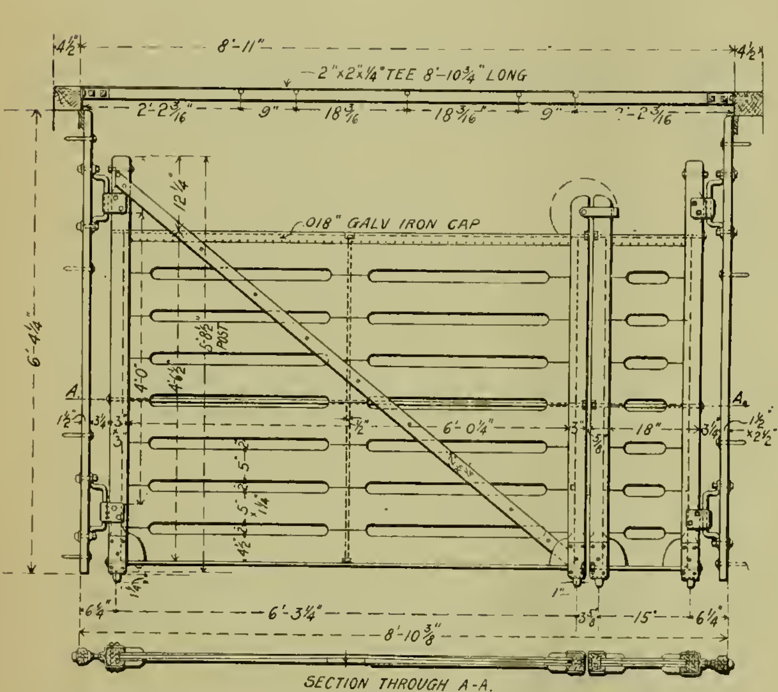


FIG. 2.—CROSS PARTITIONS.

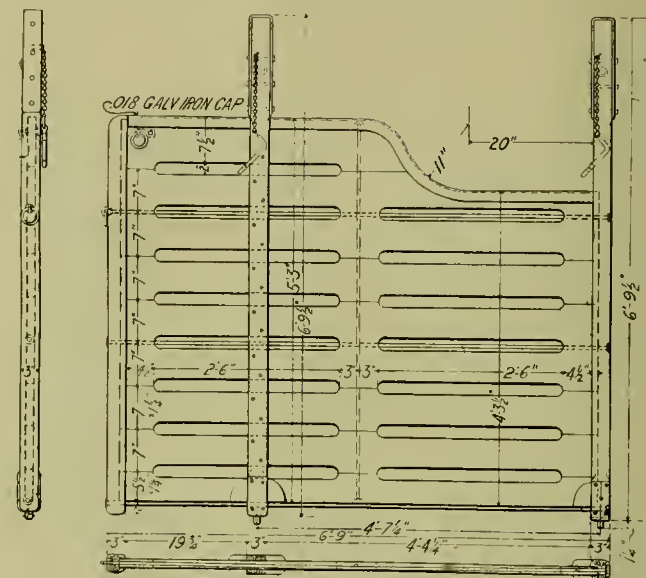


FIG. 3.—STALL PARTITIONS.

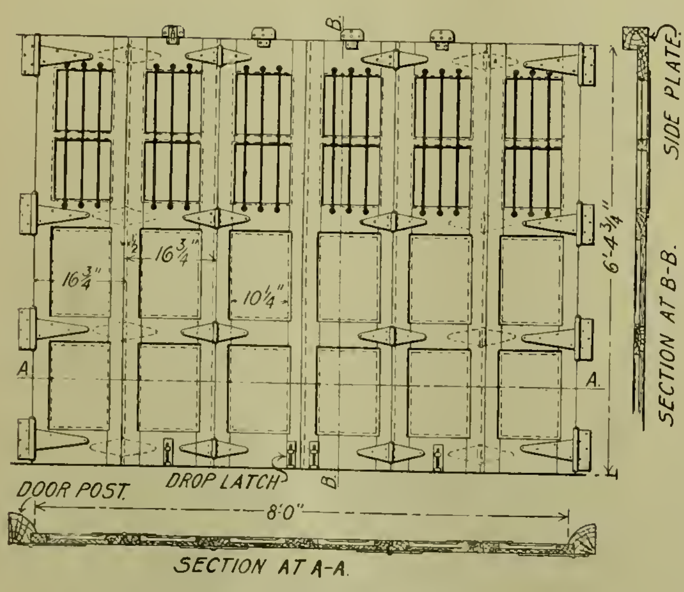


FIG. 4.—FOLDING DOORS.

60-FOOT HORSE CAR.

CENTRAL RAILROAD OF NEW JERSEY.

This car was especially designed for carrying horses, but is so arranged that the stall and cross partitions can readily be swung to one side and it can be used for express or baggage. The framing is practically the same as used on the 60 ft. baggage cars on this road, except that it is modified to allow the use of one 8-ft. and two 4-ft. doors on each side, the larger doors being used for carriages. The car has stub ends and sliding end doors.

Cross partitions made in two parts, shown in detail in Fig. 2, are placed at B-B and C-C. The smaller part forms a door for the attendant as he passes from one end of the car to the other and the larger part is so arranged that it can be swung to the side of the car when not needed. These partitions are held in place by 1-in. pins at the bottom, which fit into holes in small iron plates let into the floor. Iron strips, 2½ x ¼-in., are let into the floor so that when the partitions are being swung to the side the pins will not injure the floor. The stall partitions, shown in Fig. 3, are placed lengthwise in the car and are held in position by 1-in. pins at the bottom which fit into holes in the iron strips that extend across the car and by pins which fasten the straps at the top to the T irons upon which they slide. These partitions are placed at each end of the car, at both sides of the cross partition at B-B and at the left side of the cross partition at C-C. Five sets of stalls are thus provided for and as the car is arranged for either three or four stalls crosswise it will accommodate from sixteen to twenty horses. The breast boards are supported by pocket castings on the sides of the car and when not in use are placed on wrought iron brackets above the side doors. The partitions and breast boards are made of hard wood and all corners and edges are rounded. The sides and ends of the car on the inside are covered with ⅛-in. steel plates to a height of 5 ft. from the floor.

In order to comfortably accommodate four horses across the car it was found necessary to do away with the standard sliding doors and to use folding doors, shown in detail in Fig. 4. These doors are so constructed that the joints fit tightly when closed and they are locked by ordinary latch bolts at the bottom and by special latches at the top which drop into place when the doors are closed and rest against the small iron plates on the door. The 4-ft. doors are made in the same way but contain only half as many parts. Five small sliding windows are placed on each side of the car to furnish good ventilation and light.

The car is equipped with the American Steel Foundries' cast steel double body bolsters, Standard Coupler Company's steel platform, Buhoup 3-stem coupler, and Westinghouse high speed air brakes. We are indebted to Mr. W. McIntosh, superintendent of motive power, and Mr. B. P. Flory, mechanical engineer, for this information and drawings.

HEAVY FREIGHT TRAINS.

One of the 2—8—0 type freight locomotives on the Lake Shore & Michigan Southern Railway (illustrated in the American Engineer January, 1904, page 12) on August 19 hauled a train of 95 steel cars loaded with coal from Ashtabula to Youngstown. The train weighed 5,974 tons. This was during a series of tonnage tests and not a part of regular service. August 22, coming north, the same engine, No. 1006, hauled a train of 100 steel coal cars, making a total weight of 6,762 tons, 600 lbs., exclusive of locomotive, tender and caboose. The actual running time for the 54 miles from Youngstown to Ashtabula was 4 h. 32 m. The heaviest grades are 0.2 per cent., southbound, from Ashtabula to Youngstown. From Mr. H. F. Ball, superintendent of motive power, the following table of test runs has been received:

TONNAGE HAULED BY ENGINE NO. 1006, AUGUST 16 TO 22, 1904.

Date.	Cars.	Tons.	Left.	Arrived.
16	70	5,584	A* 11.15 a. m.	Y† 5.35 p. m.
17	54	4,320	A 11.30 p. m.	Y 5.15 a. m.
18	80	5,164	Y 8.50 a. m.	A 2.15 p. m.
18	60	3,594	A 11.15 p. m.	Y 6.25 a. m.
19	95	5,974	Y 12.08 p. m.	A 5.30 p. m.
21	75	4,620	A 4.48 p. m.	Y 10.45 p. m.
22	100	6,762	Y 10.58 p. m.	A 6.15 p. m.

*Youngstown.
†Ashtabula.

These approach the length of the mythical train having but one end, and the record is a remarkable one, even though the heaviest train was hauled over favoring grades. They surpass in several instances the record train of 5,212 tons hauled 132 miles over the Pennsylvania from Altoona to Harrisburg, August 9, 1898, which consisted of 130 cars of coal. A train of 5,936 tons was hauled over the Union Pacific from Cheyenne to Sidney in 1900, but this is a favorable grade of about 32 ft. per mile, if the writer's memory serves him correctly.

The heaviest train of which we have record was that of 134 steel cars, loaded with coal, hauled from Archer to Egbert, 24 miles, on the Union Pacific, April 4, 1900. The total weight, exclusive of locomotive, tender and caboose, was 7,765 tons. The grades favored the train, and the 24 miles were made in 45 minutes.

From information supplied by Mr. D. T. Murray, division superintendent of the Lake Shore, the test trains were helped out of the yard at Youngstown by a pushing engine, but the road engine hauled the trains unaided a distance of 33 miles. Our description of the locomotive, already mentioned, and the figures given in the table on page 275 of the July number for the Class C engines for the Lake Shore, may be consulted for weights and dimensions of this locomotive. Such trains, of course, are not to be operated in regular service. The runs were made for purposes of demonstration of the capacity of the locomotives.

COAL CONSUMPTION OF LOCOMOTIVES.

One of the reports at the convention of the Master Mechanics' Association last June, received too late for appropriate discussion, was that on locomotive coal consumption. It was one of the most valuable documents presented, and should have earnest attention, because locomotives are larger than they used to be. The conclusions of the committee, of which Mr. H. T. Herr was chairman, are presented here, and it is hoped that they will be carefully studied, particularly with reference to the remarks concerning firemen and the proper maintenance of locomotives. The conclusions are as follows:

The increase in efficiency of enginemen and firemen in road service depends largely upon the employment of suitable material to fill the position of fireman. For numerous reasons proper consideration has not in the past few years been given to this matter, and this has led to diminished efficiency in coal consumption, influenced by the method generally followed of pooling the engines without proper facilities to maintain them in such handling.

The relatively large boiler results in economy, as indicated in the body of the report, not only in itself, but also economy in the engine, so that it is desirable to have as large a boiler as the limitations imposed by the engineering department will warrant for any particular design of locomotive.

The grate area of the locomotive boiler should be limited to a certain rate of combustion per square foot of grate, and small decrease in efficiency in boilers is obtained by increasing the rate of combustion within a maximum limit of 120 lbs. of coal per square foot of grate per hour, yet, due to the fact that with a slow rate of combustion, a milder draft will serve from the standpoint of the locomotive actually moving the train (assuming the same efficiency of firing obtains), the large grate with a slow rate of combustion has an advantage in increasing the efficiency of the engines.

The loss of fuel at delays is probably greater as the area of the grate increases and is in a measure offset by the fact that with a large grate a large engine is expected, resulting in operating fewer trains to move a given tonnage, and consequently diminishing such delays, which would have a tendency to counterbalance the increased fuel consumption due to increased grate area, leading to the conclusion that there should be a design of grate of sufficient area to give a certain rate of combustion in order to generate the requisite amount of steam to develop a given power which would be a compromise between loss due to delays and at terminals from the large grate and the loss in efficiency while running due to the small grate.

The introduction of designs of locomotives with a larger proportion of the weight on trucks and trailers has resulted in efficient performance as regards fuel economy, for both boiler and engines, has been illustrated by consideration of the E engine in the report, and generally with this design the capacity of the boiler is relatively increased in proportion to the available power developed by the cylinders (which is limited by the weight on drivers), and consequently such designs would be best adapted to give efficient performance where a relatively high horse-power is to be maintained for a comparatively long time, such as, for instance, in passenger service or in through-freight service.

The relative worth of a large unit of power to a small unit warrants the maintenance of large engines to a higher standard than small engines, and to accomplish this proper facilities should be provided.

The methods of comparison of locomotives in road service from a standpoint of fuel economy should be such as to eliminate as far as possible the influence of variable conditions which might lead to erroneous conclusions from statistics now compiled, remembering that the value of fuel consumption should be proportional to the power developed by the locomotive.

Fast Transit in England and France.—The total number of runs scheduled at 55 miles per hour, or upward, from start to stop, is 53 in Great Britain and 35 in France.—*Rous-Marten in The Engineer.*

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

In this issue appears the first of the series of articles on economical operation of locomotives by Mr. G. R. Henderson. It indicates the nature of the study and character of the method employed in determining the most efficient rating of locomotives. The author bases his investigation upon original figures from tests made by himself, and presents factors relating to wages from schedules now in use on prominent roads with which he has been connected. Such an analysis, if made before, has never been published. It is commended to the attention of operating officials in the hope that they will examine their own practice by its aid. Unless some such examination is undertaken it is impossible to take the measure of the efficiency of train operation or to know what locomotives are doing.

A new roundhouse is being constructed on one of the trunk lines, and is to have the distinction of providing four drop pits for driving wheels. This seems like a somewhat startling suggestion, but it is justified, for the reason that when a locomotive comes into the terminal requiring work on driving boxes, or which, for any other reason, requires the wheels to be dropped, it should not be necessary to wait a moment in order to get this work under way. One or two drop pits are not sufficient for a terminal handling one hundred or more engines, and as these conveniences do not cost much the proposition of four seems to be an excellent idea. This is, by the way, a step indicating the increasing importance of the roundhouse in connection with running repairs, and it would be difficult to provide too many, or too good, facilities for accelerating the work which must be done at the end of runs. The roundhouse is frequently one of the weakest points in the matter of equipment and organization, and the tendency indicated by the attitude of the road referred to is interesting and significant.

If all cases of unsatisfactory service of compound locomotives were investigated, as in the instance described by Mr. Kinsell in this issue, perhaps compounds, as a type, would have a better name. Roads on which locomotives are specially well cared for have generally found compounds very satisfactory. It is not to be supposed that the valve motion of two-cylinder compounds are often as badly askew as Mr. Kinsell describes, but this is a noteworthy example of the possibilities. It is exceedingly important to know what locomotives are doing, whether simple or compound, and more railroads would now be enjoying the advantages of compounding if the diseases of the type had been more skillfully diagnosed and patiently treated.

STEEL PASSENGER CARS.

Fireproof passenger cars are in service in the New York subway. They are probably not perfect in all respects, but as new cars they are exceedingly creditable, and are worthy of the attention of car builders the world over. The design throughout is novel and interesting, particularly the disposition of the floor. Continuous service may develop valuable information about fireproof cars, and it will not be strange if changes are made in future construction. The steel frame passenger car, however, has become a fact, and the starting point for cars of heavier service has been reached. In this an important step has been taken. Mr. Gibbs has shown that the problem of weight in metal construction can be overcome, and there is reason to hope that steel cars may be made which will be both stronger and lighter than present wooden ones. In view of the great weight of modern passenger equipment per passenger carried, this subject should not be lightly passed over by railroad managements.

MASTER MECHANICS AND SHOP SUPERINTENDENTS.

Nothing in connection with the maintenance of locomotives has multiplied as fast, with the recent advance in size and capacity, as the boiler work. This is not alone due to the fact that boilers are larger and locomotives are worked harder than they used to be, but also to the fact that the proportion carrying relatively low pressure is rapidly becoming less and less. While boilers carried only 150 lbs. pressure it was comparatively easy to patch and repair them, but pressures of 200 lbs. are an entirely different matter; not only is it necessary to provide better boiler shop facilities and increased force, of the utmost obtainable skill, but every effort should be taken in the operation of the locomotives to reduce as much as possible running repairs.

On one of the trunk lines the boiler work recently increased to an alarming extent, and one of the best master mechanics on the road was detailed to give his entire attention for a time to efforts in the direction of keeping down boiler repairs. In a vigorous campaign, and by the aid of roundhouse foremen and road foremen of engines, he rearranged the methods of washing out boilers and cleaning fires at ash pits. He also systematized the use of soda ash in the locomotive tanks, and in the space of two months found it possible to reduce the roundhouse boiler repairs by over 50 per cent. This was done without the special expenditure of a cent of money, it being the result of placing this important matter in the hands of an official who was thoroughly capable of handling it, and the officers of that road were quite satisfied that it paid. So impressed are they with the importance of looking after boiler and other running repairs, in connection with the operation of the locomotives on the road, that it has been decided to appoint a superintendent of shops for each shop on the system and enable the master mechanics to devote more of their attention to the operating problems of their department.

The writer is frequently asked for suggestions with respect to roundhouse organization. The road referred to in these paragraphs seems to be on the right track. Every railroad now has sufficient organization for its roundhouses, the difficulty being that the men who are capable of looking after these important factors are also expected to handle shop problems through a general foreman. The proper course seems to be to divide the work to permit the master mechanic to spend his time on the road problems and provide him with a competent assistant to follow the infinite details of each shop.

It may be asked, Why not reverse matters, putting the master mechanic in charge of the shops and provide outside foremen for the road work? As the executive officer the master mechanic should be closest to the executive work and that which comes in contact with the operating officers of the road; on the other hand, the one who is directly responsible for the shops should never be asked to attend to anything else; the master mechanic, however, by personally getting into close contact with the roundhouse and locomotive operation can, if necessary, take the ultimate responsibility for the shop as well as running repairs, if he is adequately assisted.

The shop superintendents may report directly to the superintendent of motive power, or, if the road is large enough, through a general shop superintendent to the chief of the department. No matter how this is done, the master mechanics should not be expected to devote their personal attention to shop details, and at the same time keep locomotives going on the road.

RAILWAY APPLIANCE EXHIBITION.

Plans for an exhibition of railway appliances in connection with the approaching convention of the International Railway Congress, to be held in Washington next spring, are matured. The general committee of arrangements has organized, with Mr. George A. Post as chairman; Mr. Charles A. Moore, treasurer, and Mr. J. Alexander Brown, secretary, the committee consisting of thirty-five gentlemen representative of the strongest elements in the field of American manufacture of railroad equipment and supplies. The movement originated at the recent Saratoga convention of the railroad mechanical associations, and the preliminaries have been arranged as outlined in a report, a copy of which has been received from Mr. Post.

The exhibition itself is now to be organized, and without doubt this will be easily accomplished. The only apparent obstacle is the necessity for legislative action, in order to secure the use of the only space available in Washington for such a purpose. This is known as the "White Lot," situated back of the White House grounds, upon which no temporary buildings may be erected without an act of Congress. As precedents for the contemplated use of the ground are not lacking the necessary authority will probably be granted, providing those interested exert themselves sufficiently to induce their representatives in Congress to take the necessary action.

Over 500 foreign railroad officials are expected to attend, this being the first meeting of the organization in this country. They include the administrative, mechanical, operating and maintenance of way officials of the progressive railroads of the world. No such opportunity has ever presented itself for an exhibition of the railroad equipment and devices of this country, and a most important display is assured. Those who have given the high educational as well as commercial value to the annual exhibits at the Master Mechanics' and Master Car Builders' conventions may be trusted to embrace this opportunity to secure attention in the railroad markets of the world. If the exposition is what it ought to be it will constitute one of the most important features of the congress in bringing so many foreigners face to face with the most advanced American railroad practice.

A turbine air compressor was exhibited by Mr. C. A. Parsons at a recent meeting of the Institute of Civil Engineers (England). *Engineering* says it is capable of supplying 18,100 cu. ft. of air per minute at a pressure of 12 ins. The turbine is apparently one of the latest type, the casing being of uniform diameter throughout.

THE CROSS-COMPOUND LOCOMOTIVE.

DISTRIBUTION OF POWER.

BY W. L. KINSELL.

An equal distribution of power on both sides of a cross-compound locomotive is possible, with the valve motion used at present, only through a short range of speed and a small variation of cut-off. For this reason such an engine should be assigned to a certain class of road work, and the valve motion should be adjusted so that under average conditions the work done on one side of the engine will be equal to that done on the other. A test of a two-cylinder compound on the Norfolk & Western Railway, so arranged that it could be worked either simple or compound and in which the power was quite equally distributed over a wide range, was described in the June, 1898, issue of your journal.

The following tests, made on the Chicago, Great Western Railway, emphasize the necessity for a careful study of the power distribution of these engines by the mechanical departments under whose care they come. Following are some of the dimensions of the locomotive tested:

Type	2-6-2
Diameter of drivers	63 ins.
Diameter H.P. cylinder	22 ins.
Diameter L.P. cylinder	35 ins.
Stroke	28 ins.
Weight on drivers	135,500 lbs.
Weight of engine	189,500 lbs.
Clearance per cent. head end H.P. cylinder	22.74
Clearance per cent crank end H.P. cylinder	22.98
Clearance per cent head end L.P. cylinder	10.71
Clearance per cent crank end L.P. cylinder	10.42
Grate area	49.3 sq. ft.
Heating surface	3,225 sq. ft.
Sq. ft. damper opening in ash pan	3.25
Throw of eccentric	6 ins.
Steam lap H.P. cylinder	1¼ ins. each end
Exhaust lap H.P. cylinder	3-16 in. clearance each end
Steam lap L.P. cylinder	1 in. each end
Exhaust lap L.P. cylinder	¼ in. clearance each end

The first test showed that the engine as delivered by the builders was not in condition to economically do the work to which it was assigned. The power developed on the two sides came the nearest to being equalized when the engine was running slowly at a long cut-off, but even then the work done on the low-pressure side was nearly 40 per cent. greater than that done on the high-pressure side, and this difference became greater as the speed increased and the cut-off decreased until, at high speed, all of the work was being done on the low-pressure side, and, as the throttle was opened wider, work was actually being done against the high-pressure piston. With the boiler pressure at 200 lbs. the steam was exhausted into the receiver at about 70 lbs. pressure without doing any effective work, and this of course would indicate a large loss.

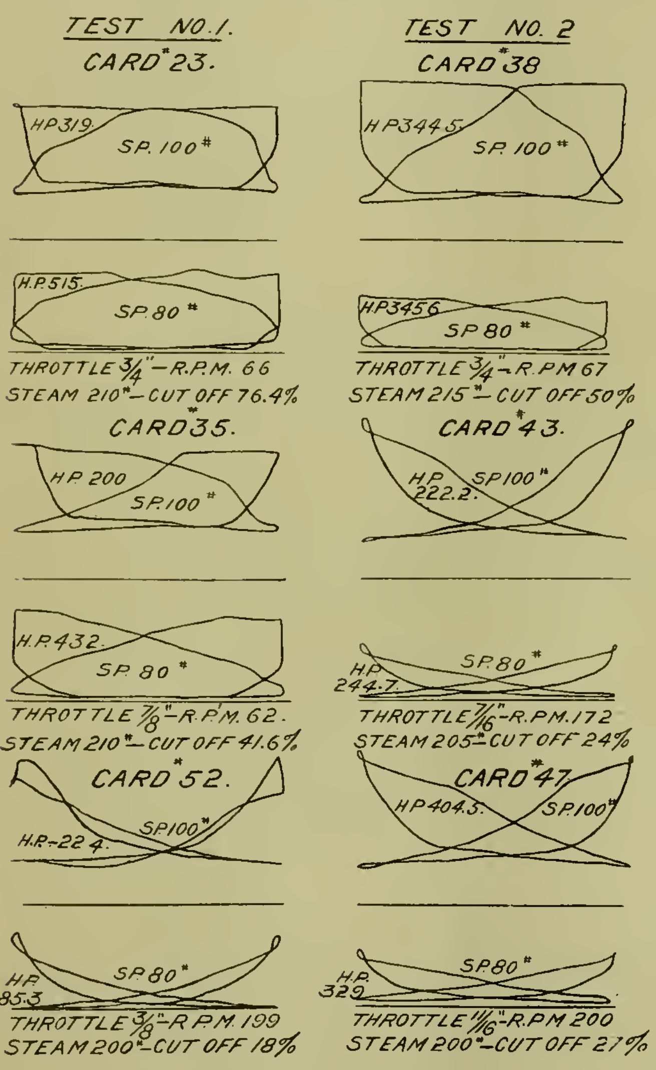
	Test 1.	Test 2.
Number of miles run	162	150.8
Actual running time	7 hrs. 57 mins.	8 hrs. 33 mins.
Average speed per hour, not including stops	20.37	17.64
Number loaded cars	31	25
Number empty cars	1	1
Total tonnage back of tender	961	982
Pounds water evaporated at 52 degrees F.	142,170	126610
Pounds coal burned	20,400	25530
Pounds coal burned per ton mile	.131	.153
Pounds water evaporated per ton mile	.915	.815
Pounds water evaporated per lb. coal	6.98	5.62

Forty indicator cards taken under normal conditions showed that 70 per cent. of the work was being done on the low-pressure side, or on the average 2⅓ times as much pressure was being exerted on the main pin on that side than on the other. This was quite noticeable, as the temperature of the main pin on the low-pressure side was considerably higher than that of the other.

The engine had a piston valve with outside admission, the body of the valve being 1/32-in. smaller than the bore of the bushing. On the first test the ring on the cut-off side of the high-pressure valve was broken, and card 35 taken at 41.6 per cent. cut-off with a ¾-in. throttle opening and a speed of 11.3 miles per hour, plainly shows that as soon as the exhaust edge of the valve closed the port and compression began the steam blew through the ring where the piece was broken out and increased the compression to the initial pressure when the piston was more than 2 ins. from the end of its stroke. The cut-off point is not very clearly marked, the steam blowing through the broken ring until the exhaust port opened to the receiver. The crank end card is very good, the packing rings in that end of the valve being in good condition. This card shows that only 31.6 per cent. of the work was done on the high-pressure side.

Card 23, taken at 76.4 per cent. cut-off, 1¼-in. throttle opening, at a speed of 12 miles per hour, shows that the high-pressure cylinder was doing only 38.2 per cent. of the work. Card 52, taken when running 36.2 miles per hour, with an 18 per cent. cut-off and ¾-in. throttle opening, shows that work was actually being done against the high-pressure piston.

After this test the valve motion was adjusted by taking a low-pressure card when running under normal conditions and adjusting the cut-off on the high-pressure side so that the high-pressure cylinder would deliver to the receiver that amount of steam at a pressure which would cause the same amount of



INDICATOR CARDS.—CROSS COMPOUND LOCOMOTIVE.

work to be done in the low-pressure cylinder. The proper cut-off on the high-pressure side was obtained by shortening the high-pressure link-hanger 9/32 in., since it was desired to reduce the work done in the low-pressure cylinder faster than in the high-pressure.

The broken high-pressure ring was renewed and another test made over the same division with very satisfactory results. On this test the speed varied from 5 miles per hour, at which the slowest card was taken, to 40 miles per hour, at which speed several cards were taken, the throttle opening varying from ¼ in. to 2 ins. and the cut-off varying from 12.7 to 82 per cent., the engine running under normal conditions. In this large range of speed, cut-off and throttle-opening the largest variation in work done in each cylinder was 44 per cent. on the high-pressure, with 56 per cent. on the opposite side, while the average per cent. of work done in each cylinder throughout the whole test was 50, showing that the power was properly distributed for these conditions. Comparing the high and low-pressure cards taken on the second test, it will readily be seen that the desired result had been accomplished; card 38, taken at one-half cut-off, and under average conditions, shows a good distribution of power. On card 43, taken at a comparatively high speed and a small throttle opening, and on card 47, taken at a still higher speed with a larger throttle opening, the power is not so evenly distributed.

This test was made with the same train crew as the first, but the weather was very stormy, which should cause an increase in the pounds of water evaporated per ton mile, but comparing the two tests reveals a decrease of 0.1 lb. of water per ton mile for the second, or a saving of 15,568 lbs. of water over the first test, which, at 6.98 lbs. per lb. coal, would cause a decrease in coal burned on the trip of 2,230 lbs., or a saving of at least one ton. On the second test the coal was not as good as on the first, the time of stops longer, and the speed slower, which all go to decrease the evaporation factor of the boilers, yet the amount of water used per ton mile was 11 per cent. less than on the first, showing very plainly that small defects in valve motion will cause a large loss in steam and indirectly a loss in dollars and cents. Although the high-pressure valve cuts off earlier than before with the same position of reverse lever and the valve travel is shorter, the increased wire drawing is not noticeable, and the low-pressure valve has the same travel as before with a large port opening. The engine now hauls the same tonnage as before, more smoothly and much more economically, thus fully demonstrating that the compound locomotive valve motion, if not adjusted properly, can cause a large loss in fuel consumption.

VARIABLE SPEED MOTORS IN RAILWAY MACHINE SHOPS.

BY J. C. STEEN.

In railway machine shop work, as in commercial establishments, it is necessary to secure as large an output as possible with the lowest expenditure of time and money consistent with a good quality of work. With this end in view it is sometimes advisable to improve certain machine tools as well as the methods of operating them. For instance, with the improved tool steels machine tools can be operated at a much higher rate of speed than former practice required or permitted.

The work to be done may be such that it is only necessary to use higher speeds, already provided for in the machine; but when it is general in character and a comparatively wide range of speeds is required at the higher rate, some more modern and efficient means of driving must be looked for than from the usual belt drive, and the best alternative in such cases is to apply a motor directly to the machine. In many cases the various parts of the machine will be found strong enough to stand the work, but the increased speed at which the cuts are taken demands a proportionate increase in the amount of power expended, and this may overtax the belts and shafting, perhaps already well loaded. The simplest remedy in such a case is to isolate the machine and apply an individual motor. Such a change from the usual methods of driving involves the consideration of some arrangement by which the necessary variation of speed can be obtained. In this connection, it is assumed that the shop is already provided with a direct-current single-voltage system, and from this source the desired variable-speed drive is to be obtained. With the single-voltage system and a constant-speed motor as the only available source of power, the user naturally hesitates about applying a motor-drive to the machine, because of the necessity of securing speed variation by some system of gearing more or less complicated, according to conditions. With the variable-speed motor, however, the amount of gearing employed is reduced to a minimum, and in some cases may be dispensed with altogether and the entire variation in speed be secured from the motor alone.

Variable-speed motors can now be obtained that have been designed especially for use with the single-voltage system, and are not only simple in construction but very efficient in operation, and thus the problem of individually driving old machine tools is much simplified. Wherever the variation required is too great to be secured through the motor alone, change gears can be introduced, and almost any variation of speed can be had within reasonable limits. The relation between the motor speed variation and the ratio of gear changes, where gears are used, should, of course, be such as will give the proper succession of speeds through both runs.

Compared with a constant-speed motor, one with a variable-speed has the additional advantage that speed variation can be much more easily secured through the manipulation of a controller handle than by any other means; and, as compared with the belt drive, this method of speed variation is obviously so far superior to belt shifting that the saving of time, not to mention temper and the wear and tear of the operator's mental disposition, tends very much to an increased output. Frequently the increased output secured, due to more efficient operation of the machine, is sufficient to pay for the entire outlay in a very reasonable time.

Many hesitate regarding the consideration of changes in existing driving mechanism, owing to the amount of work involved in making the change. The problem is to bring about a change in the least expensive manner and at the same time to secure an arrangement that will be efficient in action and simple in operation. Any device that involves undue complication of parts is to be avoided when possible. Individual driving of machine tools, by well designed and properly selected variable-speed motors, is one of the means by which some of the vexing problems of shop management are solved; and such drives can readily be applied to machine tools, either new or old.

The variable-speed motor has been developed in response to a demand for progressive appliances, and the fact that such a motor can be used with a single-voltage system gives it many advantages over more complicated systems.

THE APPLICATION OF INDIVIDUAL MOTOR DRIVES TO OLD MACHINE TOOLS.

BY R. V. WRIGHT.

McKees Rocks Shops.—Pittsburgh & Lake Erie Railroad.

XIV.

This article completes the description of the application of motors to the old machine tools at the McKees Rocks shops, and although the machines described have been in service about a year and during that time high speed tool steels and commercial methods have been introduced into the shop as rapidly as possible, yet practically all of them have given good satisfaction. In a railroad repair shop there is a large amount of work that does not require heavy roughing cuts, and the old tools, if in good condition, can handle this class of work nicely, although running at a considerably higher cutting speed than they were designed for. Again, although the machines are spoken of as old, because they were used in the old shops, several of them were purchased during the year or two just preceding the building of the new shops, and are of good modern design.

Fig. 63 illustrates a motor application to a D. Saunders' Sons IXL pipe cutter. The belt pulley was replaced by the large Morse silent-chain sprocket, and the motor was set on a 4-in. oak block on the floor and covered with a casing to protect it

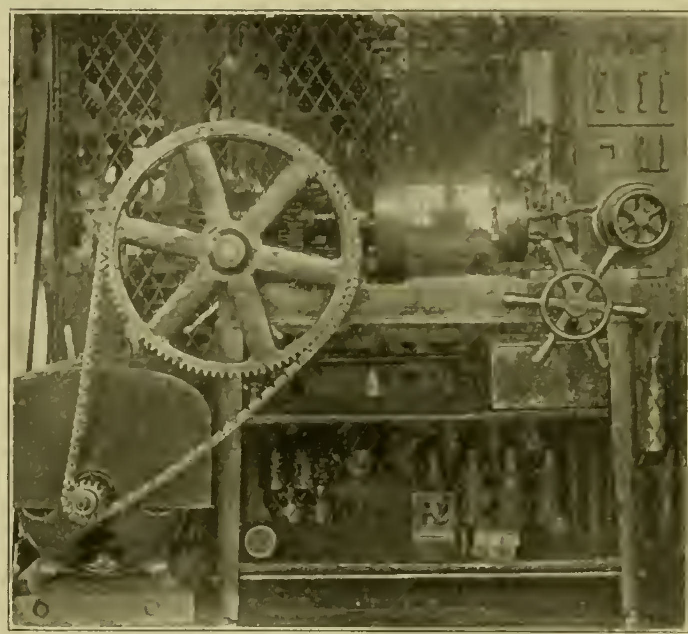


FIG. 63.—MOTOR DRIVE APPLIED TO SAUNDERS IXL PIPE CUTTER.

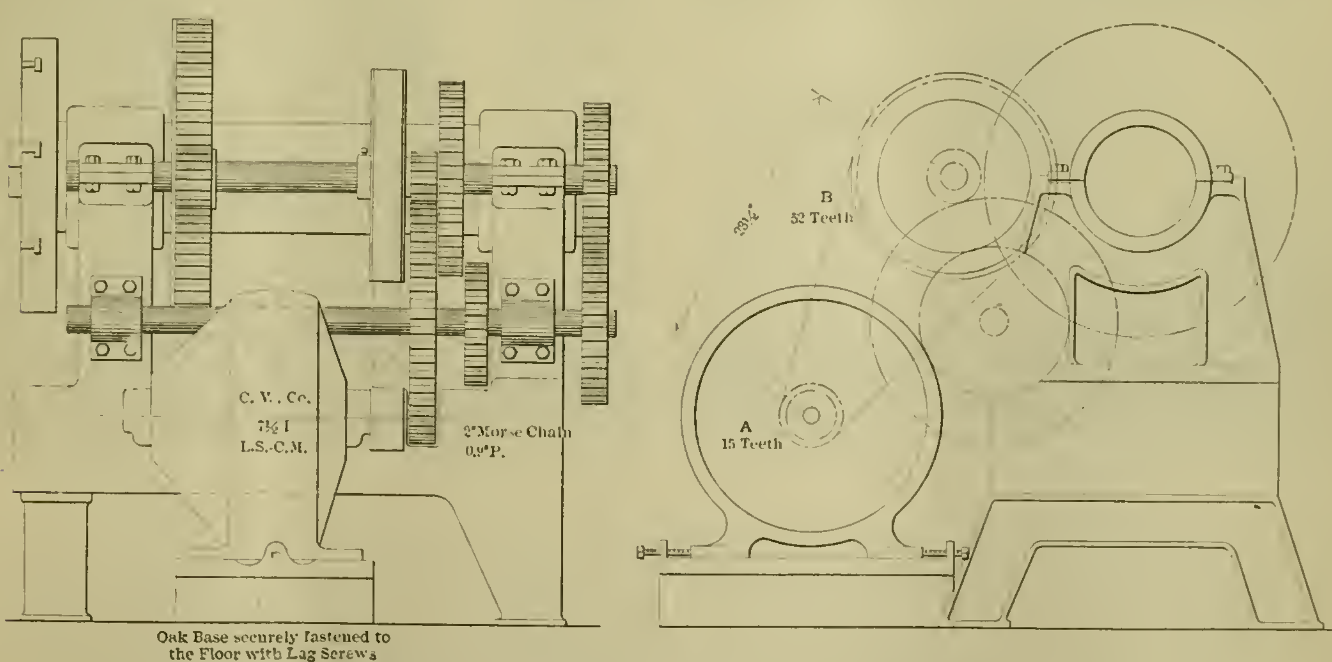


FIG. 64.—MOTOR APPLIED TO NO. 5 SAUNDERS SONS' PIPE CUTTER.

from oil and dirt. In the upper right hand corner of the half tone is shown the panelboard that holds the switch, fuse block and controller. The controller is an M.Q. 6 type made by the Crocker-Wheeler Company, and furnishes six speeds, or one for each of the voltages of the 4-wire system. This machine has a maximum speed of 107 revolutions per minute and is driven by a Crocker-Wheeler Company 3 h.p. motor.

A motor application to a Saunders Sons' pipe cutter No. 5, which has a capacity for pipe up to 6 ins. in diameter, is shown in Fig. 64. In this case the motor was set on oak blocking on the floor at the rear of the headstock end of the machine and connected by Morse silent-chain to a sprocket which replaced the speed cone used with the belt drive. The motor is a Crocker-Wheeler Company 7½ h.p., and is operated by an M.F.-21 controller. The machine itself has three runs of gearing, and this, in connection with the motor, gives a wide range of speed.

The motor application to a 200-ton Niles wheel press, which will take up to 72-in. wheels, was very simply made, as shown in Fig. 65. The large belt pulley was replaced by a sprocket that is connected by a Morse silent-chain to the motor, which is bolted to oak blocking on the floor to the right of the machine. The pump is run at a constant speed of 165 strokes per minute and the motor is a Crocker-Wheeler Company 7½ h.p. The panelboard for the starter, switch and circuit-breaker is placed at the extreme right, where it is out of the way of the wheels and axles but convenient to the operator.

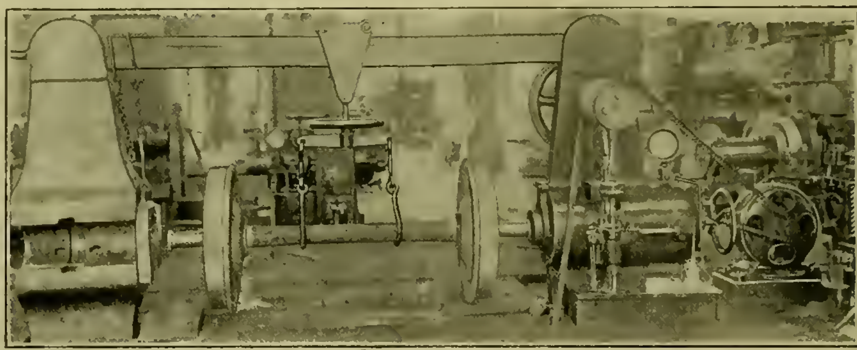


FIG. 65.—MOTOR DRIVE APPLIED TO NILES WHEEL PRESS.

METHOD OF REPAIRING CRACKED CYLINDERS.

MICHIGAN CENTRAL RAILROAD.

The accompanying engravings illustrate a novel and effective method of making a permanent repair upon some cracked cylinders, that was resorted to at the Jackson, Mich., shops of the Michigan Central Railroad. Trouble was experienced with breakages of the high-pressure cylinders of some of the heavy 2-cylinder compound locomotives that are being used upon the Michigan divisions of the system in freight service, but the trouble was not only checked but taken care of by the following method of strengthening these cylinders:

Fig. 1 shows the location and character of the cracks that took place. In all of the several cases of breakage, the crack started on the upper side of the piston-valve case, just at the rear of the forward ports, and extended around and downward, curving forward and ending at the front edge of the cylinder at or near its horizontal diameter. It has been impossible to assign a cause for this cracking, as the cracks usually developed slowly until at length destruction of the entire cylinder was threatened.

The method of repairing adopted was a very simple and effective expedient, and its worth has been proven in service, as no further trouble has been experienced since these repairs. As may be seen from Fig. 2, heavy wrought iron bars were forged with right-angle bends at each end, forming fixed clamps; the distances between the jaws were made somewhat less than the lengths of the cylinder castings outside. The bars were then heated and slipped, while red hot, over the edges of the castings as shown in Fig. 2; when cooled they shrunk onto the casting so tightly as to effectively and completely close up the crack.

This has been done on all the engines upon which cylinders have cracked, and with universally good results. The cylinder shown in Fig. 2 is one that had appeared beyond hope of repair, but it has now been in service over a year. In one of the first cases it was found necessary to brace the cracked portion of the port chamber from within, which was done by means of jacks placed between the vertical partitions and the walls of the steam passage leading to the by-pass valves. This gives a solid resistance for the braces which would otherwise have no effect on these walls.

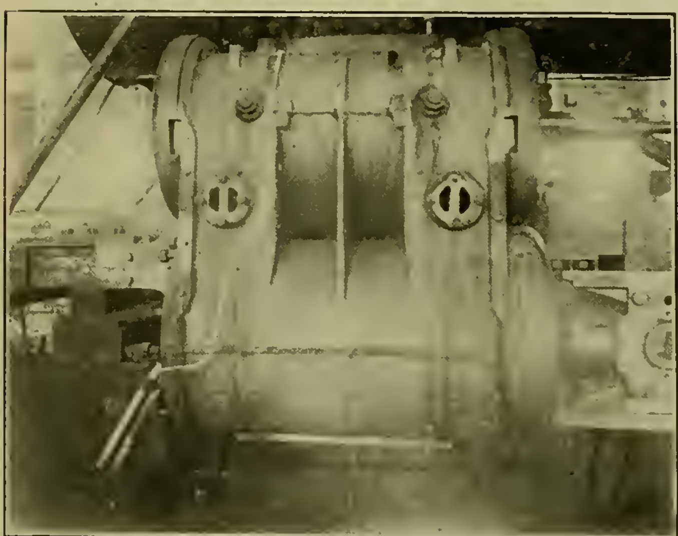


FIG. 1.—ONE OF THE CYLINDERS STRIPPED TO SHOW CRACK.

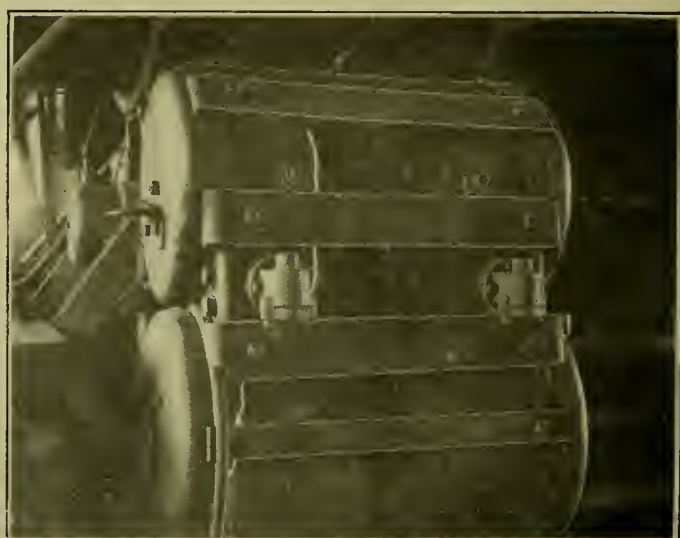


FIG. 2.—CYLINDERS AFTER BRACES HAVE CLOSED UP CRACK.

Since this trouble developed and was so effectively reduced, the high-pressure cylinders of all of the remaining 2-cylinder compounds of similar class have been strengthened by the application of similar binding bars shrunk in place. On those which have not cracked, however, only two bars are applied, one above and one just below the two relief valves shown. The remarkable feature of this work is that these bars are so located as not to interfere with the cylinder covers or to prevent the application of the cylinder lagging. The cylinder covers were chipped out sufficiently to clear the braces, where they project over the edge of the cylinder casting.

We are greatly indebted for this information to Mr. D. R. McBain, master mechanic, and to Mr. M. D. Franey, foreman, of the locomotive shops at Jackson, to whose originality this interesting and effective method of repair is due.

AMERICAN RAILWAY APPLIANCE EXHIBITION.

To Be Held in Washington.

The Railway Supply Men's Association inaugurated a movement at Saratoga last summer which led to the passing of a resolution authorizing Mr. George A. Post, chairman of the meeting, to appoint a committee to prepare for and conduct an exhibition of railway appliances at Washington during the convention of the International Railway Congress in that city May 3 to 13 next. This selection of the committee was made by Mr. Post and at a meeting held September 8 the committee organized with the following officers and members:

Chairman, George A. Post, President Standard Coupler Company, New York.
Treasurer, Charles A. Moore, Manning, Maxwell & Moore, New York.
Secretary and Director of Exhibits, J. Alexander Brown, The Pocket List of Railway Officials, New York.
H. P. Bope, Vice-President Carnegie Steel Company, Pittsburg.
J. B. Brady, Vice-President Standard Steel Car Company, New York.
L. F. Braine, General Manager Continuous Rail Joint Company of America, Newark, N. J.
J. A. Brill, Vice-President J. G. Brill Company, Philadelphia.
A. E. Brown, Vice-President Brown Hoisting Machinery Company, Cleveland, Ohio.
C. A. Coffin, President General Electric Company, New York.
O. H. Cutler, President American Brake Shoe & Foundry Company, New York.
F. H. Eaton, President American Car & Foundry Company, New York.
Harry Elliott, Jr., Vice-President Elliott Frog & Switch Company, St. Louis.
William Goldie, Sr., William Goldie, Jr., & Co., Pittsburg.
H. S. Hawley, President Railroad Supply Company, Chicago.
F. N. Hoffstot, President Pressed Steel Car Company, Pittsburg.
A. B. Jenkins, Jenkins Bros., New York.
Alba B. Johnson, Baldwin Locomotive Works, Philadelphia.
B. F. Jones, President Jones & Laughlin Steel Company, Pittsburg.
A. M. Kittredge, Vice-President Barney & Smith Car Company, Dayton, Ohio.
William V. Kelley, President Simplex Railway Appliance Company, Chicago.
E. B. Leigh, Vice-President Chicago Railway Equipment Company, Chicago.
William Lodge, President Lodge & Shipley Machine Tool Company, Cincinnati.
General Charles Miller, President Galena-Signal Oil Company, Franklin, Pa.
Franklin Murphy, President Murphy Varnish Company, Newark, N. J.
D. C. Noble, President Pittsburg Spring & Steel Company, Pittsburg.
H. S. Paul, President Verona Tool Works, Pittsburg, Pa.
A. J. Pitkin, President American Locomotive Company, New York.
Alfred A. Pope, President National Malleable Castings Company, Cleveland, Ohio.
H. Kirke Porter, H. K. Porter & Co., Pittsburg.
W. W. Salmon, President General Railway Signal Company, New York.
C. W. Sherburne, President Star Brass Manufacturing Company, Boston.
H. A. Sherwin, President Sherwin-Williams Company, Cleveland, Ohio.
C. A. Starbuck, President New York Air Brake Company, New York.
Albert Waycott, Vice-President and General Manager Damascus Brake Beam Company, St. Louis.
H. H. Westinghouse, Vice-President Westinghouse Air Brake Company, Pittsburg.
Ward W. Willits, Vice-President Adams & Westlake Company, Chicago.

With these gentlemen in charge the exhibition is sure to be a complete success. Such an opportunity of displaying American railway appliances to 500 or more foreign officials, coming as they will to represent their roads, has never been offered before. Such difficulties as remain to be removed will doubtless be easily disposed of, such, for instance, as the provision of suitable space for the exhibition. This subject is mentioned editorially elsewhere in this issue.

IMPROVED TOOL STEELS.

The following table and statement showing the effect of the alloy tool steels on the cost of output for turning a pair of old and badly worn standard driver tires 70 ins. in diameter is taken from a paper read by Mr. W. R. McKeen, Jr., before the recent convention of the Master Mechanics' Association:

COMPARATIVE COST OF OUTPUT FOR ONE PAIR OF DRIVING WHEELS.

Operation.	Carbon. Hrs. Min.	Air Hardening. Hrs. Min.	High Speed. Hrs. Min.	Carbon.	Air Hardening	High Speed.
Setting tool, etc., throughout job	1:30	1	:36	$0.50	$0.33	$0.20
Grinding roughing tool	1:30	1	:20	.50	.33	.11
Grinding flanging tool	1:30	1	:04	.50	.33	.02
Roughing cut	8	5	1:00	2.65	1.65	.33
Finishing cut	5	2:30	:30	1.65	.83	.17
Flanging cut	2:30	1:30	:30	.85	.50	.17
Total labor	20:00	12:00	3:00	6.65	3.97	1.00
Interest, depreciation, repairs, etc., figured at 15% on first cost, per hour				(.13)	(.13)	(.40)
per job				2.60	1.60	1.20
Power, at 3 cents per horse-power hour...per hour				(.07)	(.12)	(.18)
per job				1.00	1.00	.50
Total fixed charges				3.60	2.60	1.70
Total of all items				10.25	6.57	2.70

In this table, showing comparatively cost of output, it will be seen that there is not a single operation in which the new tools do not directly or indirectly effect a saving in setting and grinding tools, varying from 50 per cent. to 98 per cent. of time originally taken with the carbon steels. These savings are real gains and not mere statements on paper.

To take up the table part by part: The first line shows time consumed in setting tools; where these tools have been taken out of the holder frequently for regrinding, etc., more time will be so occupied that when practically no resetting occurs. The grinding shows up clearly the comparative durability of the tools; the old steel requiring much more frequent grinding than the high-speed or alloy steels. Grinding a carbon roughing tool will require 15 minutes (walking to and from emery wheel, etc.) and each tool will ordinarily be reground three times for each tire turned; whereas the high-speed tool will last throughout the job with one grinding. While the flanging tool does not have such severe usage as the roughing tool, it requires much greater care in grinding. With the alloy tool one grinding of same will answer for about fifteen wheels, or an average of four minutes for each pair. In the tests the flanging tool was of special design, being quickly ground to standard by tool room; the average time occupied for grinding per each pair of wheels being two minutes.

The next three items—roughing, finishing and flanging cuts—are the main economical features, and are entirely due to the high speed capacity of the new tools. It will be seen that the labor cost in the case of the high speed is only half that with the ordinary air hardening steel, and less than one-third as much as with the old carbon steel tools.

The interest, depreciation, repairs and renewals to machine and electrical equipment have been estimated at 15 per cent. on $6,000 for the modern lathe, or 40 cents per hour, and at 10 per cent. on $3,000 on old style lathe, which would be sufficiently fast for the speed capacity of the old carbon steel tools. It must be remembered, in this connection, that there has as yet been no driving wheel lathe built expressly for high-speed alloy steels.

The power (delivered to work) has been taken in all cases at 3 cents per horse-power hour, a conservative figure for conditions in the Middle West, and considering the many transmission losses.

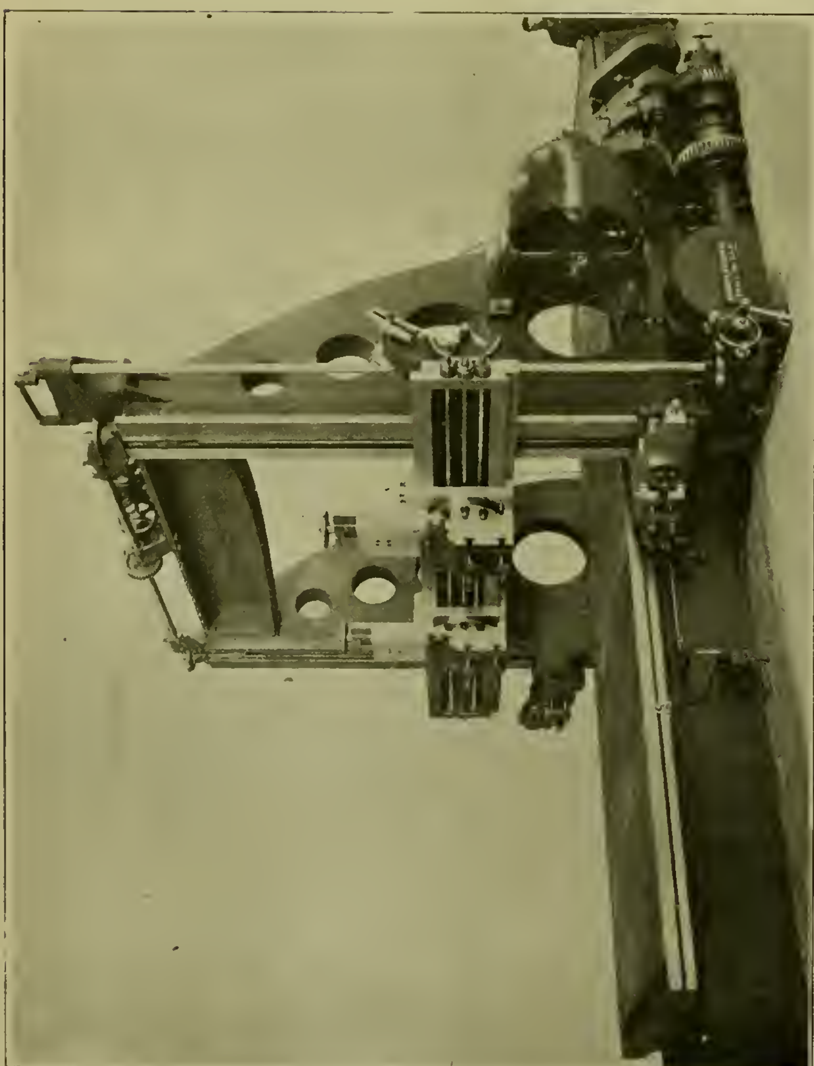


FIG. 1.—PLANER WITH PNEUMATIC CLUTCHES.—BEMENT, MILES & COMPANY.

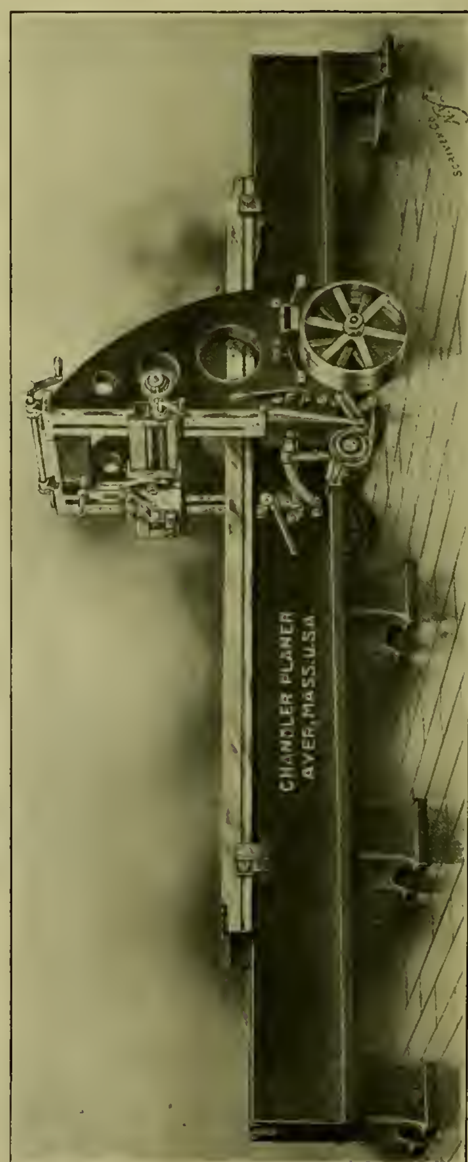


FIG. 2.—HIGH SPEED PLANER.—CHANDLER COMPANY.

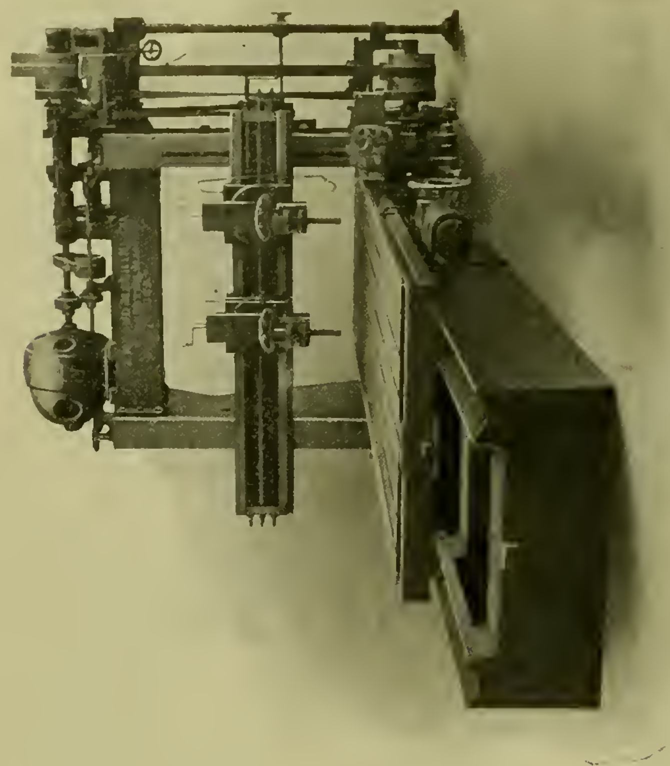


FIG. 3.—96-IN. BY 24-FT. PLANER.—L. W. POND MACHINE & FOUNDRY COMPANY.

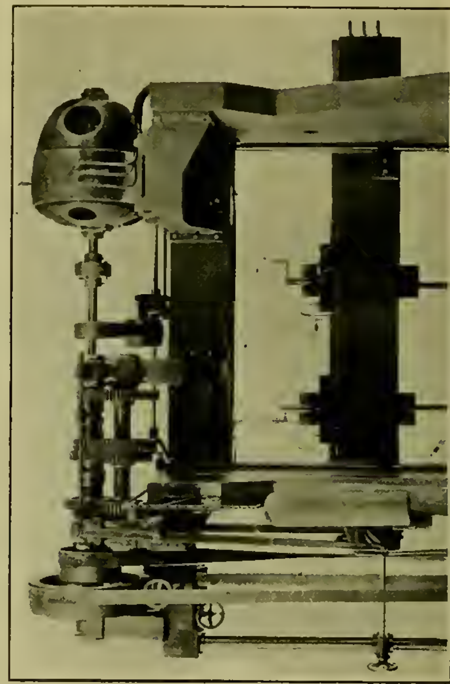


FIG. 4.—APPLICATION OF MOTOR TO L. W. POND MACHINE & FOUNDRY COMPANY'S PLANER.

IMPORTANT IMPROVEMENTS IN PLANER DESIGN.

With the advent of high speed tool steels and individual motor drives and the stimulus they gave to improving shop methods, the question of increasing the cutting and return speeds of planers has been a perplexing one. The limitations of the ordinary type of planer had apparently been reached and the builders realized the necessity of improving their designs to meet the new requirements. Those who have followed the improvements as reported from time to time in this journel have noticed the steady progress which is being made, and that the builders have studied the question carefully is shown by the different ways in which they are overcoming the difficulty. As will be noted from the planers described in this article, some very radical changes in design have recently been made with surprising results.

The planer shown in Fig. 1, made by Bement, Miles & Co., is on exhibition at the St. Louis Exposition and is of interest because of its size, the friction clutches operated by air which reverse the table, and the application of the individual motor drives.

The width between the uprights and also the distance between the table and the crossrail when it is in its highest position is 10 ft. 2 ins. and the table, which is of very heavy construction, is 8 ft. 8 ins. wide, 30 ft. long, exclusive of the pans at each end, and runs on two V's each 12 ins. wide, which present a bearing surface of 9,000 sq. ins.

The V's are self-lubricating by means of pockets and rollers and these pockets are so connected that oil poured in one of them is equally distributed to all. The table is driven by a heavy pitched rack with a 15-in. face which engages with a large bull wheel within the bed, which is mounted together with other gearing on framework detachable from the bed.

Friction clutches operated by compressed air are used to reverse the table as the table speeds and the power required are greater than could be obtained by the use of shifting belts. These clutches, two in number, run in opposite directions and are mounted on the shafts which usually carry the pulleys. One clutch gives the forward or cutting speed to the table and is equipped with change gears in order that the cutting speed can be varied for different materials. The other clutch is arranged to give a constant speed for the return stroke, regardless of the cutting speed. A small operating valve with a lever for controlling the clutches is attached to the side of the bed and this lever is tripped by dogs on the table in a manner similar to the ordinary belt shifting device, but of lighter construction. A light and neat handle at the operator's position is provided for reversing the table travel independently of the dogs, this handle being connected with the air valve. From the valve, pipes lead to the rear end of the clutch shafts, where there is a gland and stuffing box connection for conveying compressed air through the centre of the shaft to the clutches.

The machine was designed to have a return table cutting speed of 80 ft. per minute and was tested at the shops to 100 ft. per minute. It is driven by a General Electric Company 60-h.p. motor, which is mounted on the side of the housing and is geared direct to the clutch shaft. Cutting speeds can be obtained by the change gears from 18 to 36 ft. per minute.

The uprights are 20 ins. across their faces and each has a substantial side head having automatic vertical feeds. The tool slides have 24 ins. horizontal travel and can be swiveled for angular work. An independent 3-h.p. motor mounted on the side of the machine is used for quickly traversing the side heads up and down the upright. The crossrail is 30 ins. wide on the face and is fitted with two saddles, made right and left handed for bringing the tools close together. The vertical tool slides have 30 ins. traverse and can be swiveled to any angle. The tool aprons are outside gibbed with T slots and tool clamps and have automatic tool relief operated by vertical feed spline shaft. The saddles have feeds in either direction across rail and tool slides have vertical feed in their saddles. The crossrail is made of sufficient length to permit one saddle being traversed clear of the upright and allow full traverse of the other saddle between uprights for finishing work of maximum width. At the rear of the crossrail is a 3-h.p. motor connected by gearing to screws and feed spline shaft in rail. By means of a lever and switches conveniently placed for controlling this motor, the saddles can be traversed quickly on the rail, and the tool slides vertically in their saddles. For raising and lowering the crossrail, a 5-h.p. motor is mounted on top of machine, and geared direct with the screws in the uprights.

Fig. 2 illustrates a 24-in. x 24-in. x 12-ft. planer made by the Chandler Company, Ayer, Mass., which is accomplishing wonderful results. This company guarantees any cutting speed up to 100 ft. per minute. If the cutting speed does not exceed 75 ft. per minute, the platen is returned at a speed of 200 ft. per minute. If the cutting speed exceeds 75 ft. per minute, the platen is returned at a speed of 150 ft. per minute. At these high speeds the platen reverses smoothly and without shock or jar and is operated by a belt only 1 in. wide. Three belts are necessary to accomplish this, one for driving when cutting, one for reversing and one for running the platen back at high speed.

The platen is reversed at the end of the cutting stroke by an intermediate or reversing belt, running at such a rate of speed as is practical to secure the highest and best reversal from the speed of the cut. Immediately after the platen starts back on the return stroke, the tappet encounters a second step in the dog, which throws off the intermediate or reversing belt, and throws on the high speed belt, which remains in action until near the end of the reverse stroke, when the cycle is reversed; the high speed reversing belt going off, succeeded by the intermediate belt, from which the platen is reversed to the cutting stroke. An illustration of the application of this principle is shown in the two Chandler planers now in operation. On one the cutting speed is 50 ft., the intermediate speed 90 ft., and the quick return 200 ft.; on the other, the cutting speed is 92 ft., the intermediate speed 80 ft., and the quick return 154 ft. Of the three pulleys shown in the engraving, the middle one only is tight on the shaft. The belt which drives the platen on the forward or cutting stroke runs on the outer one and the belt for reversing it runs on the inner one. The belt which operates it on the quick return is on the other side of the planer.

If the quick return is not desired, as, for instance, on an extra short stroke, where the too frequent reversing of the high-speed belts is liable to cause them to burn, or where a particularly accurate stop may be required, or where the character or exigency of the load may make a slow return speed more desirable, lifting a latch on the return dog keeps the high speed belt out of operation, and the platen is returned on the intermediate speed or reversing belt. The speed of the platen can be varied without changing the speed of the driving belts by a combination of gearing and clutches located between the pulley shaft and the bull gear, and operated by a lever. The shafts are large and are case hardened and accurately ground in order to reduce the friction to a minimum, and this is partly the cause of the excellent results obtained. The Chandler Company claims that they are the first to successfully harden such large shafts. The first planer built on the above principles, a 24-in. x 24-in. x 6-ft., has been in service five months and has been subjected to the most severe tests. In order to prove that heavier planers can be successfully operated, they have equipped and are running daily one of their planers with a platen weighing 3,750 lbs., with a load of 8,500 lbs. on it, and are operating the platen at a return speed of 200 ft. per minute with a 1-in. belt. The feed regulating device is operated by a lever moving on a marked dial convenient to the operator.

Figs. 3 and 4 illustrate a 96-in. planer with three heads and a 24-ft. table, built by the L. W. Pond Machine & Foundry Company, of Worcester, Mass., and driven by a 35 h.p. Crocker-Wheeler Company type I compound wound motor, mounted on top of the housing. It is coupled to the shaft driving the fly-wheel pulley, and the diameters of the pulleys and the gearing under the table are proportioned to give a return table speed of 70 ft. a minute with the motor running at its maximum

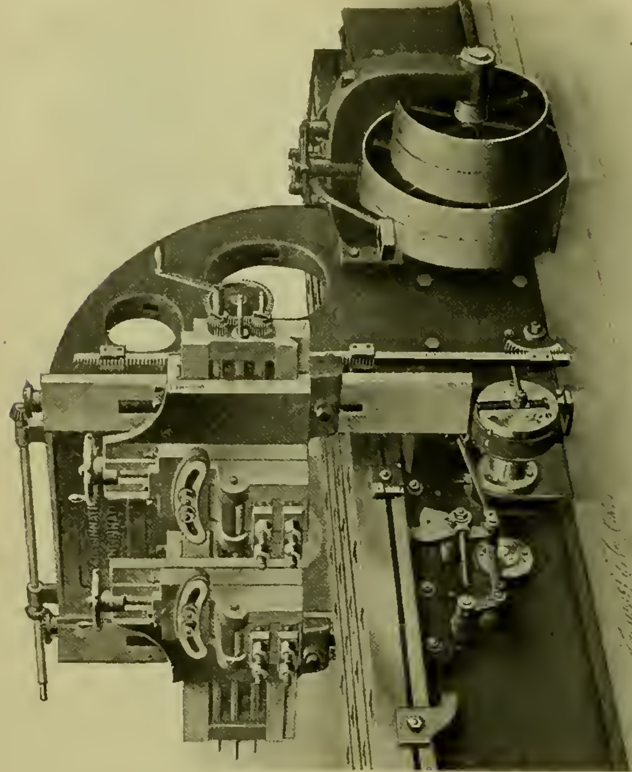


FIG. 5.—HEAVY FROG AND SWITCH PLANER.—CINCINNATI PLANER COMPANY.

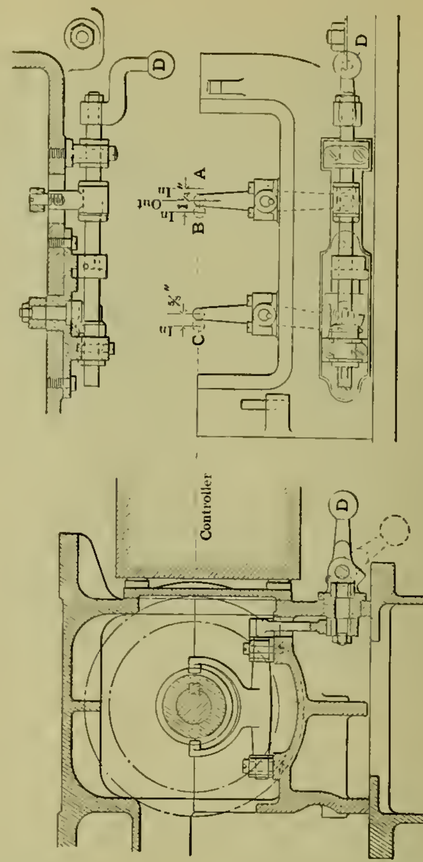


FIG. 3.—ARRANGEMENT FOR THROWING CLUTCHES.

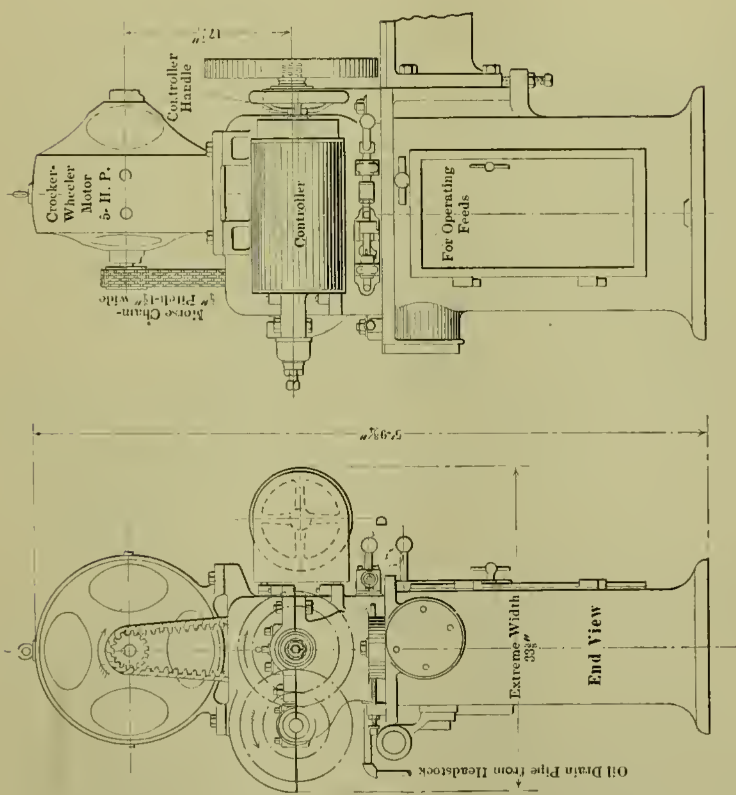


FIG. 1.—MOTOR DRIVEN TURRET LATHE.—AMERICAN TOOL & MACHINE COMPANY.

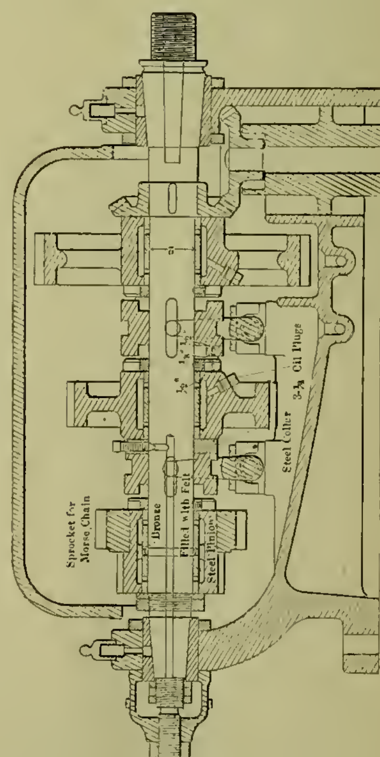


FIG. 2.—SECTION THROUGH HEADSTOCK.

speed. The upper pulley for the forward-motion belt is mounted on a sleeve concentric with the above mentioned shaft, and by means of suitable gearing and jaw clutches operated by a hand wheel conveniently placed at the side of planer, this sleeve and pulley may be driven at any one of four speeds by the inner shaft, thus giving for a return table speed of 70 ft. a minute forward speeds of 35, 27, 20 or 15 ft. a minute. The changes of speed are regulated by a dial on the hand-wheel, the latter being mounted on a shaft carrying a cam drum which operates two levers for shifting the gear-controlling clutches overhead. Each lever thus controls two speeds, and the cam and levers are so arranged that one of the levers must remain stationary while the other is moved to shift its clutch. Hence there is no possibility of both clutches being accidentally engaged at the same time. If finer cutting speed variations are desired, they are obtained by varying the motor speed.

The remarkable feature of the equipment is that the reversal of the table, even at the highest speeds, causes practically no peak load on the motor; or stated another way, the ammeter readings for a complete cycle with 8-ton casting on table, running at maximum speeds, are as follows:

During cutting stroke	50 amperes.
At reversal	75 amperes.
During return stroke	70 amperes.
At reversal	70 amperes.

Thus it requires hardly any more power to reverse than it does to move the table during the return stroke, which means that a considerably smaller motor can be used than would otherwise be necessary. This desirable result has been obtained by making but a few slight alterations in a standard planer, the main points being the use of a proper sized fly-wheel, changing the proportions of the lower driving pulleys and the use of the lightest-weight pulleys consistent with strength. The two latter changes cause the reverse to take place quickly, smoothly and without any of the customary objectionable shrieking of belts. "The total work done in stopping and starting the moving parts at each reversal (this work being transformed into heat that destroys the belts) is but one-third of that which is wasted where the design is the customary one for planers of this size. Although the planer has been used chiefly on very short stroke work for the last six months, it has been found unnecessary to employ the belt tightening idlers intended for use in case the extremely hard duty should cause the belts to stretch unduly." This interesting machine is the result of extensive experiments and study of the problem made by the Crocker-Wheeler Company in the course of its investigations into the subject of motor-driven machine tools, and they are the authority for the above statement.

Fig. 5 shows a new planer, 36 ins. wide and 18 ins. high, designed specially for the heaviest class of frog and switch work by the Cincinnati Planer Company, of Cincinnati. The table, massively proportioned, is 32 ins. wide, and has an inside bearing its entire length, overcoming the pressure of the heavy side cuts, and adjustable steel gibs are provided on each side to prevent lifting. The V's are very wide and are lubricated by a series of automatic roller-oiling devices. The cross-rail has a deep box brace on the back for stiffness and is secured to the housings by a very rigid construction. The driving belts are 3½ ins. wide, the driving shafts are of large diameter, are accurately ground and have extra long bearings, and the pulleys are so constructed that they require oiling only once in 60 days. The shifting mechanism is provided with a safety locking device which prevents the table from starting, except at the will of the operator. The bull wheel and rack have 10-in. face and 2 pitch.

Recruiting Firemen.—Nearly every railroad follows the general rule of obtaining enginemen by promoting firemen who have passed through a reasonable course of training in road service prior to their promotion. This being so, the importance of employing proper material for firemen is apparent. The primary requisites in employing firemen are: a fair general education, knowledge concerning fuel consumption, the best methods of firing to result in fuel economy and the operation of the locomotive to prevent fluctuations in temperature which are detrimental to the boiler and consequently efficient operation. Satisfactory evidence should be given by firemen applying for a position of their knowledge and ability to handle fuel, prior to the approval of the application. Railroads have had to employ men on short notice and have consequently taken the material which has offered. If, however, it were well established as a general rule that each railroad required certain qualifications to be fulfilled before employment would be given, vacancies could be filled with material of a higher order, as the inducements offered are superior to those of most trades consistent with the requirements from the applicant.—*Report on Coal Consumption of Locomotives, Master Mechanics' Association*, 1904.

Mr. I. C. Hicks, general foreman of shops at San Bernardino, Cal., has been appointed master mechanic of the Atchison, Topeka & Sante Fe Coast Lines, with office at Albuquerque, N. M.

MOTOR-DRIVEN TURRET LATHE.

The neat and compact arrangement of the headstock, the interlocking device for operating with one handle the single and double clutches which control the three runs of headstock gearing, and the arrangement of the electrical apparatus on a No. 1 motor-driven cabinet turret lathe, furnished by the American Tool and Machine Company of Boston to the Pittsburgh & Lake Erie Railroad for their McKees Rocks shops, are worthy of notice. (For illustrations see page 398.)

Referring to Fig. 1, which shows the side and end views of the headstock end of the lathe, it will be seen that the motor bracket forms a hood or casing for the headstock and that the motor controller is bolted to the door on the front of the hood, which permits access to the headstock. The controller handle is thus convenient to the operator and as the wires to the controller are carried in a flexible conduit and are attached at the left hand end near the hinges, they do not interfere with the opening or closing of the door. The Crocker-Wheeler Company 5 h.p. motor is connected to a sprocket on the main spindle by Morse silent chain.

Fig. 2 is a section through the headstock showing the arrangement of the gearing and clutches on the main spindle. The gears run loose on the spindle and mesh with corresponding gears which are keyed on the back shaft. The Morse chain sprocket is keyed to one end of the steel pinion, and the gears which run loose on the shaft are fitted with bronze bushings which have oil cellars back of them that are filled with felt and can readily be oiled by removing the oil plugs. The bevel gears at the right transmit motion to the feed mechanism.

The interlocking device and the arrangement for throwing the clutches are clearly shown in Fig. 3. When the handle D is turned down, thus turning the shaft to which it is keyed, motion is transmitted by means of the mitre gear sectors to the shaft which passes through the hood casting at the left and has a small pinion keyed to its end which meshes with the large sector and thus throws the single clutch to the position C. A little to the right of the mitre gear, on the shaft to which the handle D is keyed, is fastened a casting, so designed that when the shaft is turned and the single clutch is engaged, a small projection on it slides into a slot on the hood and thus prevents the shaft from being moved endwise. When clutch C is out the handle D can be moved either to the right or the left, thus throwing in either clutch B or A. When the long shaft is thus moved the projection on the small casting mentioned above is thrown out of line with the groove and prevents the shaft from being turned and engaging clutch C while either A or B are engaged. The arrangement is quite simple and ingenious and works easily.

Three geared feeds are provided which are operated by moving the handle just below the clutch handle and above the cabinet door either to the right or left.

Carnegie Gift to Engineering.—A circular from Prof. Hutton, secretary of the American Society of Mechanical Engineers, announces that Mr. Carnegie has prepared a deed of gift of a building to cost one and a half millions for use of the mechanical, electrical and mining engineers' organizations, and, therefore, the refusal of the American Society of Civil Engineers to join in the enterprise has no effect upon the plan. A number of architects are now preparing competitive plans for the building, and suitable progress is being made. The committee having the plans in charge hopes to report at the next annual meeting of the American Society of Mechanical Engineers, to be held in New York in December,

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Light Reciprocating Parts.—Most engineers of experience know that for high-speed work the parts of an engine should be as light as possible. Thus, by employing aluminum as an experimental material for a piston in a motor car engine an increase in speed of 300 r.p.m. has been obtained, as compared with the maximum possible when a heavier piston was used.—*The Engineer*.

LOCOMOTIVE TESTING PLANT AT ST. LOUIS.

Schedule From Observed Data.

On page 301 of the August number the beginning of the schedule of data taken from Bulletin No. 3 was presented. This list is concluded in abstract below:

OBSERVED DATA.

All instruments will be read at intervals of ten minutes during the test. Observations of the more important facts will be taken by two methods, and all calculations will be carefully checked.

Item No. 196. The locomotive will be gradually brought to the required conditions of speed and drawbar pull, and after it has been running under these conditions for a sufficient time to secure uniformity in the rate of firing and to allow all parts to come to their normal working condition, the test will be started.

The heavy power tests will continue until 30 lbs. of water have been evaporated per sq. ft. of heating surface, the lighter power test being stopped at the end of four to six hours.

The duration of test, given in hours and decimals of an hour, is the elapsed time from the start as given above to the close of test.

Item No. 197. A return crank, attached to the rear pair of drivers, is connected to a rotating revolution counter, which will be read at the beginning and end of test; and every ten minutes as well. A reciprocating revolution counter is connected with the corresponding supporting axle. From the diameters of the driving wheel and supporting wheel, a factor will be obtained by which the number of revolutions shown on supporting wheel counter can be compared with the number shown by driving wheel counter.

A tachometer will also be driven by the supporting axle, and this will provide a check for the average revolutions.

Item No. 206. For the smokebox temperature a thermometer with carbon dioxide above the mercury will be used as a check on the indications of the pyrometer.

Items Nos. 207 and 212. Le Chatelier couples and a galvanometer reading to millivolts, will give the smokebox and firebox temperatures.

The couple in the smokebox will remain in position; the couple in the firebox will be inserted through an opening in the side, about midway of its length, and at a height above the bed of coal of about 12 ins. After it has been in position with the fire door closed a sufficient time to assume the temperature of the firebox, readings will be taken and the couple withdrawn from the firebox.

Item No. 210. The temperature of the steam in branch pipe will be calculated from the observed pressure of steam in same and from the observed pressure and temperature of the steam in the calorimeter connected to the branch pipe.

Item No. 211. The feed water temperature will be taken in the receiving tank.

Items Nos. 217, 218, 219 and 220. Steam pressures will be obtained by special test gages; the gage for indicating boiler pressure will be located on the steam dome on the calorimeter pipe connection, and the gage for branch pipe outside of smoke front, connected to branch pipe by as short a pipe as possible. The pressure gage located in pipe from boiler or branch pipe and leading to throttling calorimeter will be read (after the other calorimeter readings have been taken) with the valve between boiler or branch pipe and calorimeter closed on account of the drop in pressure in the pipe leading to the calorimeter while that valve is open.

Item No. 221. The barometric pressure will be measured by use of a mercurial barometer, readings being corrected for temperature, and readings in inches of mercury converted into pounds per square inch.

Items Nos. 222 and 225. The draft will be measured by "U" tube draft gages, the readings of which will be checked by recording draft gages of an approved type.

Items Nos. 228, 229 and 230. The quality of steam in dome and branch pipe will be obtained by Peabody throttling calorimeters, provided with mercurial gages reading to tenths of pounds, and thermometers reading to half degrees.

Item No. 232. All coal used will be furnished by one mine throughout the entire period of the tests, precautions being taken to have it as uniform as possible.

Items Nos. 236 and 237. Both of these quantities will be found by analysis, because the draft in a locomotive firebox is so great as to draw a part of the ashes through the flues and give incorrect data if actual weights were taken. If the ash is found by analysis the combustible must necessarily be obtained in the same manner.

Item No. 238. The smokebox front will be cleaned at the beginning of test and at close, and the quantity of cinders which have collected during the test will be weighed by an accurate scale.

Item No. 239. The stack, by which the smoke will be removed from the building, is provided with a deflector and a receptacle into which the sparks which strike the deflector will fall. This receptacle will be cleaned at commencement of test and at close, the sparks which have been collected during the test being carefully weighed.

Items Nos. 241 to 246. The analysis of the coal will be made in accordance with the method decided on by the Committee of the American Chemical Society, and given in Volume 21, No. 12, of their Journal.

Items Nos. 248 to 250. The calorific value of the coal and cinders and sparks will be determined in the Thompson calorimeter.

Items Nos. 253 to 256. The analysis of smokebox gases will be conducted by the use of the Orsat apparatus.

Item No. 259. The water used by the boiler will pass through two calibrated water meters to two steel measuring tanks holding about 1,500 lbs. of water each; and from thence to a receiving tank holding about 17,000 lbs. of water.

The measuring tanks rest on calibrated platform scales, so that their capacities can be calibrated at frequent intervals, correction being made for temperature.

To obtain the total water delivered to injectors, the number of times each tank is emptied will be multiplied by their calibrated capacities at the average temperature of water during the test, and the fractional part of tank weighed out at close, added.

At the beginning of test the level of water in the boiler and receiving tank will be noted; the levels of water in both will be kept slightly below these levels during the test. At the close sufficient water will be fed into the receiving tank to restore the initial level. The level in the boiler will be noted, and when not the same as at the start, a correction will be made.

The quantities found by the measuring tanks are checked by two meters. Provision being made to catch and measure the small amount of water wasted in filling the tanks, the meter readings less this waste will be a check on the quantity delivered by the measuring tanks.

Items Nos. 260 and 263. The water which escapes from the injector overflow pipes will be caught and returned to receiving tank; and no credit will be given the boiler for the rise in temperature, if any, of this water.

Great care will be taken to prevent leakage from the boiler; the air pump and steam heat throttles will be disconnected so that leakage may be detected and the throttles made tight.

Leakage tests, when necessary, will be made on boiler after close of test, due allowance being made for change of temperature of water.

Item No. 265. The pull exerted by the locomotive will be measured by a traction dynamometer, already described in Bulletin No. 2.

The pen on the dynamometer will give a continuous record of the drawbar pull, which will be measured at ten-minute intervals; the average of these measurements to the scale of springs used will will give the average drawbar pull.

An integrating attachment records the square inches of the area included between the line of zero pull, or the base line, and the line of drawbar pull; this area, divided by the length of diagram, will give the average height and provides a check for the mean height obtained in the method first described.

Items Nos. 266 and 267. The maximum and minimum drawbar pull will be found by measuring the diagram after the test, or will be registered by an automatic attachment.

Items Nos. 268 to 291. The percentages of stroke, at which cut-off, release, and beginning of compression take place, will be determined by locating on each card the points at which these events occur. This will be done by the same method throughout the entire series of tests.

The length of each indicator card will be measured and an average obtained for cards for each end of each cylinder; the length of stroke up to the time cut-off takes place will be measured and averaged in a similar manner. The percentage that this average length of cut-off forms of the average length of card, will be the result on the data sheet. The percentage of stroke at which the other events mentioned take place will be calculated in a similar manner.

Items Nos. 292 to 299 and 306 to 329. The points showing the events of the stroke on indicator card at which pressures are measured, are described in the preceding paragraph, with the exception of the point representing the initial pressure, which also will be measured.

The pressures of steam corresponding with the several events of stroke in cylinder, as shown by the indicator card, will be measured by appropriate scale, and the results for each end of each cylinder averaged for each event. The average thus obtained will be corrected for the error of the spring under the conditions and pressure, *i. e.*, whether under increasing or decreasing pressure.

Items Nos. 301 to 304. Indicator cards will be taken from indicator on steam chest, the pressure given is the average pressure of these cards.

Items Nos. 330 to 337. The least back pressure will be measured in the same way as the pressures under Items Nos. 292 to 299, and the results averaged.

The exact location on the card of the point of least back pressure will vary somewhat on different cards of the same test, but the least back pressure will be taken without regard to exact location.'

SUMMARY OF AVERAGE RESULTS.

Boiler.

Items Nos. 340 and 341. The "moist steam per hour," Item No. 340, is the average water evaporated by boiler per hour uncorrected for moisture in steam, while "dry steam per hour," Item No. 341, is corrected for moisture by multiplying No. 340 by the "factor (F) of correction for quality of steam."

Item No. 346. The equivalent evaporation from and at 212 deg., per lb. of coal as fired, is found by dividing the equivalent evaporation per hour, Item No. 344, by the weight per hour of coal as fired, Item No. 233 ÷ Item No. 196.

Item No. 347. The equivalent evaporation from and at 212 deg. per pound of dry coal, is found by dividing the equivalent evaporation per hour, Item No. 344, by the weight per hour of dry coal, Item No. 338.

Item No. 348. The equivalent evaporation per pound of combustible is found by dividing the equivalent evaporation per hour, Item No. 344, by the weight per hour of combustible, Item No. 236 ÷ Item No. 196.

Item No. 349. The boiler horse-power will be found by dividing the equivalent evaporation per hour, No. 344 by 34.5.

Item No. 350. The efficiency of the boiler is found by multiplying the equivalent evaporation per pound of dry coal, No. 347, by 965.8, and dividing the product by No. 248, the number of thermal units in one pound of dry coal.

No credit is given the boiler for heat units used in evaporating moisture contained in fuel as fired.

Engines.

Items Nos. 351 to 358. All indicator cards will be integrated twice by different computers.

After the average mean effective pressure of the indicator cards for each end of each cylinder has been ascertained, the card most nearly approximating the average will be selected to represent the test. In case these cards are subject to correction, resulting from a calibration of the indicator spring, the following method will be used:

Vertical lines dividing the length of card into ten or twelve equal parts will be drawn. At the points where these lines intersect the lines of the card, the card will be corrected (correction curves having been made for each spring); if an increasing pressure, for the error of the spring under similar conditions, if descending, in like manner. A new card will be drawn through the points thus located and the relation of the area of the rectified to the actual card will give a factor which will be used in finding the corrected M. E. P.

Items Nos. 365 to 372. The indicated horse-power is found by multiplying together the I. H. P. constant, the average revolutions per minute and the mean effective pressure.

For the head end of right high pressure cylinder, the indicated horse-power = No. 180 × No. 198 × No. 351.

The formula for the other items will be similar in form, with the corresponding quantities substituted.

Item No. 381. The dry steam per indicated horse-power per hour is found by dividing the dry steam per hour, Item No. 341, less the steam used by calorimeters or other instruments, by the total indicated horse-power, Item No. 379.

Item No. 382. The B. T. U. per I. H.-P. per hour is found by multiplying the dry coal per I. H.-P. per hour, Item No. 380, by the calorific power of one pound of dry coal, Item No. 248.

Locomotive.

Item No. 383. The dynamometer horse-power is found by multiplying together the D. H.-P. constant, Item No. 179, the average revolutions per minute, Item No. 198, and the average draw-bar pull, Item No. 265, or D. H.-P. = No. 179 × No. 198 × No. 265.

Items Nos. 384 to 386. The pounds of coal, steam and B. T. U. per D. H.-P. hour are found in the same manner as the corresponding items for indicated horse-power hour.

Items No. 387 to 389. The number of foot-pounds is found by multiplying together the average drawbar pull, Item No. 265, the average circumference of the driving wheels in feet, Item No. 13, and the total revolutions, Item No. 197.

Item No. 395. The machine friction of locomotive in terms of horse-power, is the difference between the average indicated horse-power and the average dynamometer horse-power. This does not take into account the friction due to engine truck and trailing wheels and axles.

Item No. 396. The machine friction in terms of pounds mean effective pressure, for simple engines, will be taken as the machine friction in horse-power (No. 395), divided by the average horse-power constant and the average revolutions per minute.

Item No. 397. The machine friction in terms of pounds drawbar pull is the frictional horse-power, No. 395, multiplied by 33,000 to convert it into foot-pounds, divided by the distance in feet per minute.

Item No. 398. The machine efficiency of locomotive in per cent. will be taken as 100 times the ratio of the D. H.-P., No. 383, to the I. H.-P., No. 379.

Item No. 399. Efficiency of locomotive will be found by dividing the heat equivalent of one horse-power for one hour, by the B. T. U. per dynamometer horse-power hour, No. 386, shown by test. This quantity multiplied by 100 will be the efficiency in per cent.

Coal Calorimeter.

The calorimeter to be used is the William Thompson calorimeter with some slight modifications to facilitate working and output. This calorimeter has been standardized by testing in it two samples of coal which were previously tested in ten different bomb calorimeters, including a test in the bomb calorimeter at the Bureau of Standards, Washington, D. C. The mean of these ten determinations is taken as representing the heat units in these two coals, and these coals when tested in the Thompson calorimeter, enable it to be standardized so as to give results the same as the bomb calorimeter. Furthermore, a sufficient amount of these two coals has been prepared so that the Thompson calorimeter can be frequently checked. It also provides a means of ready standardization, in case of accident to any of the parts of the Thompson calorimeter, or in case of getting a new instrument complete.

Orsat Apparatus for Anaylsis of Smokestack Gases.

The Orsat apparatus to be used in analysizing the smokebox gases has had its measuring pipette carefully calibrated by filling with water at room temperature, and then weighing this water as a whole and in successive portions corresponding to the graduations on the measuring pipette. The necessary corrections, where any were found requisite, will be used in reading the percentages from the measuring pipette.

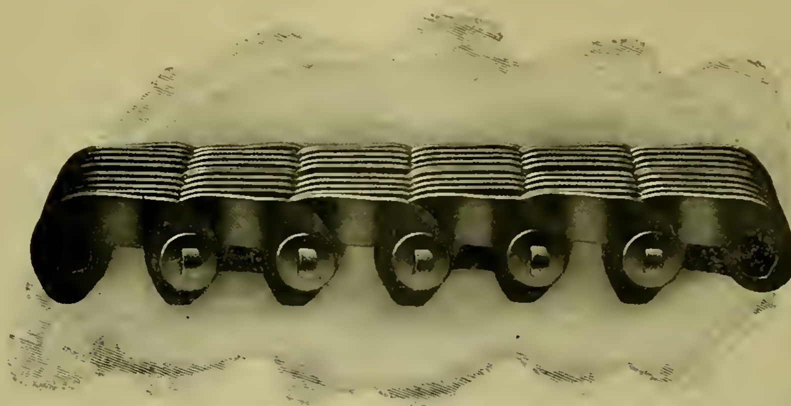
MORSE SILENT CHAIN.

To the engineer who is confronted with the problem of applying individual motors to either old or new machine tools, or who is looking for a compact and efficient means of transmitting power, this chain is invaluable. It is much more efficient than belting, and where the size of pulleys is limited or it is necessary or desirable to use a short distance between centers or to transmit a large amount of power it can be used where belting cannot be. Because of its noiseless action and the positive and large speed ratios which can be obtained it can often be used to good advantage in place of gearing. Those who have watched the progress of motor-driven machine tools or who have followed the series of articles which have appeared in this paper on the application of individual motors to the old machine tools at the McKees Rocks shops, will recognize its value for such work.

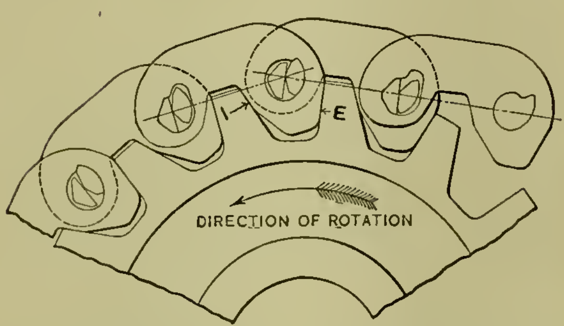
It can be run up to speeds of 2,000 ft. per minute, can run on sprockets with as few as 13 and as many as 130 teeth, has a sustained efficiency of nearly 99 per cent, is silent running, can be used in the presence of moisture, heat or dust, and does not wear the joint or lengthen from the lack of lubrication.

Its construction is clearly shown on the accompanying illustrations. The joint consists of two pieces of hardened tool steel, so shaped and arranged that, as the joint works while passing on and off the sprockets, one piece rocks or rolls on the other. Each part of the joint is fixed in opposite ends of the links, and as there is only a pure rolling friction on hardened tool steel surfaces with ample contact area to stand the pressure, there is no tendency for the joint to wear and cause the chain to lengthen. To prevent undue vibration under high speeds and the consequent wear, the rocker pins of the high-speed, silent-running chain are so shaped that the contact surfaces are greatly increased when the chain is drawn straight

LINK SHOWING HOW PINS FIT.



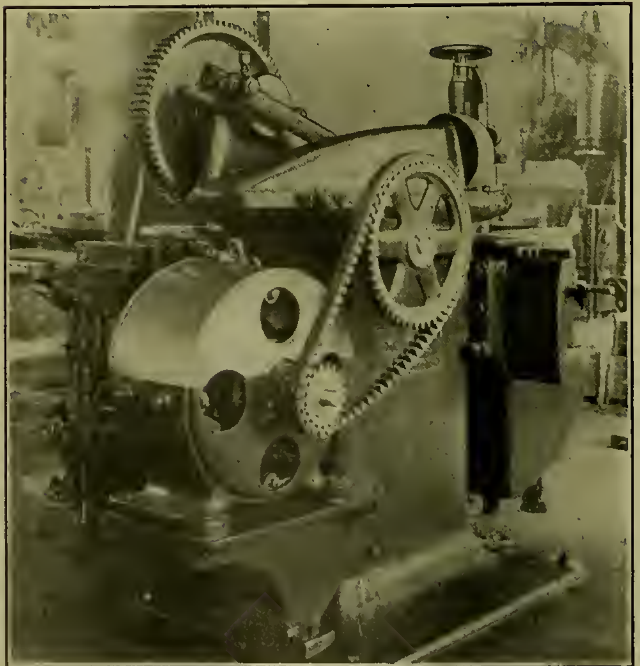
EXTERIOR APPEARANCE OF CHAIN.



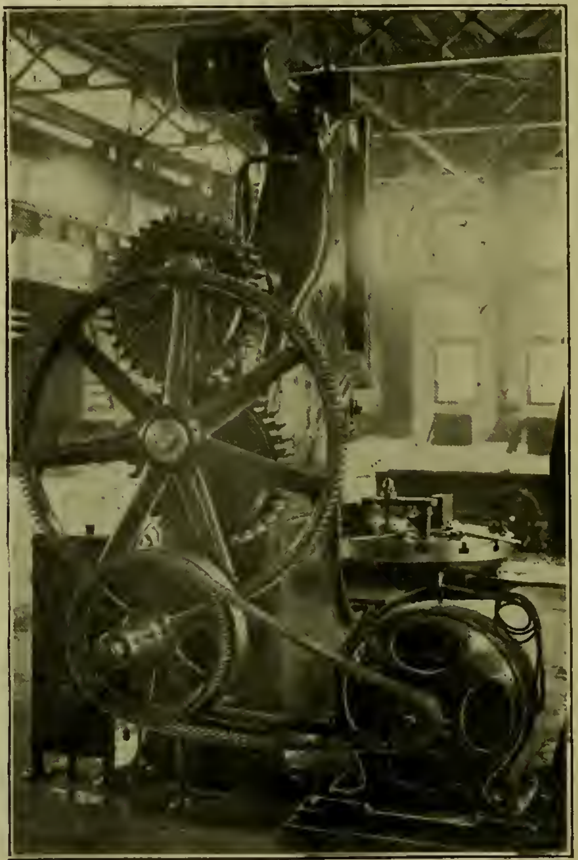
SHOWING ACTION OF CHAIN ON SPROCKETS.

TWO 50 H.P. MAIN SHAFT DRIVES ON 48-IN. CENTERS SHOWN IN MOTION.—TWO CHAINS FROM EACH MOTOR, RUNNING AT 1,445 FT. PER MINUTE.

ACTION OF ROCKER PINS ON STRAIGHT PULL AND ON SPROCKET.



APPLICATION TO 12-IN. HEWES & PHILLIPS SHAPER.



APPLICATION TO 19-IN. PUTNAM SLOTTER.

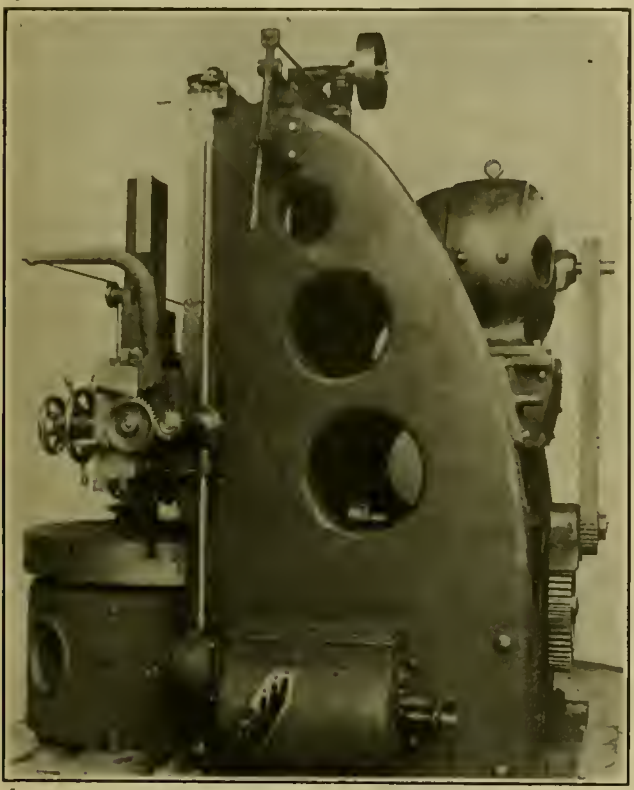
MORSE SILENT CHAIN AND APPLICATIONS.

between sprockets, giving a broad bearing in this position. The two-part pin used in the Morse rocker joint permits of an unbroken contact the whole width of the chain, less the outside links, thus nearly doubling the length of the bearing surface over a chain with a single-pin joint.

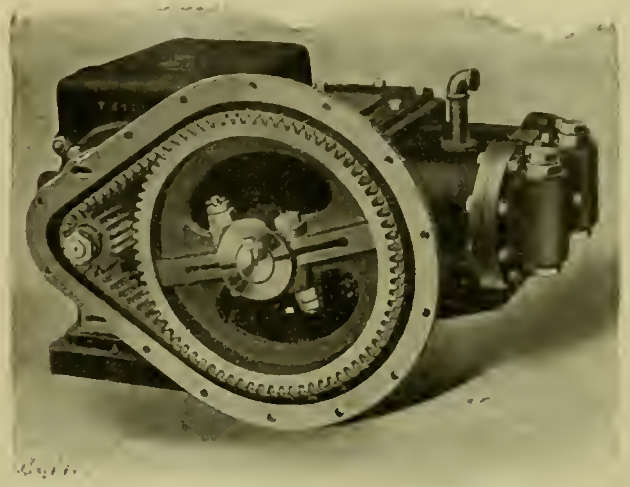
As the rocker joint is subjected only to rolling friction it does not require lubrication, and the speed limit is therefore not fixed by the point at which the centrifugal force will throw off the lubricant. On the small line cut showing the action of the chain on the sprocket the link engages the tooth at E on the driving sprocket and at I on the driven sprocket. The chain will run in either direction. A paste grease, sufficiently heavy so that it will not be thrown off at high speeds, affords proper lubrication for the chain in its contact with the sprocket teeth and between the plates of the chain itself. As the pressure between the chain and the sprocket teeth is inversely proportional to the number of teeth in contact with the chain, and as this number is large, the pressure is small, and very little wear will take place. The life of a silent-chain is proportional to the number of teeth in the large sprocket, and since the lengthening of the Morse chain is very slight it is possible to use very large sprockets and make large speed reductions. The relation of the size of the wheel to the life of the chain—and this is the principal feature that makes it silent—comes from the fact that the chain climbs higher on the tooth as it lengthens and does not become inoperative until the top of the tooth is reached. The height of the tooth for a given pitch is practically the same for all sized wheels, and it follows that in a unit length of chain, equal to the circumference of any wheel, the total lengthening that may take place before the top of the tooth is reached is the circumference of a circle whose radius is the height of the tooth. The amount of stretch, therefore, that can take place per link in this unit of length of chain is inversely proportional to the number of teeth in the wheel, which equals the number of links in the chain. It is for this reason that with a chain having the less lengthening due to joint wear the greater the number of teeth that can be satisfactorily used in the large wheel, with a consequent larger speed ratio.

The sprocket wheels are made of high grade cast iron, accurately cut, and in use show little or no wear. For exceptionally hard service or when there is little metal around the shaft, hardened steel sprockets are furnished. To properly guide the chain, special guiding links are used, projecting below the balance of the chain into grooves turned in the sprockets. The holes in the opposite ends of the links are punched to conform in shape to and securely hold, in the large end of the link the rocker pin, and in the small end the seat pin, there being no motion between either part of the joint pin and link. The outside links are bent laterally so that the large end comes under the small end of the adjoining link to permit of the proper engagement with both seat and rocker pin. The joint pins are made of the best grade of tool steel carefully hardened, the shouldered ends of the seat pins being softened to permit of being riveted in the outside links or in washers in the larger pitches to securely hold the chain together.

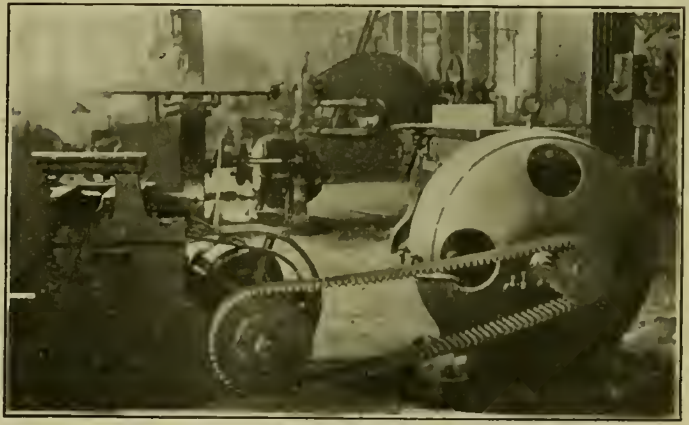
This chain has a wide range of applications, from heavy main drives direct from engine or motor on short centers, to light drives on machine tools. A few interesting applications are shown on the accompanying illustrations. The chain is made by the Morse Chain Company, Trumansburg, N. Y.



Bausch 51-in. Boring Mill.



7-H. P. Air Compressor.



Cut-off Saw.

MORSE CHAIN APPLICATIONS.

More steam (about 250 b. h. p.) can leak out through a 1-in. hole in a steam pipe at 150 lbs. steam pressure than one fireman would usually supply by steady coaling. Leaks in steam pipes are apparently insignificant, but they rapidly dissipate the heat generated in the consumption of a large amount of coal. Uncovered steam pipes also waste large amounts of coal. Approximately about 1-3 of a lb. of steam would be condensed by each square foot of naked steam pipe per hour, which would mean that 1 b. h. p. is dissipated by every 90 sq. ft. of naked steam pipe.—*Prof. R. C. Carpenter in Power and Transmission.*

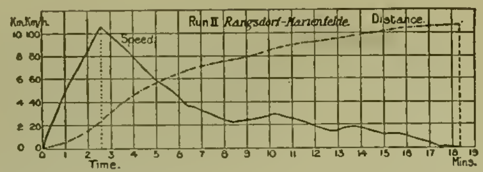


FIG. 1—CURVES SHOWING RETARDATION OF CAR "A."

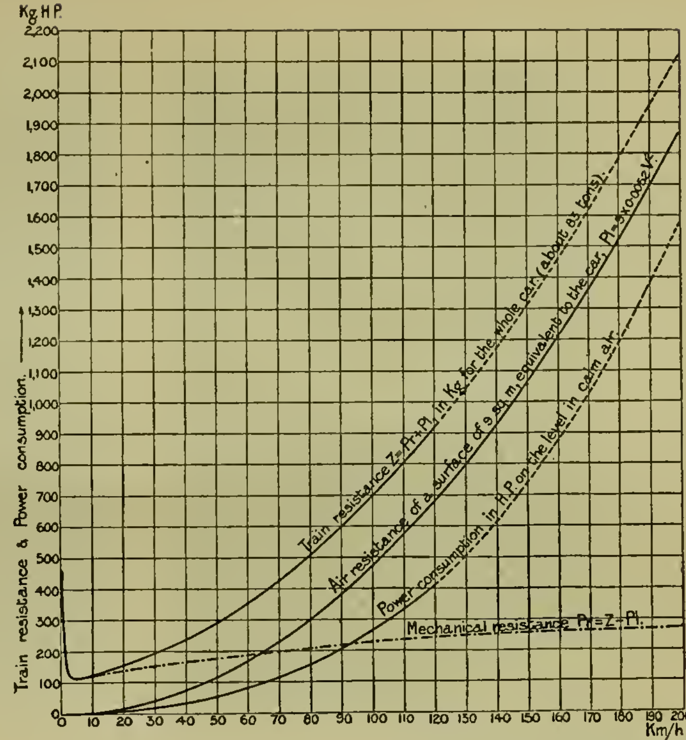


FIG. 2—TRAIN RESISTANCE AND POWER CONSUMPTION OF HIGH-SPEED CARS.

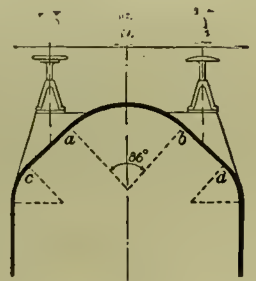


FIG. 3—SHAPE OF FRONT OF CAR.

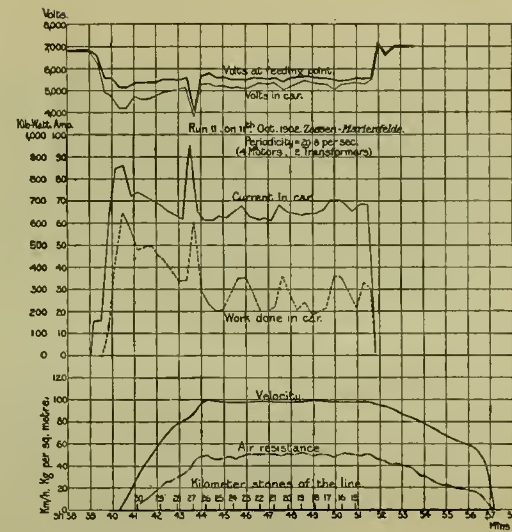


FIG. 4—RUNS WITH CAR "A."
Weight = 89,500 *Kg*.

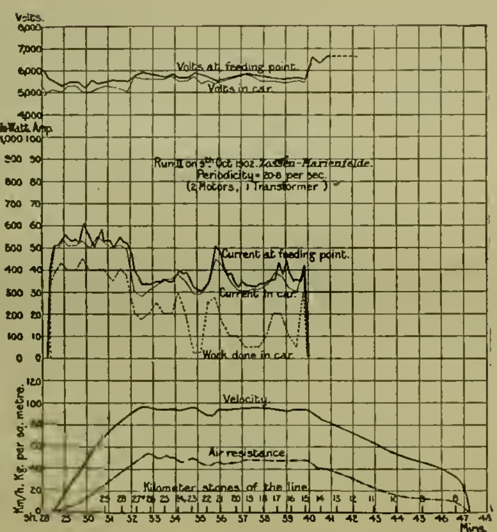


FIG. 5—RUNS WITH CAR "S."
Weight = 77,900 *Kg*.

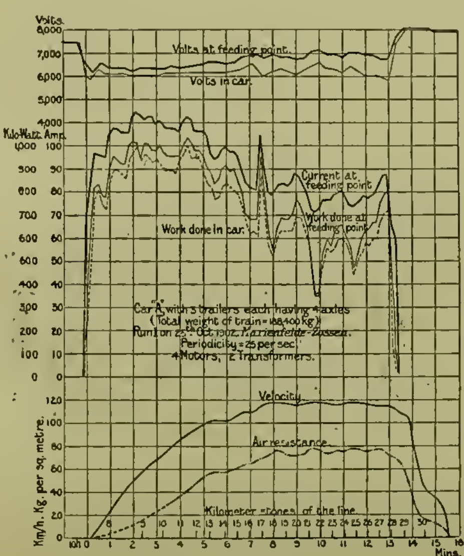


FIG. 6—RUNS WITH TRAILERS.

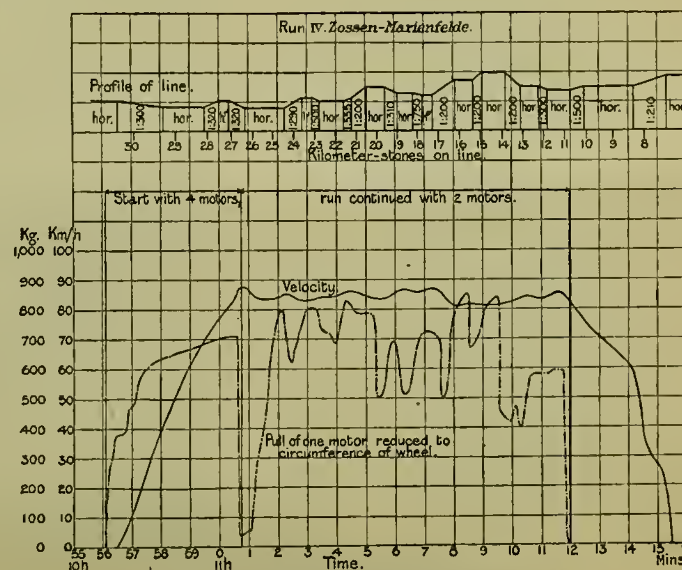


FIG. 7.—TRIAL RUNS WITH CAR "A."

HIGH SPEED RECORDS ON MARIENFELD-ZOSSEN EXPERIMENTAL LINE.

HIGH SPEED EXPERIMENTS.

MARIENFELD-ZOSSEN ELECTRIC LINE.

An elaborate paper by Mr. Alexander Siemens before the Institute of Electrical Engineers (London) presents valuable records and statements concerning the result of these trials. The paper is too long to reprint. It recites the history of the groups of experiments and presents purposes and methods and describes the equipment and apparatus. The following paragraphs constitute an attempt to describe the most important features of the paper.

There was no serious difficulty with conducting and transmitting high tension current to the cars and motors. This portion of the problem is considered solved. The permanent way, however, was not satisfactory at the highest speeds, due to the great weight of the cars. The cars were too heavy for economical operation and the experiments show the necessity for using stationary transformers and otherwise lightening the electrical machinery, also for using very high voltages without transformers.

Two cars are referred to in the paper, one having been equipped by the Allgemeine, Elektrizitats-Gesellschaft and designated car "A." The other was equipped by Messrs. Siemens & Halske and designated car "S." Most careful, elaborate and complete data were taken as to speeds, power, air resistance and acceleration. Regular runs of both cars began October 14, 1901. In the third series of experiments car "S" reached a speed of 160.2 km. per hour on November 5. The track was severely punished and the speeds were afterwards restricted to 130 km. per hour.

To attain a speed of 100 km. per hour required a distance of from 2,000 to 3,200 meters and from 138 to 220 seconds, giving an average acceleration of 0.13 to 0.2 m. per second, and requiring from 700 to 1,000 h.p. With a motor capacity of 3,000 h.p. more rapid acceleration might have been attained except for the deficiencies of power at the generating station. The experimenters found the braking question more important than acceleration, because it concerns the safety of the train. The braking trials, however, were not considered as conclusive. Both cars had Westinghouse quick-acting brakes, hand brakes and electric brakes acting by reversal of the current through the motors. The "A" car had in addition an accumulator battery, the current of which would be put through the three-phase motors. In Fig. 1 is shown a curve of speed from car "A" when allowed to drift trom a speed of 160 km. per hour.

Observations of power required at constant speed are given in the following table:

POWER REQUIRED AT CONSTANT SPEED.

Car.	Speed. Km. per hour.	B. H. P. Measured at feed-lug point.	B. H. P. Measured at car collector.	B. H. P. Calculated from speed.	Efficiency of electrical outfit. Car by itself. Per cent.	Efficiency of electrical outfit. Car and conductors. Per cent.	Consumption of steam. Kg. per B. H. P. per hour. At car wheels.	Consumption of steam. Kg. per B. H. P. per hour. At flywheel of steam engine.
"A"	118	478	455	397	87	83	5.84	4.6
"S"	115..	431	405	341	84	79	6.12	

Air resistance was most carefully studied by means of air tubes and water gauges. By a process of exploration it was found that a cone of uniform pressure exists in front and at the back of the car the apex of which was about 3 m. from the car. It will be necessary to wait for further experiments to obtain a definite formula for the air resistance. Fig. 2 records the traction resistance of a car weighing 83 tons, the air resistance of a surface of 9 sq. m. and the horse-power required on a level with no wind. From these curves the mechanical friction may be obtained by subtraction. These curves show how important air resistance becomes at high speeds. Fig. 3 illustrates the form determined upon for the car fronts.

Figs. 4, 5 and 6 give data as to power required with and without trailers. Turning moments were measured directly from the motors, and the results of a run made November 8 on car "A" are given in Fig. 7.

The experiment to show the possibility of using motors with high tension currents are considered to have demonstrated the feasibility of employing three-phase currents of 10,000 volts without transformers.

The complete paper must be consulted by readers who desire to study the results in detail.

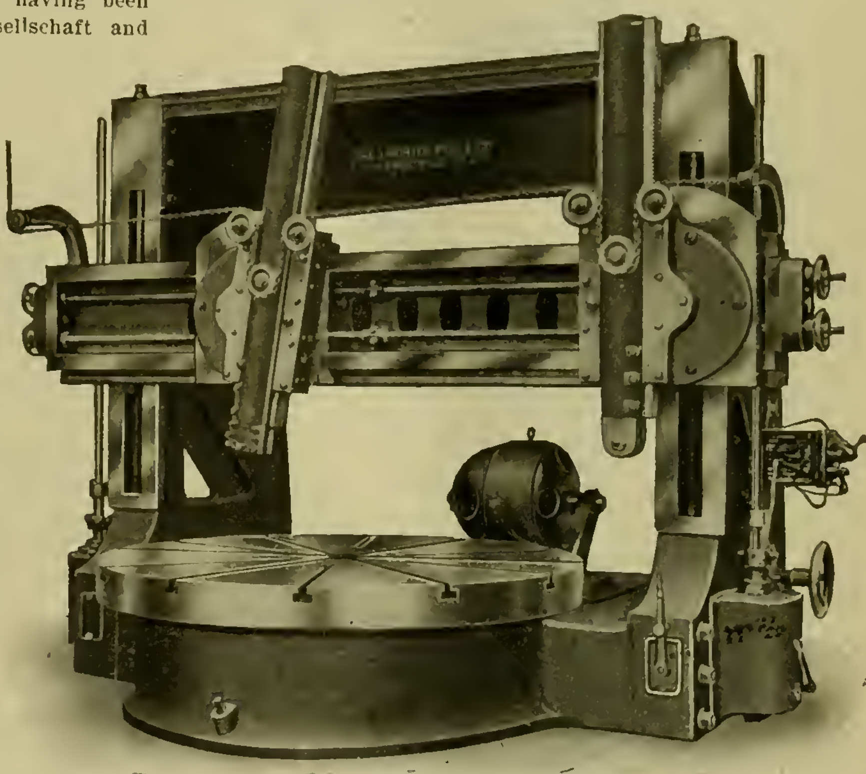


FIG. 62.—10-FT. BORING MILL.—J. MORTON POOLE COMPANY.

MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

XV.

A powerful driving mechanism arranged to furnish several different table speeds, and a geared variable-speed feeding mechanism are features of the boring mills made by the J. Morton Poole Company, of Wilmington, Del. These machines are designed for the use of high-speed tool steels, and can be arranged for either a motor or a belt drive.

Fig. 62 shows one of their 10-ft. motor-driven boring mills. The table rests upon a wide flat annular bearing near its outer edge which is automatically lubricated by rollers located in pockets and held against the bearing by springs. It is driven by a powerful "Hindley" worm wheel which is mounted on the spindle between the upper and lower bearing and runs in an oil chamber. Placing the worm wheel on the spindle in this way enables the operator to elevate the table from its outer bearings and take the thrust on the spindle step bearing without destroying the alignment of the worm and wheel.

Fig. 63 shows the arrangement of the worm gearing and

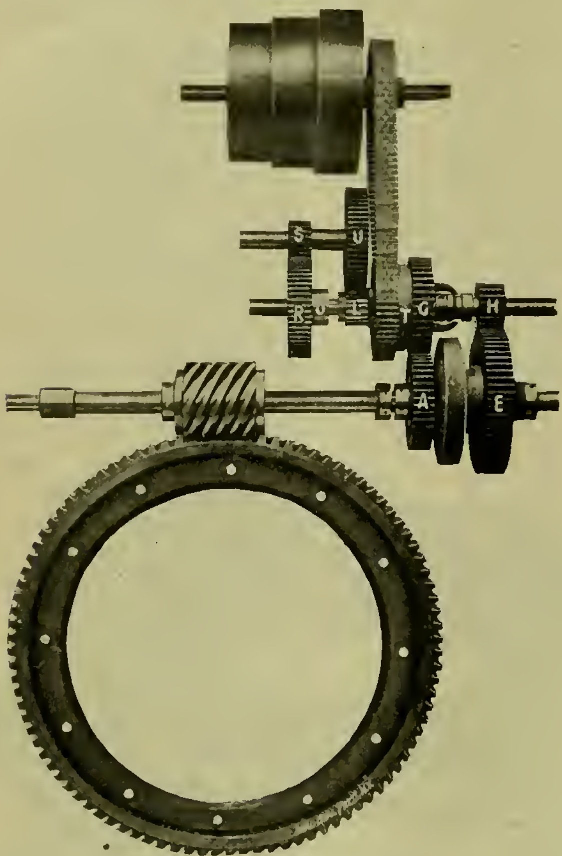


FIG. 63.—DRIVING MECHANISM.

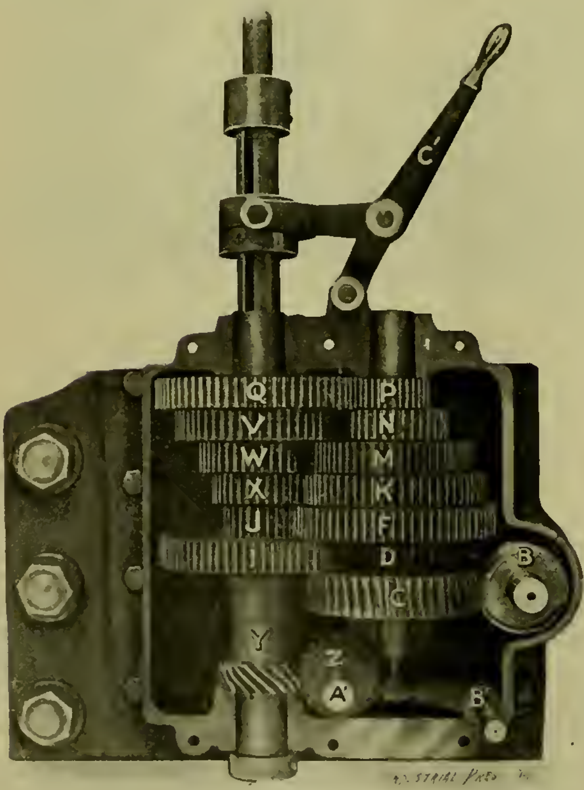
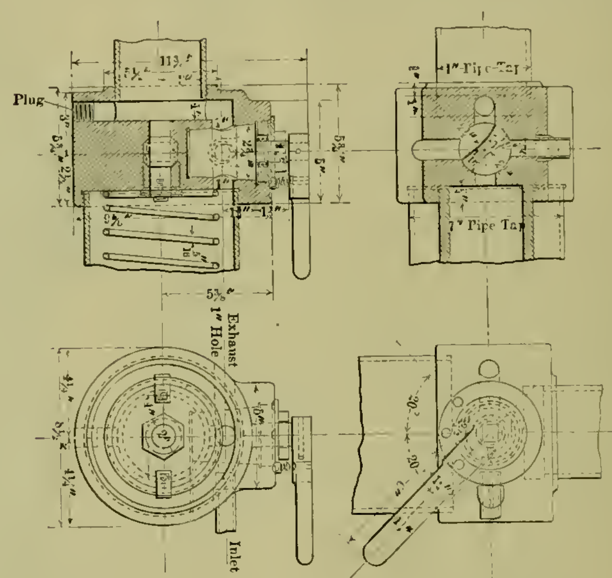


FIG. 64.—FEED GEARS.

driving mechanism. With a motor drive the speed cone is replaced by a motor. Gears G and H are keyed to the back gear shaft and drive the loose friction gears A and E. The chain sprocket T runs loose on the back gear sbaft and carries the pinion L, which drives the back gears U, S and R, the latter running loose on the shaft. The chain sprocket can drive the back gear shaft direct, by operating the friction clutch between G and T, or a back gear ratio of 8 to 1 can be obtained by engaging the clutch O, which is keyed to the shaft with the hub of gear R. This arrangement of gearing furnishes four speeds with back gear ratios of 12, 36, 95 and 285 to 1. If the machine is belt driven and a three-step cone pulley and a two-speed friction countershaft are used, 24 table speeds are available and either series of eight speeds can be obtained without shifting the belt or stopping the machine. Speed changes are made by means of the hand wheel and a lever at the right side of the machine.

The feed box with the cap removed is shown in Fig. 64. On each end of the main worm shaft is a feed worm, B, driving the worm wheel C, which is keyed to the pinion D running loose on the shaft. Gear F is also loose on the shaft and is driven from D through gears I and J which run loose on the other sbaft and give a feed back gear of 8 to 1. Either D or F can be engaged with the shaft by means of a sliding key operated by the lever B'. Gears K, M, N and P are keyed to the shaft and drive the four loose gears Q, V, W and X, any one of which or the rapid traversing spiral gear Y can be engaged with the shaft by the lever C', which operates a sliding key on the sbaft. If the machine is operated by a belt-drive, spiral



FOUR-WAY COCK FOR PNEUMATIC STAYBOLT BREAKER.

gear Y is driven through gear Z and tbe shaft A' by a pulley and gears placed on the outside of the feed box. When motor driven the pulley and gears are removed and the shaft which extends through the feed box and into the bed is driven from the main drive back shaft by a silent chain. The various combinations of gears furnish 8 feeds ranging from 1-64 to ¾ in., and also a quick traverse of the crossheads in and out and of the tool bars up and down at a rate of 8 or 13 ft. per minute. The feeds can be changed without stopping the mill and it is impossible to throw the traverse and power feeds in at the same time. The feeds and the traverse of the crossheads are controlled by the two hand wheels on the gear boxes at each end of the crossrail. The two heads are entirely independent.

A lever in front of the right band upright controls a friction clutch for elevating and lowering the crossrail which travels at a rate of 4 to 7 ft. per minute.

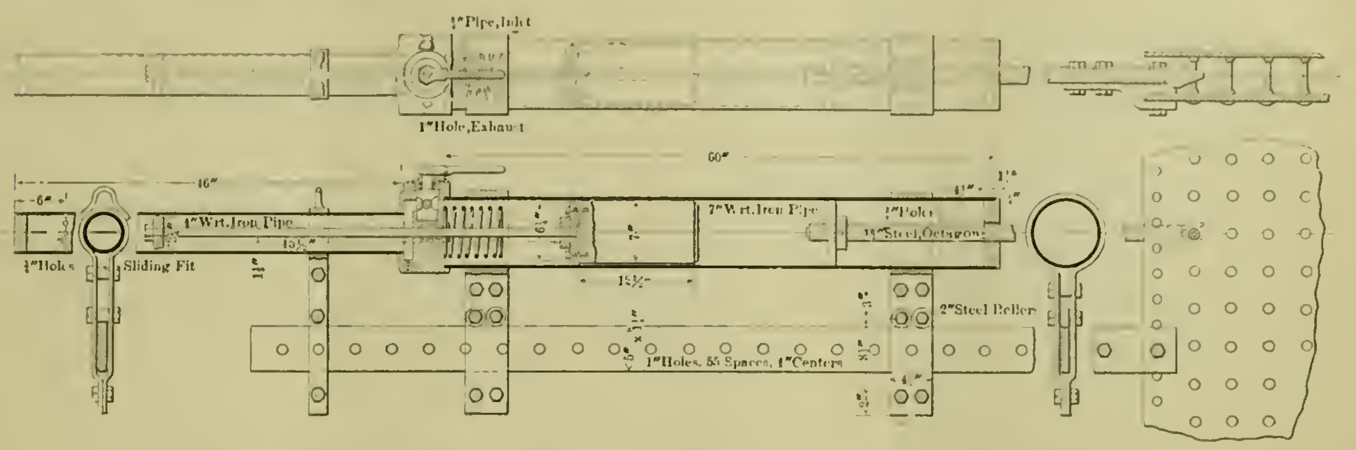
While we need about 10 2-3 lbs. of air per pound of combustible carbon and should have, to insure safety, probably 15 lbs., we usually find 25 to 30 lbs. have passed through our furnace. The economic result of this large supply is to increase the amount of heat wasted in the chimney from a minimum of 8 to 12 per cent. to an amount averaging frequently 25 to 30 per cent. The wastes due to an excessive supply of air can be largely reduced by good firing and by use of proper appliances. —*Prof. R. C. Carpenter in Power and Transmission.*

PNEUMATIC STAYBOLT BREAKER.

Chicago, Rock Island & Pacific Railway.

At the Moline shops of the Chicago, Rock Island & Pacific Railway a pneumatic staybolt breaker is in very satisfactory use. It breaks one and often two or three staybolts with one blow. This device can be easily constructed by any tool room force, and it offers marked advantage over the usual sledge-and-laborers method.

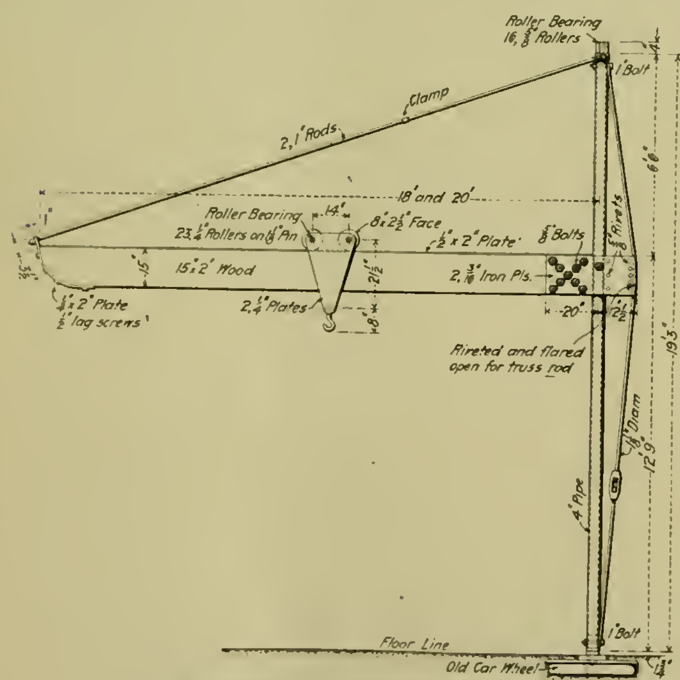
A heavy, single-action plunger 7 ins. in diameter strikes the 1¾-in. octagon steel cutter bar, which is placed against the staybolt. A 4-in. pipe constitutes the return, or pull-back, cylinder, the control being by means of a 4-way cock, the casting of which forms the connection between the two cylinders. The cylinders rest upon rollers on a 5-in. by 1¼-in. bar, the right hand end of which is secured to the firebox. This bar has 55 1-in. holes at 4-in. centres, and a pin is passed through it at the proper location for a resistance to the cylinder against the blow of the ram. The engravings show a longitudinal section and plan and details of the 4-way cock.



PNEUMATIC STAYBOLT BREAKER.—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

AN INEXPENSIVE FORGE SHOP CRANE.

In view of the fact that a crane such as the one shown in this engraving may be made from scrap material which is to be found in any railroad shop plant, there is no excuse for the absence of such conveniences in either forge or machine shops. The sketch speaks for itself. The crane costs nothing and will carry a load of 1,500 lbs. It is used at the Atlanta shops of the Southern Railway, the drawing having been furnished by Mr. S. S. Riegel, chief draftsman. These cranes are supplied with both air and chain hoists.



INEXPENSIVE FORGE SHOP CRANE.

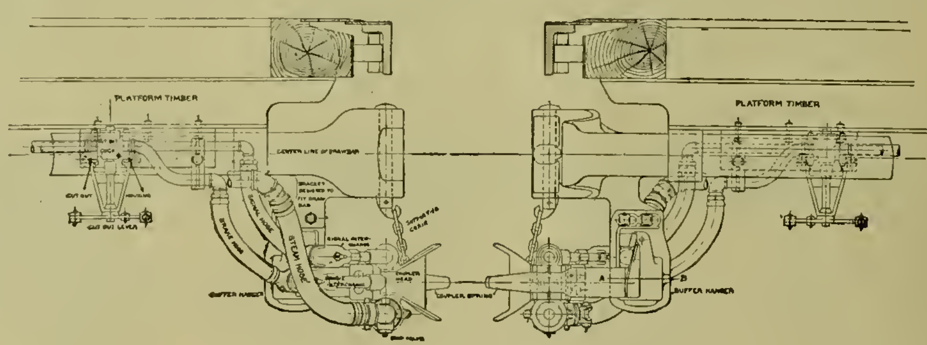
THE WESTINGHOUSE AUTOMATIC AIR AND STEAM COUPLER.

The objects in view of a device to do away with the common method of hand clamping of inter-car hose connections were threefold. The question of the safety of the railroad employe was regarded as of first importance. Despite the adoption of the automatic car coupler, railroad employes engaged in making up and distributing trains were still exposed to a very serious danger in this hose coupling, the platforms, safety chains and hand brake rods impeding escape from between the vestibuled cars of passenger trains in case of a premature starting signal to the engineer, and the great length of freight trains, with only a few men to attend to coupling and confusion of authority in starting, making freight hand hose coupling especially dangerous work. Instances of scalding as a result of the unexpected uncoupling of a hand steam connection while being tightened were not infrequent, and inconveniences in handling hot steam connections were a still further element of danger and delay. These features of hand coupling were not without their bearing on the financial reports of the big railroad companies. It is self evident that automatic hose couplings which have withstood the severest durability tests entirely eliminate all elements of danger. The Westinghouse device, placed in a special machine arranged to couple and uncouple a set twenty-six times a minute for ten hours a day, showed the first signs of weakening only after 64,000 couplings—an equivalent of about twenty years' actual service—had been effected.

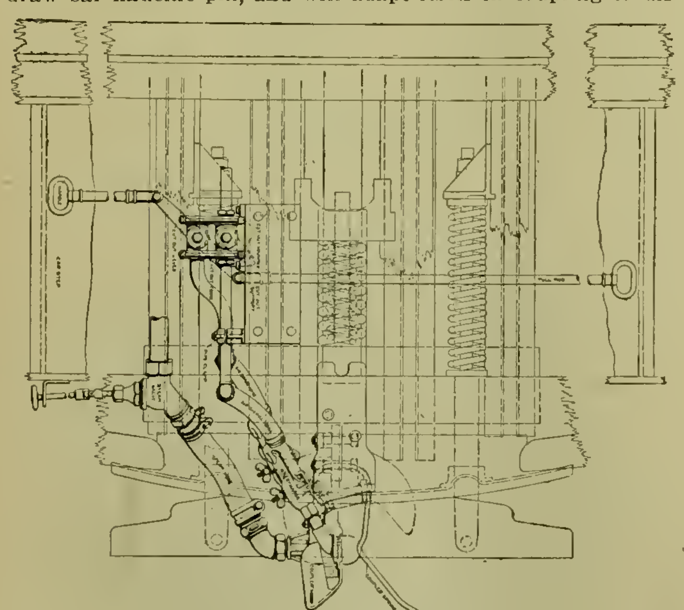
Time economy was the second and no less important object in view, and the records of several years' operation on a number of the best known American railroads indicate that the opportunities for improvement of schedule by the completion of the equipment of automatic coupling had not been underestimated. The Long Island Railroad, which has equipped its entire passenger rolling stock, 565 cars and 170 locomotives, with the modern device, has found that congestion at terminal stations has easily been avoided since its adoption. The New York Central Railroad, which operates its entire Putnam Division, consisting of 84 cars, with this automatic hose coupling, has found a great saving of time in making up trains. The Missouri Pacific, which has adopted the automatic coupling for its entire suburban service out of St. Louis, after very complete trial, has found it to be a factor of considerable value in the maintenance of a heavy short haul schedule. The Texas Midland, which has equipped its entire passenger service with it, the Pennsylvania, which has used it on the Middle Division between Harrisburg and Altoona, the Boston & Maine and the Queen & Crescent roads report equally satisfactory results.

The New York Central Railroad has estimated that the cost of hose under the old method was 230 per cent. of that under the new. It has been estimated, after careful compilation of reports as to the length of service of hose removed from the cars on one big railroad system during 1903, that the average life of hose, when uninjured by accident or careless treatment, was about 35 months for the best grades and from 20 to 25 months for the cheaper grades. The monthly inspection reports of the same road, however, showed that only 60 per cent. of the hose removed had become porous, as an indication that it had run its full service, the other 40 per cent. having been burned, cut, chafed, or strained or torn at the nipple, as a result of carelessness in coupling or uncoupling or in permitting the hose to dangle along the tracks, or as a result of exigencies or service or accidents in which cars were pulled apart before the hand hose connections had been uncoupled. The Westinghouse automatic hose couplings, which will operate perfectly on a 20-degree curve with 4-in. variation in the height of cars, give positive assurance that the couplings are at all times perfectly made, without the slightest friction or pull on the hose connections, and are at the same time so constructed that the uncoupling, which is always automatic, will positively be effected without strain of any kind on the apparatus, should the train be parted by accident, the air brakes being thus automatically applied.

The Westinghouse automatic hose couplings, as exhibited at the St. Louis Fair, are interchangeable, with no rights or lefts. The coupling head, which is of malleable iron having V and wedge shaped guides projecting toward the front and an outwardly bent spring firmly riveted to the back, is supported by the coupling spring resting in the slotted buffer hanger, the hanger being bolted to a cast steel bracket riveted to the drawbar. It is held in proper position by a chain attached to the draw bar knuckle pin, and will adapt itself in coupling to differences in height of cars or angles of contact which would not permit the operation of the automatic car coupler itself. The slotted buffer hanger consists of a malleable iron frame embodying a spring seat and a cup shaped buffing piece pivoted from the upper part of the hanger, a volute spring holding the buffing piece forward to furnish a yielding resistance for the head during the coupling, the car coupler itself checking the impact before the buffer spring of the automatic hose coupling has been fully compressed. The coupling heads, which are alike for passenger and freight service except in the number of gasket openings in the face, are so modeled that the positive engagement of the connections is effected without friction or wear on the gaskets, the gaskets being placed in holes in the coupling face connected to the pipe terminals by short hose. In designing the automatic hose coupling the importance of an interchange arrangement by which it could be adapted for use in connection with the old hand couplings was not overlooked, and proper provision has been made for accomplishing this purpose in a number of different ways, the difference being in the fittings of the lower end of the hose from the pipe terminals and in the attachments to the coupling face. Interchange with cars equipped with hand couplings is effected in little more than the time necessary for the usual hand couplings under the old method. The accompanying engravings illustrate the passenger equipment coupler, the freight device being somewhat simpler.



SIDE ELEVATION.—PASSENGER EQUIPMENT.

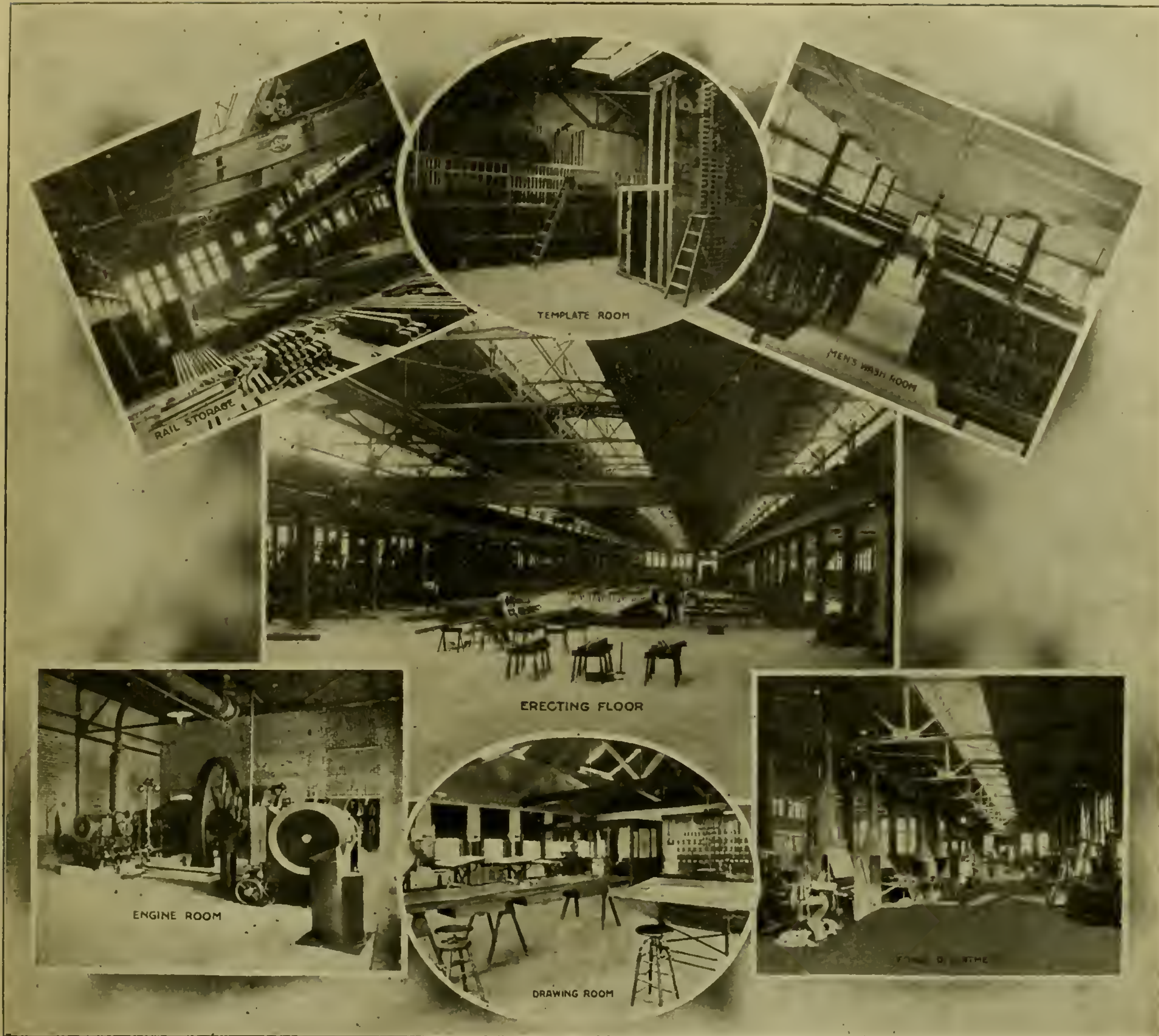

PLAN.—PASSENGER EQUIPMENT.

NEW WORKS OF WEIR FROG COMPANY.

The Weir Frog Company, of Cincinnati, have completed their new works in Norwood, a suburb of Cincinnati, and located on the Baltimore & Ohio, the Pennsylvania Lines and the tracks of the Cincinnati Traction Company, thus having exceptionally good shipping facilities. The plant was designed by Bert Baldwin & Company, architects and engineers.

The plant consists of a main shop and two smaller buildings, interior views of which are shown in engraving. The main shop is 622 ft. long by 125 ft. wide, and gives 83,000 sq. ft. of floor area in a single story building. It has a main aisle 61 ft. 2 ins. wide and two 31-ft. bays. Steel roof trusses on steel columns support the roof. Natural lighting is provided by side windows set about 6 ft. above the floor and by four skylights in the roof itself, in addition to the side windows in the main roof. Heating apparatus was furnished by the American Blower Company and the Webster vacuum system, using exhaust steam from the shop engines. The erecting and main machine floors are of concrete and cement, occupying 260 ft. by 125 ft., situated just beyond the tool room and template storage room, which are first entered after leaving the office building. The 60-ft. span is served by two Case Manufacturing Company electric cranes, one used chiefly to unload cars and the other to handle material from the stock department. On this floor are the planers, straightening machines and special machinery. Beyond the erecting floor is the stock department, where all material taken into the shop is stored. This end of the building is entered by a track holding 10 cars and depressed to unload material directly upon the shop floor. This department is 60 ft. by 400 ft., and is enclosed by a fence. All heavy material, such as rails, plates and bars, is piled on the floor; small supplies, such as rivets, bolts and nuts, being kept in bins. On the south side of the main building is the forge department, equipped with forging machines, presses, hammers, heating furnaces and smith fires. Opposite the forge department, on the north side, are located special tools for bending, curving and drilling rails.

The power plant consists of a 500 h.p. Brown automatic compound engine, built by I. & E. Greenwald Co., Cincinnati, direct connected to a 300-kw. Bullock 220-volt generator. Except a



INTERIOR VIEWS OF THE NEW WORKS OF THE WEIR FROG COMPANY, CINCINNATI, OHIO.

few small machines taking power from a motor-driven shaft, every machine in the shop has an individual motor. An Ingersoll-Sergeant air compressor furnishes power for the riveters and for pumping water. An 8-in. 320-ft. artesian well supplies all the water used for boilers and other purposes. It is pumped by compressed air and stored in a 20,000-gal. tank, elevated 60 ft. above the ground. The floors of the boiler and filter room are 10 ft. below the level of the engine room and about 8 ft. below the grade level of the surrounding ground. Coal is received in hopper cars and dumped directly on the floor of the boiler room. Steam is supplied by four 250 h.p. Stirling boilers, equipped with American stokers. The well water is softened and filtered by the We-Fu-Go process, and is heated in a Webster exhaust steam heater.

At the end of the main shop building are two 2-story brick buildings 40 ft. by 60 ft. One is used for the general offices and drafting room and the other provides, on the first floor, for the workmen's wash and locker rooms, and on the second floor for the pattern shop and storage. Each of these buildings connects with the main shop by covered passageways.

With this fine new plant the company is admirably equipped to deal with its constantly increasing business.

BOOKS AND PAMPHLETS.

Air Brake Tests. Compiled and Published by the Westinghouse Air Brake Company. In connection with its exhibit of braking appliances at the Louisiana Purchase Exposition, 1904.

This handsomely bound book of 323 pages (5 by 7 ins. in size) contains the history of the air brake in the United States as marked into periods of development by the series of well known brake trials which indicate the important turning points of improvement. It is therefore the most valuable and important work which has thus far appeared in connection with this subject. The scope of the book is indicated by the chapters, which are follows: Growth of Car Braking, Galton-Westinghouse Tests, Paris and Lyons Railway Tests, The Burlington Brake Trials, Westinghouse Freight Train Trials, Karner Trials, Sang Hollow Tests, Shiproad Tests, Nashville Locomotive Brake Tests, Absecon Tests, Atsion Tests. Each of these chapters represents an investigation for a specific purpose and each has marked a turning point in the advancement of the art of braking. Some of the test records have been published previously and some have not, but not even the most assiduous collector of air brake data has had all the facts which are recorded in this book. It is put in very convenient form and those who carry responsibilities of any kind in connection with train operation will need to study the book and keep it at hand for reference. Inasmuch as the ability to stop trains safely limits the speed at which they may be run, the art of braking must not only keep pace with, but must advance ahead of, acceleration of schedules. At the present time the chapter on the high speed brake is the most important of the book, and is the one to which operating officers should give their attention. The Absecon tests on the Pennsylvania Railroad were undertaken in order to obtain reliable data of the stopping power of the high speed brake as compared with the ordinary quick-acting brake on passenger trains. Stops were made from speeds of more than 80 miles per hour and the high-speed brake was found to stop in about 26 per cent. less distance than the ordinary brake employing train-pipe pressures of 70 lbs. These trials also revealed the importance of higher pressures in additional storage capacity and they also indicated the importance of the locomotive truck brake as well as the vital necessity of maintaining locomotive, tender and car equipments up to the point of maximum service efficiency. It would be difficult to praise this book too highly.

Technology of Paint and Varnish. By Alvah H. Sabin, John Wiley & Sons, 43 East 19th street, New York. Price $3.00.

The author aims to give a correct general outline of the subject of paints and varnishes, with a brief account of their modern use and of the principles which are involved in their manufacture and application. The first chapters are devoted to definitions and to an interesting account of the early history of paints and varnishes, and this is followed by a very thorough account of the modern methods of their manufacture and application. The subject, while treated in a technical manner, is arranged so that a layman can readily follow it.

Loci in Mechanical Drawing. Part III. Piston acceleration. By Alec. MacLay. D. Van Nostrand Company, 23 Murray street, New York. Price $2.00.

Curves of velocity and acceleration are discussed and worked out in connection with piston motion in engine mechanism of the slider crank order.

The Centrifugal Pump, Turbines and Water Motors. By Charles H. Innes. Fourth edition. D. Van Nostrand Company, 23 Murray street, New York. Price $2.00.

A treatise on the theory of turbines, centrifugal pumps and fans, specially adapted for engineers with a view to assisting them in designing such machinery.

Poor's Manual.—Sample pages of the edition of January, 1904, have been received. This list will constitute a supplement to Poor's Manual of Railroads and will contain all important facts required by investors and others interested in bonded indebtedness. The compilation in preparation is the fourth annual volume. Poor's Manual for 1904 will be ready for distribution September 15 and will constitute a volume of 1,900 pages with 24 colored State maps and 50 maps of leading railroads. The statistics will show the great growth and relatively increasing importance of the electric traction systems as well as the progress of the steam roads. The volume for this year promises to be the most important and valuable issue of this indispensable publication.

Falls Hollow Staybolts.—A leaflet issued by the Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio, presents eight strong claims made for these well known staybolts with explanations of the ways in which the hollow material meets them. These cover the elastic character of the hollow bolts, the relief of the fibers of the iron because of its form, the protection from burning, relief of the side sheets from stresses causing cracking, the admission of oxygen to the fire through the holes, the infallible warning of broken bolts, and long service of the bolts. The pamphlet closes with an extract from an article in *The Railway Age*, in which the advantages of these staybolts are outlined.

Wire Rope.—The Broderick & Bascom Rope Company, of St. Louis, are distributing from their unique exhibit at the St. Louis Exposition a small pamphlet entitled, "Nothing New Under the Sun," so-called, because it shows a piece of wire rope taken from the ruins of Pompeii, and estimated to be 2,000 years old. It describes their exhibit, which shows in a very artistic manner the designs of rope made by them.

Machine Tools.—The Warner & Swasey Company, of Cleveland, are sending out a 1904 general catalogue which illustrates their hollow hexagon turret lathes, screw machines, turret lathes and other brass working machine tools.

Graphite.—September Graphite, published by the Joseph Dixon Crucible Company, is a special number and contains some excellent half tone illustrations of notable steel structures and some instructive articles on the preservation of metal surfaces.

The Cincinnati Machine Tool Company are now in their own building on Queen City avenue, Cincinnati, Ohio. The plant is thoroughly up to date in every respect, and is equipped with all modern facilities.

NOTES.

The Walter A. Zelnicker Supply Company, St. Louis, reports the establishment of new sales offices at 1711 Tremont street, Denver, Col., and at 45 Dey street, New York City. The branch office at Seattle serves the extreme Western and Northwestern trade. Other branch offices are located in Mobile, New Orleans and Houston. The rail yard and warehouse are at East St. Louis, and the factory for maunfacturing the "double clutch" car mover is at New Madison, Ohio. Reports from the main office in St. Louis indicate that the coming year will bring the largest volume of business in the history of the company.

Northern Electrical Company.—Contract has been awarded to this company for the entire motor equipment, about 450 h.p., for the new Southern Railway Company shops at Spencer, N. C., details of which were arranged under the direction of Mr. S. D. Cushing, signal and electrical engineer of that road. A combination of group and individual drive will be used, motor driven machine tools requiring variable speed to be equipped with 2-wire variable speed motors. They will also furnish a 50-kw. generator for lighting the shops at Alexandria.

American Locomotive Equipment Company.—This company made an interesting exhibit of its specialties at the recent convention of the Traveling Engineers' Association in Chicago. They displayed the Sarver auxiliary exhaust valve, the Moone journal cellar, the Wade-Nicholson firebrick arch, Curran chime whistle, the Sarver automatic steam chest choke, and Northern metallic packing. The Sarver auxiliary exhaust valve is an appliance for relieving compres ion and back pressure. The Wade-Nicholson hollow arch is constructed of specially designed firebrick for effecting complete combustion. These features of the exhibits attracted special interest. On Thursday evening this company entertained the visitors in the large dining hall of the Lexington Hotel to the number of about 250 members and ladies. After a preliminary concert by a string orchestra four special vaudeville numbers were presented by comedians. Refreshments were served and a number of members addressed the assembly. The company was represented at the convention by Mr. Charles B. Moore, general manager; Mr. J. B. McMichael, secretary, and by Messrs. J. B. Bond, C. A. Crane, A. J. Stott and A. Munch.

Roundhouse Heating.—Those interested in the construction of railway shops will find an article in the April issue of this journal, by R. H. Soule, particularly interesting in regard to roundhouses. Referring to the question of heating he said: "Heating by hot air from the fan is most satisfactory, especially if the dampers are so arranged that a large volume of hot air can be delivered under an engine in one pit and quickly thaw it out." This system of heating roundhouses is to be found throughout the country and especially in all the large roundhouses. By means of the fan, which is driven by a direct-connected steam engine, fresh air is drawn over the coils of steam pipes encased in a fireproof jacket and distributed through systems of distributing pipes, one overhead and another underground, the latter discharging the air under the engine and car-trucks for the purpose of removing the ice and snow from the engines and cars as they enter the roundhouse in the winter season. Among the recent installations of the fan heating system by the B. F. Sturtevant Company are those at the Wabash Railway roundhouses at St. Louis, Mo., and Montpelier, Ohio; the Pennsylvania roundhouse at Philadelphia, Pa.; the Illinois Central, Chicago, Ill.; the C., M. & St. Paul Railway, Galewood, Ill., and nine roundhouses of the Canadian Pacific Railway at North Bend, B. C.; Regina, Assa.; Sault Ste. Marie, Ont.; Cartier, Ont.; Webbwood, Ont.; Chalk River, Ont.; McAdam's Junction, N. B.; Outremont, P. Q., and Toronto Junction, Ont.

J. McGregor Adams, one of the founders of the firm of Crerar, Adams & Company, and the head of the Adams & Westlake Company, died in Chicago September 17.

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL

NOVEMBER, 1904.

CONTENTS.

ECONOMICAL TRAIN OPERATION.

BY G. R. HENDERSON.

PART II.

Cost of Operation.

It has been indicated in Part I. how the different expenses connected with train operation should be grouped and detailed in order to make a comprehensive study of the economy to be derived from various speeds and loads, and it now remains for us to apply this data to the different schedules so as to determine the relative cost of movement. We know at once that the profile of a division will greatly affect not only the rating of the engine but the cost of transportation, and as there may be an unlimited variety of profiles, we must arbitrarily select some specific cases for our investigation. Let us first assume an operating division 150 miles in length, the profile of which is a uniformly 1 per cent. up grade in the direction of prevailing traffic. It is true that the engines, and perhaps empty cars, must be brought down the hill, but in this case little fuel will be used, the speed should undoubtedly be as great as safety will permit, depending upon alignment, etc., and the trains should be as long as can be handled without danger. The down hill work is evidently not one requiring much study, as the equipment must be brought back, as well as the crews, and the longest trains and the highest speeds at which it is practicable to do this will give us the greatest economy, as well as the quickest return of the rolling stock to profitable use. The up grade work, however, requires a thorough investigation in order to determine the method of operation which will produce the maximum efficiency and the minimum cost, and in order to obtain a complete comparison we will consider the engine so loaded that the best running time that it can make is 5, 10, 15, 20 and 25 miles an hour. From Fig. 1 (in Part I.) we found that the maximum gross weight of train possible at these speeds is 1,600, 1,570, 1,240, 960 and 750 tons respectively (the last value is found by calculation: 21,000 lbs. A. T. F. ÷ 28 lbs. per ton grade and speed resistance, or 20 + 8, which gives us 750 tons), or 1,450, 1,420, 1,090, 810 and 600 tons back of the tender, allowing 150 tons for weight of engine and tender as we have already assumed. Now these latter values, multiplied by the distance, 150 miles, give us the ton mileage of each trip, including cars and loading. In order to show clearly the results of the calculations in each step of the investigation, table A is constructed, by setting down first the values already obtained on lines 1, 2, 3 and 4.

As a certain time is always spent upon side tracks waiting for trains, etc., we have allowed 20 per cent. in addition to the running time, and line 5 shows the time between terminals, while line 6 gives the average speed, including layouts. It will be considered that no fuel is used while standing upon side tracks, and while this is not strictly true, yet the amount is relatively small; and besides, it will be independent of the tonnage or the running speed, so that it may be omitted without sensible error; moreover, it cannot well be estimated.

The value of "a" can be determined from Fig. 1 as follows: At 5 miles an hour and a total train weight of 1,600 tons, we find that 700 pounds of coal per mile would be consumed, because the point intersected by the 5-mile an hour line and the 1,600-ton curve is also intersected by the 700-pound per mile curve; so for the trip we should have 150 miles × 700 lbs. = 105,000 lbs. of coal, as set down on lines 7 and 8. In the same manner we see that 1,570 tons, gross, at 10 miles an hour will require 800 tons per mile; the other quantities are found in the same way, completing line 7. At our supposed price of $2 a ton, the coal for the trip would cost the amounts set down in line 9.

As seen in Part I., the other locomotive supplies were taken at 1.5 cents per mile, or for 150 miles, $2.25 for the trip; train supplies being considered at the same rate, lines 10 and 11 both show the same amounts throughout. Thus lines 9, 10 and 11 correspond to cost items a, b and c, under the general caption of "Supplies."

Line 12 gives the amount of repair charges (and renewals) to the engine for the trip, being based on our derived rate of 8 cents per 1,000 ton miles, the latter being taken from line 4 of the table; thus 217.5 thousand ton miles × 8 cents = $17.40. Line 13 shows the same for the cars in the train. These two lines 12 and 13 cover cost items d and e of "Repairs."

We must now calculate the cost of service or wages, items f, g and h. Commencing with the enginemen (engineer and fireman) the combined rate is $7 per 100 miles or less, or 7 cents a mile if over 100 miles, with overtime at 70 cents an hour. For the first schedule the average speed between terminals is only 4.2 miles an hour, so the men will be entitled to 36 hours × 70 cents = $25.20, as given in line 14. The second schedule is 3 hours (18 — 15 = 3) over the schedule speed allowance, so the same rate would apply, viz., 70 cents an hour, or $12.60 for the trip. On the remaining three schedules, however, no overtime is earned, and the rate of 7 cents a mile applies, or 150 × 7 = $10.50.

The pay of the trainmen is worked up in a similar manner, allowing for the conductor and two trainmen, or a combined rate of 3.45 + 2.3 + 2.3 = 8.05 cents per mile or 80.5 cents per hour. The first two schedules will be on the hour basis as before, and the last three on the mileage basis, and the cost is shown by line 15.

The roundhouse labor is set down as $2 each trip on line 16, in accordance with the decision in Part I.

Line 17 gives the interest charges at 10 cents an hour, it being assumed that a lay-over of 5 hours is necessary each trip, for ordinary care of the engine. If the crews need rest, this time of idleness would be increased, but it can hardly be less than the period stated. By adding 5 hours to the time between terminals (line 5) we obtain the period on which to figure the interest. Thus in schedule 1, 36 + 5 = 41 hours total per trip and turn, and at 10 cents an hour = $4.10. This corresponds to item "i."

By summing up lines 9 to 17 inclusive we have the cost of the trip, as far as these special and immediately concerned charges are affected, as explained in Part I. This has been done in line 18. If we now divide the values in line 18 by the ton miles made per trip, as given in line 4, we shall obtain the cost per ton mile, which is reduced in line 19 to the rate per 1,000 ton miles as this is a more convenient figure. Again if we take the time which is used in making a trip and its lay-over of 5 hours, and divide by it the number of hours in a month, we obtain the number of trips which could be made in this period, and this multiplied by the ton mileage of each trip gives the hauling rate in ton miles per month for the engine and schedule being considered. Thus for the first arrangement we have $\frac{720}{41} \times 217.500 = 3,820,000$ ton miles per month of 30 days, and so for the other values on line 20. Further, if we divide the values of line 8 by those of line 4 expressed in hundreds, we obtain the pounds of coal burned per 100 ton miles, as indicated by line 21. From lines 19, 20 and 21 we find that if our engine is loaded so that it can and does make a running speed of 15 miles an hour, with delays approximating 20 per cent. of the running time, or an average speed between terminals of 12½ miles an hour, we will move the greatest volume of traffic, will operate at the lowest rate per ton mile for expenses, and will also consume the least amount of coal per ton mile hauled.

Before drawing our conclusions, however, let us examine some other profiles and find out how the question of load and speed then affects the results. The case which we have just studied was that of a continuous rise of 1 per cent. throughout the 150-mile division; let us now consider a division of the same length, but having a summit in the middle, and a continuous grade of 1 per cent. approaching this summit from both ends of the division. This will amount to an average level, as both ends of the division will of necessity be at the same altitude. We will suppose that a speed of 25 miles an hour is maintained on the down hill portion, and that no fuel is burned while descending. This is not strictly true, as the air pump will require a certain amount of steam, but the variation will no doubt be negligible as between trains of various loading, such as are likely to be assigned to the engine. Table B gives the results of these calculations. As the controling grade is identical with our first case, line 3, the net weight of train will be the same as before; also the ton miles, as in line 4. The time between terminals is reduced by the higher downhill speed; thus for the first schedule the uphill portion will consume $\frac{75}{5} = 15$ hours, and the downhill portion $\frac{75}{25} = 3$ hours, and allowing 20 per cent. for delays we have $(15 + 3) \times 1.20 = 21.6$ hours. The other values are obtained in the same manner, as per line 5. The average speed between terminals (line 6) is simply 150 divided by the time occupied.

While the amount of fuel consumed per mile going up hill is the same as before, as seen by line 7, the amount for the trip will be only one-half as much, as the last half of the run is made without using coal, according to our hypothesis, and as seen by line 8. Line 9 is the cost of such fuel and lines 10 to 13 inclusive are identical with the previous case, as the train miles and ton miles are identical. The wages of the engine and train crews will be different in the first schedule, but as all the others exceed 10 miles an hour, they will be the same as the last schedules of Table A. These are found in lines 14 and 15. The roundhouse labor, line 16, is identical with the previous case. The interest charges (line 17) are at 10 cents an hour, the time being 5 hours greater than the time between terminals. Lines 18 to 21 show the cost per trip, per 1,000 ton miles, coal per 100 ton miles and the rate of monthly movement as before. In this case we see that for an up hill speed of 15 miles an hour we again obtain the minimum rate of coal consumption and the maximum amount of ton mileage made per month; also the lowest cost per ton mile of train handled. The latter will run about 75 per cent. of the cost figured for the first case, where the grade was a continual rise throughout the division, but it must be remembered that we did not figure on any down hill work, as the balance of traffic was considered to be in the direction of the up grade. Besides, we are discussing the relative economy more than the actual cost of operation.

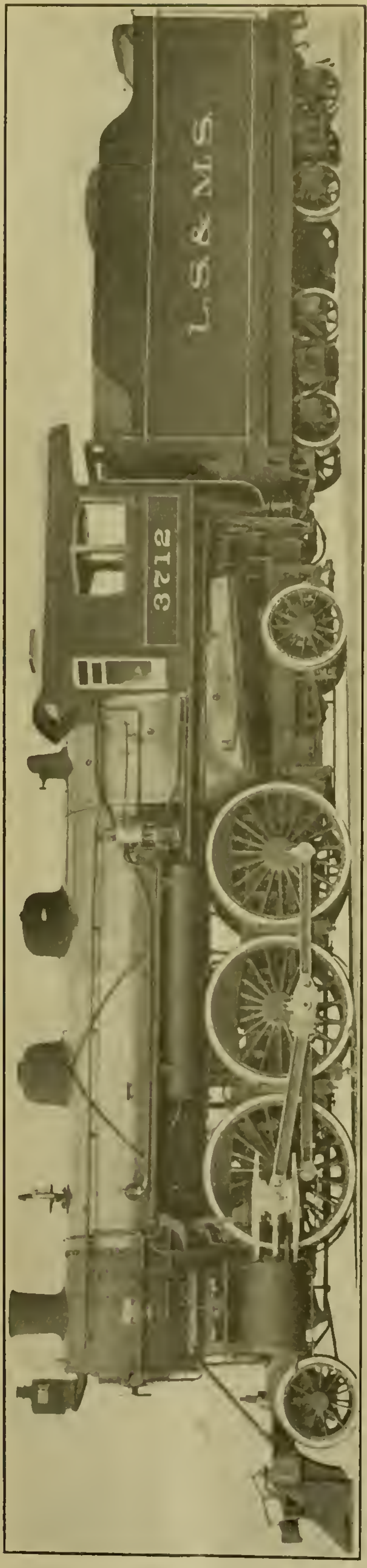
TABLE A.

1.	Running speed, miles per hour	5	10	15	20	25
2.	Weight of train, gross, tons of 2,000 lbs.	1,600	1,570	1,240	960	750
3.	Weight of train, net, tons of 2,000 lbs	1,450	1,420	1,190	810	600
4.	Ton miles per trip, back of tender	217,500	213,000	178,500	121,500	90,000
5.	Time between terminals, including lay-outs	36 hrs.	18 hrs.	12 hrs.	9 hrs.	7.2 hrs.
6.	Average speed between terminals, miles per hour	4.2	8.3	12.5	16.7	20.8
7.	Coal burned, lbs. per mile	700	800	530	400	300
8.	Coal burned per trip, lbs	105,000	120,000	79,500	60,000	45.000
9.	Cost of coal per trip, at $2 a ton	$105.00	$120.00	$79.50	$60.00	$45.00
10.	Locomotive supplies per trip, at 1½ cents per mile	2.25	2.25	2.25	2.25	2.25
11.	Train supplies per trip, at 1½ cents per mile	2.25	2.25	2.25	2.25	2.25
12.	Repairs to Locomotives at 8 cents per 1,000 ton miles	17.40	17.00	14.30	9.73	7.20
13.	Repairs to cars at 15 cents per 1,000 ton miles	32.60	31.90	26.80	18.22	13.50
14.	Pay of enginemen, per schedule	25.20	12.60	10.50	10.50	10.50
15.	Pay of trainmen, per schedule	28.98	14.49	12.08	12.08	12.08
16.	Roundhouse labor, at $2 a trip	2.00	2.00	2.00	2.00	2.00
17.	Interest on locomotive and caboose at 10 cents per hour	4.10	2.30	1.70	1.40	1.22
18.	Total cost of trip, charges 9 to 17	$219.78	$204.79	$151.38	$118.43	$96.00
19.	Cost per 1,000 ton miles hauled	1.01	.96	.85	.97	1.06
20.	Ton miles hauled per month	3,820,000	6,670,000	7,560,000	6,250,000	5,300,000
21.	Lbs. coal per 100 ton miles	48.2	56.4	44.5	49.5	50.0

TABLE B.

1.	Speed, up hill, miles per hour	5	10	15	20	25
2.	Speed, down hill, miles per hour	25	25	25	25	25
3.	Weight of train, net, tons of 2,000 lbs	1,450	1,420	1,190	810	600
4.	Ton miles per trip, back of tender	217,500	213,000	178,500	121,500	90,000
5.	Time between terminals, including lay-outs	21.6 hrs.	12.6 hrs.	9.6 hrs.	8.1 hrs.	7.2 hrs.
6.	Average speed between terminals, miles per hour	7.0	11.9	15.6	18.5	20.8
7.	Coal burned up hill, lbs. per hour	700	800	530	400	300
8.	Coal burned per trip, lbs	52,500	60,000	39,750	30,000	22,500
9.	Cost of coal per trip, at $2 a ton	$52.50	$60.00	$39.75	$30,00	$22.50
10.	Locomotive supplies per trip, at 1½ cents per mile	2.25	2.25	2.25	2.25	2.25
11.	Train supplies per trip, at 1½ cents per mile	2.25	2.25	2.25	2.25	2.25
12.	Repairs to Locomotives, at 8 cents per 1,000 ton miles	17.40	17.00	14.30	9.73	7.20
13.	Repairs to cars at 15 cents per 1,000 ton miles	32.60	31.90	26.80	18.22	13.50
14.	Pay of enginemen, per schedule	15.12	10.50	10.50	10.50	10.50
15.	Pay of trainmen, per schedule	17.40	12.08	12.08	12.08	12.08
16.	Roundhouse labor, at $2 a trip	2.00	2.00	2.00	2.00	2.00
17.	Interest on locomotive and caboose at 10 cents per hour	2.66	1.76	1.46	1.31	1.22
18.	Total cost of trip, charges 9 to 17	$144.18	$139.74	$111.39	$88.34	$73.50
19.	Cost per 1,000 ton miles hauled	.66	.66	.62	.73	.82
20.	Ton miles hauled per month	5,880,000	8,700,000	8,800,000	6,680,000	5,300.000
21.	Lbs. coal per 100 ton miles	24.1	28.2	22.3	24.7	25.0

(To be continued.)



SIX-COUPLED PASSENGER LOCOMOTIVE 2—6—2 (PRAIRIE) TYPE.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.
THE HEAVIEST PASSENGER LOCOMOTIVE.
H. F. BALL, *Superintendent of Motive Power.* AMERICAN LOCOMOTIVE COMPANY (BROOKS WORKS) *Builders.*

POWERFUL PRAIRIE TYPE PASSENGER LOCOMOTIVES.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

Ten magnificent passenger locomotives from the Brooks Works of the American Locomotive Company have just been put into service on the Lake Shore & Michigan Southern Railway. They are the heaviest passenger locomotives ever built, and are specially noteworthy because of their power, their heavy wheel loads and the wheel arrangement, which indicates the satisfactory service on this road of the 2—6—2 type. The perpetuation of this type ably supports the statements made in describing the Burlington engine on page 356 of the September number and the argument of Mr. J. Snowden Bell on page 386 of the October number. The new design is noteworthy also because of the past traditions of this road with respect to light locomotives. In this connection it is interesting to know that to meet the exigencies of present practice it has been necessary for the Lake Shore to provide new locomotive equipment at a very rapid rate. Of its present number of locomotives 54.4 per cent. have been put into service within five years. This is sufficient reason for adhering to well-established practice and for the development of designs which involve nothing experimental. These locomotives have been illustrated in this journal, and they constitute a series of which any railroad may be proud. These designs, both passenger and freight, are a result of co-operation between the officials of the road and the builders to produce powerful, serviceable and, incidentally, handsome locomotives. The new Class K engines are so well-proportioned that they do not appear to be large unless another engine is at hand for comparison.

No effort was made to break records as to size and weight. These locomotives were built to do work which now requires the Class J engines (AMERICAN ENGINEER, March, 1901, page 69) to "double head." For example, train No. 19, the "Lake Shore Limited," between Buffalo and Cleveland, 183 miles, often consists of 2 mail cars, 1 dynamo baggage car, 1 buffet smoker, 1 dining car and 8 Pullman sleepers; making 13 cars and weighing 743 tons back of the tender. The schedule speed is 44 miles per hour, including two stops, the time over the division being 4 hours 10 minutes. Train No. 43 usually has 15 cars, weighing 750 tons, making the same distance in the same time with four stops. These figures are taken from the records. The Class J engines will make the time under the most favorable weather conditions, but they are often double-headed. To avoid this the new Class K was brought out.

Comparisons with other typical examples of recent powerful passenger locomotives may be made by aid of the accompanying table:

COMPARISON WITH OTHER LARGE PASSENGER LOCOMOTIVES.

Road.	Engine Number.	Total Weight.	Total Heating Surface.	Total Weight Divided by Heating Surface.
L. S. & M. S.......	3,712	233,000	3,905	59.6
C. & A............	601	219,000	4,078	53.7
N. Y. C..........	2,794	218,000	3,757	58.2
El Paso & S. West'n	——	209,500	3,818	54.8
C. B. & Q.........	1,918	208,070	3,575	58.2
Northern Pacific...	284	202,000	3,462	58.3
A. T. & S. F.......	1,000	190,000	3,738	50.1
C. & O............	147	187,000	3,533	52.9
L. S. & M. S.......	650	174,500	3,343	52.2

RATIOS "LAKE SHORE" 2—6—2 TYPE LOCOMOTIVE.

Heating surface to cylinder volume	312.6
Tractive weight to heating surface	45.1
Tractive weight to tractive effort	5.96
Tractive effort × diameter of drivers to heating surface	598
Heating surface to tractive effort	.132
Total weight to heating surface	63.34
Heating surface to grate area	66.87
Tractive effort to heating surface	7.57

From the photograph the attractive appearance of the new locomotive is seen. These engines have piston valves with inside admission, the Player radial trailing truck, cast-steel frames 6 ins. wide, a new design of pony truck, and the front end is arranged in accordance with the AMERICAN ENGINEER tests of locomotive draft appliances. It is impracticable to present this interesting design in a single article. The drawings and information concerning a number of important details must be reserved until next month.

PRAIRIE TYPE PASSENGER LOCOMOTIVES.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

GENERAL DIMENSIONS.

Gauge .... 4 ft. 8½ ins.
Fuel .... bituminous coal
Weight in working order .... 233,000 lbs.
Weight on drivers .... 166,000 lbs.
Wheel base, driving .... 14 ft. 0 ins.
Wheel base, total .... 34 ft. 3 ins.
Wheel base, total engine and tender .... 62 ft. 4½ ins.
Tractive power .... 27,850 lbs.

CYLINDERS.

Diameter of cylinders .... 21½ ins.
Stroke of piston .... 28 ins.
Diameter of piston rod .... 4 ins.
Kind of piston packing .... Dunbar

VALVES.

Kind .... piston, 12 ins. diameter
Greatest travel .... 5½ ins.
Outside lap .... 1¼ ins.
Inside clearance .... ⅛ in.
Lead in full gear .... 1-16 in.

WHEELS, ETC.

Number of driving wheels 6
Diameter of driving wheels outside of tire .... 79 ins.
Material of driving wheel, center .... 72 ins.
Thickness of tire .... 3½ ins.
Diameter of trailing wheels, outside tire .... 48 ins.
Diameter and length of driving journals .... 9½ ins. x 12 ins.
Diameter and length of trailing journals .... 8 ins. x 14 ins.
Diameter and length of main crank pin journals .... 7 ins. x 6½ ins.
Diameter and length of side rod journals .... 7½ ins. x 4¾ ins.
Diameter and length of F journals .... 5 ins. x 4 ins.
Diameter and length of B journals .... 5 ins. x 4½ ins.
Engine truck, kind .... two wheeled swing center
Engine truck; journals .... 6½ ins x 12 ins.
Diameter of engine truck wheels .... 42½ ins.

BOILER.

Style .... extended wagon top, radial stay
Outside diameter of first ring .... 70 ins.
Working pressure .... 200 lbs.
Thickness of plates in barrel and outside of firebox.
11-16 in. ¾ in. 25-32 in. 9-16 in., 9-16 in. 9-16 in.
Fire box, length .... 109 ins.
Fire box, width .... 74 ins.
Fire box, depth .... front, 80½ ins., back, 68 ins.
Fire box plates, thickness, sides,
⅜ in., back, ⅜ in., crown ⅜ in., tube sheet ½ in.
Fire box, water space .... 4½ ins., front 4½ ins., sides, 4 ins. back
Tubes, number 322
Tubes, spacing .... ¾ in. front, 13-16 in. back.
Tubes, diameter .... 2¼ ins.
Tubes, length over tube sheets .... 19 ft. 6 ins.
Fire brick, supported on .... 4—3 ins. tubes
Heating surface, tubes .... 3,678 sq. ins.
Heating surface, water tubes .... 29 sq. ft.
Heating surface, fire box .... 198 sq. ft.
Heating surface, total .... 3,905 sq. ft.
Grate surface .... 55 sq. ft.
Grate, style .... rocking
Ash pan, style .... Hopper
Exhaust pipes .... single
Exhaust nozzles .... 5½ ins. and 5¾ ins, diameter
Smoke stack, inside diameter .... 18 ins. and 21¾ ins.
Smoke stack, top above rail .... 14 ft. 10½ ins.
Cab material .... steel

TENDER.

Style .... water bottom, gravity slides
Wheels, number 8
Wheels, diameter .... 36 ins.
Journals, diameter and length .... 5½ ins. diameter x 10 ins.
Wheel base .... 18 ft. 0 ins.
Tender frame .... 13-in. channels.
Tender trucks .... arch bar, cast steel bolster
Water capacity .... 7,800 U. S. gallons
Coal capacity .... 15 tons

NEW POWERHOUSE—WEST ALBANY SHOPS.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

In this journal in February, March, April and May of the current volume a thorough, illustrated description of the power station at the Weehawken terminal was presented. That station represented modern practice as embodied in all features which would contribute to economy, and is therefore an excellent example of up-to-date engineering. The plant at the West Albany shops furnishes power for lighting and driving the shops. The plans provide for elevated coal storage, also for coal and ash handling facilities; but these are not to be installed at present. As the exhaust steam will be needed for shop heating, condensers were not included. The plant is of good, substantial construction, and admirably suited to the purpose. It supplies alternating current for shop motors and lighting, and direct current for the crane motors. For this reason the plant is of special interest at this time. These shops are not new, but are being rearranged and rebuilt. The powerhouse is part of a plan for modernizing the method of driving whereby motors will entirely replace belt transmission from an old engine plant.

In its generic features the powerhouse resembles that of the Weehawken terminal. It has a central stack with boilers on each side, and the arrangement used in that station was modified to meet the conditions of a shop plant.

Building.—The structure is of brick, with stone trimmings. It is substantial, but plain. The outside dimensions are 113 ft. 4 ins. by 92 ft. 8 ins., with an engine room 110 ft. 4 ins. by 46 ft., inside, and a boiler room 110 ft. 4 ins. by 42 ft., inside. The engine room has a clear height of 28 ft. under the roof trusses, giving plenty of headroom. There is no crane in the engine room, but the pilasters provide for the construction of runways to be built later if needed. The ash tunnel is 10 ft. deep by 14 ft. wide; it and the ash hoppers are waterproofed with 5-ply felt and asphalt. A small vertical ash hoist in the corner of the building raises ashes to an overhead bin, which discharges into a car standing on the coal trestle. This may later be replaced by coal and ash handling apparatus. At present coal is delivered by cars on a trestle over a bin holding 125 tons, which brings the coal to the fireroom floor through the wall. The stack, machinery, boiler and building foundations are of concrete. The roof is of reinforced concrete slabs, 3 ins. thick, over steel roof trusses. It is covered with pitch and slag roofing. All floors are of concrete. Terra cotta segmental blocks are used for the main floor of the engine room and the floor over the ash tunnel.

Boilers.—Four 500 h.p. water-tube boilers were supplied, in 2 batteries of 2 boilers each, by the Franklin Boiler Works Company. The boilers work under 200 lbs. pressure, and they provide 10 sq. ft. of heating surface per horse-power. An evaporation of 9 lbs. of water from and at 212 degs. per pound of run-of-mine Clearfield coal of 12,000 B. T. U. is guaranteed. Each boiler is supported by stub posts of steel, those at the boiler fronts being constructed so as to permit of upward extension to support an overhead coal storage bin at some future time. The boiler supports are entirely independent of the brickwork, allowing expansion and contraction to take place without effecting the setting.

Chimney.—The chimney is of radial brick, 165 ft. high, with an internal diameter of 10 ft., and was built by M. W. Kellogg & Company. At the base of the stack a baffle wall 36 ft. high is built across the core to prevent interference of the gases from the two breeching connections.

Height of chimney above foundations .... 165 ft. 6 ins.
Height above boiler room floor .... 165 ft. 0 in.
Height of base above foundations .... 36 ft. 6 ins.
Side of base at top (outside) .... 17 ft. 3 ins.
Side of base at bottom (outside) .... 17 ft. 3 ins.
Diameter of base at top (inside) .... 11 ft. 5 ins.
Diameter of base at bottom (inside) .... 11 ft. 5 ins.
Height of round shell .... 129 ft. 0 in.
Weight per foot of radial brick section .... 128 lbs.

Piping.—In the absence of economizers and superheaters the piping is simpler than that at Weehawken. The engravings clearly illustrate the headers and connections for live and exhaust steam. The main steam header is short, and drains to the drop legs. Separators are located oven the engine throttles. Steam for the auxiliaries is carried in a header under the engine room floor, and is piped to the low-pressure cylinders of the engines for use in emergencies. This auxiliary header has two connections to the main high-pressure header in the boiler room. This header connects with the heating system through two reducing valves, reducing the pressure from 175 lbs. to 1 lb. per square inch for the heating main at the south end of the building, and to 10 lbs. at the north end. The exhaust piping is clearly shown in the engravings. It leads to a large exhaust tank in the basement of the engine room. The main steam header is anchored near the center, and is supported on carriers with rollers.

The boiler feed piping is arranged in duplicate. There are two duplex boiler feed pumps, with a guaranteed capacity of 22,000 gals. of water per hour against a working pressure of 300 lbs. The Holley system is used, as installed by Westinghouse, Church, Kerr & Co., for returning the high-pressure drips to boilers automatically. The main and auxiliary exhaust piping is specially well drained. The feed pumps take steam from the end of the high-pressure header in the boiler room. A large blow-off tank receives the water from the blow-off piping, as shown in the drawings of the boiler room. The feed-water heater is located beside the exhaust pipe in the boiler room, above the feed pumps. It is a Cochrane open heater of 1,600 h.p. capacity.

Main Engines.—Two horizontal cross-compound direct-connected Ball & Wood engines constitute the power units. They slight adjustment of speed may be effected while running, thus facilitating the synchronizing of the generators or changing the load carried by the engines. The following are the principal dimensions of the engines:

High-pressure cylinders, diameter	21 ins.
Low-pressure cylinders, diameter	41 ins.
Stroke	30 ins.
Normal full load speed	120 r.p.m.
Normal indicated horse-power	900

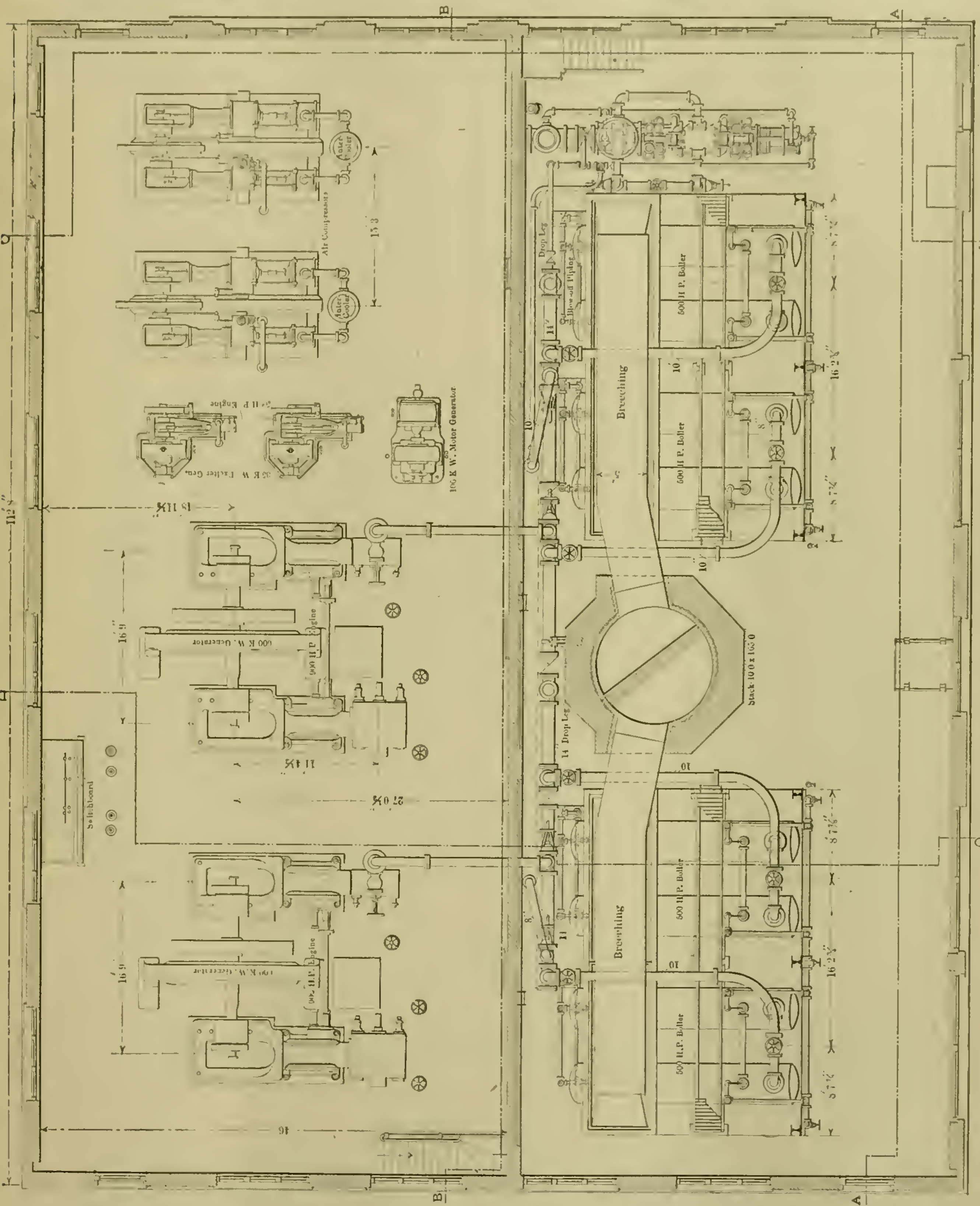


FIG. 1—PLAN OF MAIN OPERATING FLOOR OF BOILER AND ENGINE ROOMS.
WEST ALBANY POWER HOUSE—NEW YORK CENTRAL RAILROAD.

are required to govern so that the speed during one revolution shall not vary as much as to allow the generator, while delivering from no load to full load, to advance ahead or fall behind a machine running at absolutely constant speed by more than 0.08 of 1 deg. The speed of each engine is controlled from the station switchboard by a speed-changing device whereby a

Normal cut-off, high-pressure cylinders, about	37 per cent.
Normal cut-off, low-pressure cylinders, about	37 per cent.
Maximum cut-off, high pressure cylinders, about	65 per cent.
Diameter of fly-wheel	144 ins.
Weight of fly-wheel	40,000 lbs.
Governors	inertia shaft type

Exciter Engines.—For the two 35 kw. exciter units, simple 7-in. by 12-in. Woodbury engines are used. These are required

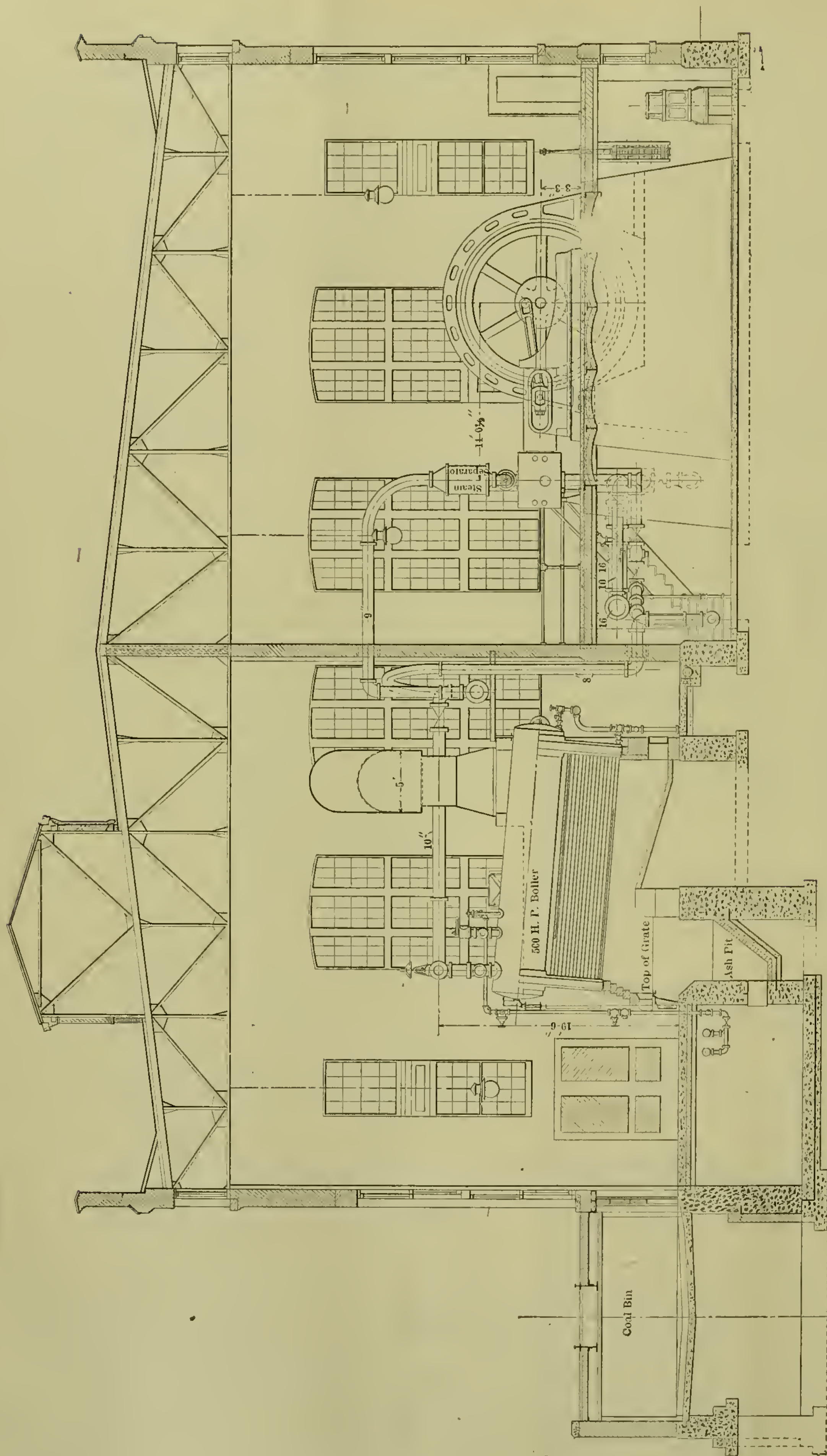
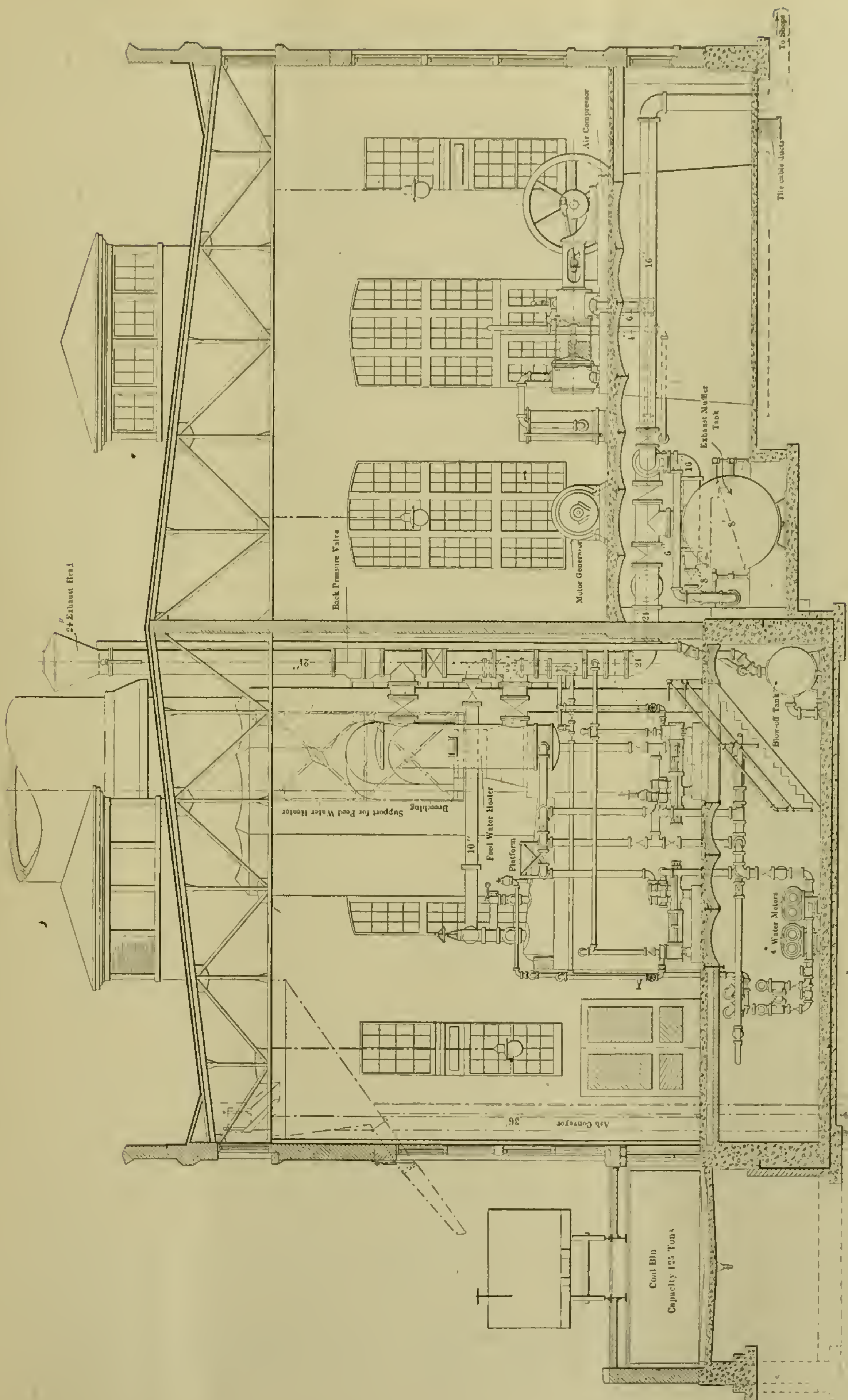


FIG. 2—SECTION THROUGH BOILERS AND MAIN ENGINES.

WEST ALBANY POWER HOUSE—NEW YORK CENTRAL RAILROAD.



Cross Section through CC

FIG. 3—SECTION THROUGH BOILER AND ENGINE ROOM SHOWING AIR COMPRESSORS AND EXHAUST AND BOILER FEED PIPING.

WEST ALBANY POWER HOUSE—NEW YORK CENTRAL RAILROAD.

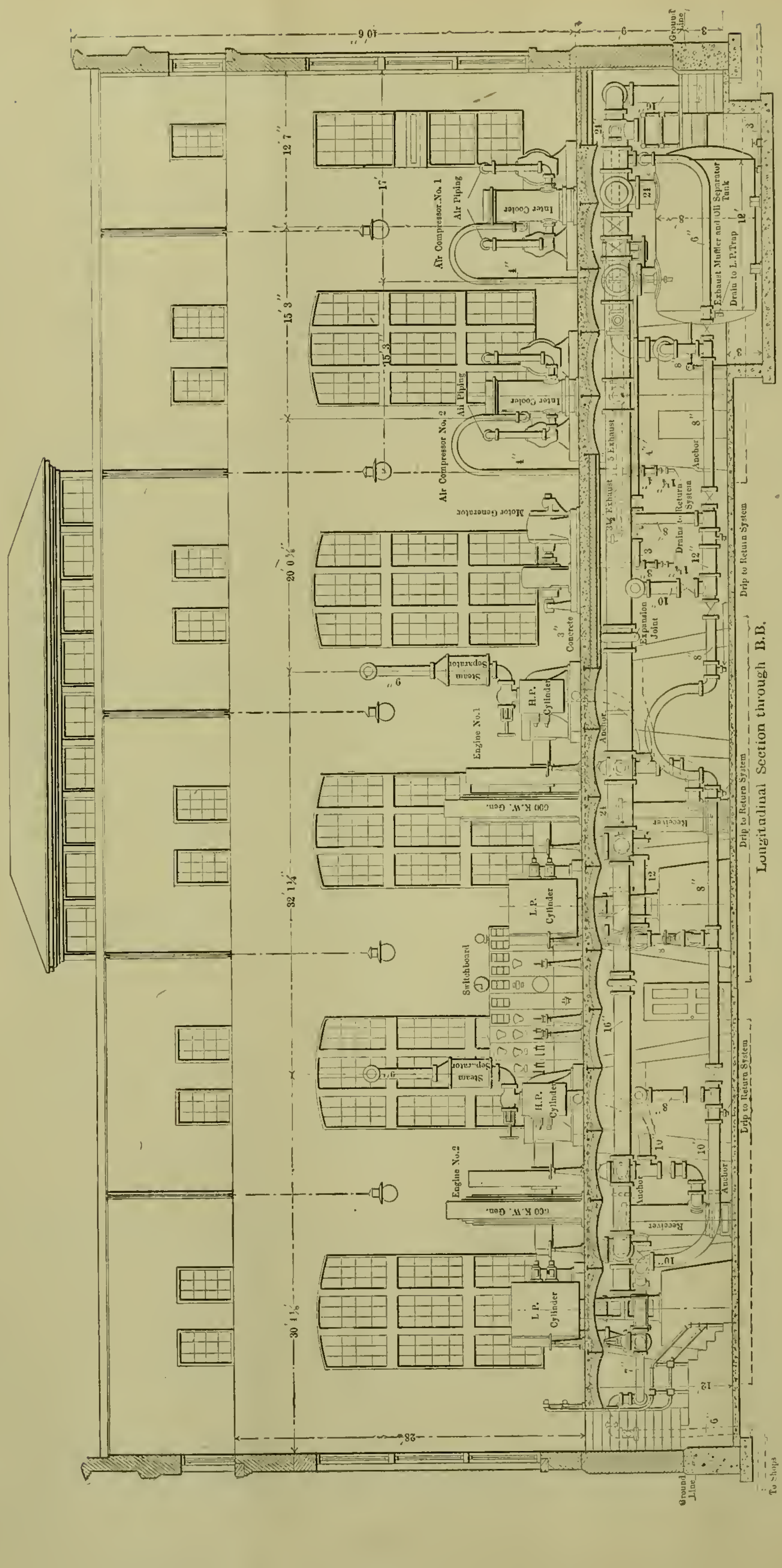


FIG. 4—LONGITUDINAL SECTION THROUGH ENGINE ROOM SHOWING STEAM PIPING.
WEST ALBANY POWER HOUSE—NEW YORK CENTRAL RAILROAD.

to run in parallel with a speed variation of 2 per cent. from full load to no load, and speed-changing devices are applied which permit of adjusting the speed within 7 per cent. of the normal rated speed. The principal dimensions are as follows:

Diameter of cylinder	7 in.
Stroke	12 in.
Normal full load speed	300 r.p.m.
Normal indicated h.p.	58
Normal cut-off	20 per cent.
Maximum cut-off	50 per cent.

revolving field type, located between the cranks of the engines, and are run in parallel, having the same armature impedance in both machines. The normal rating of each machine is 722 amperes per terminal at 480 volts and 100 per cent power factor. The normal rated output is therefore 600 kw. The collector rings on each generator are ample to carry an excitation current for 150 per cent. of the normal rated load, with a power factor of 80 per cent. The increase of pressure when the non-

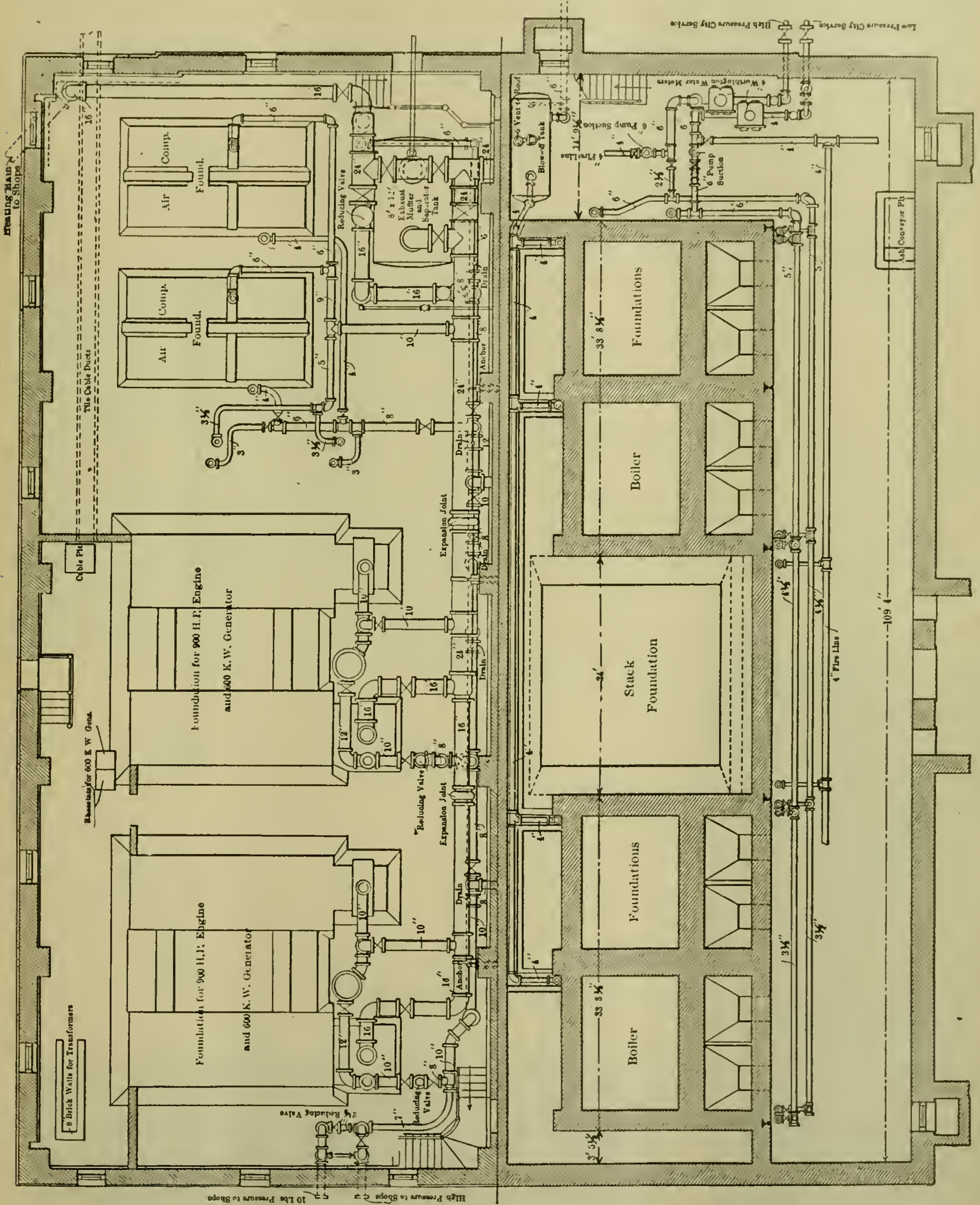


Fig. 5.—Basement Plan of Boiler and Engine Rooms.
WEST ALBANY POWER PLANT—NEW YORK CENTRAL RAILROAD.

Generators.—Two, engine type, 600 kw. alternating-current General Electric generators supply 3-phase current at 60 cycles per second at 480 volts, for light and power. They are of the inductive load is varied from no load to full load, without change of excitation, is required to be limited to 5 per cent. The generators are proportioned so that with a power factor of

100 per cent. the load may be varied from 0 to 150 per cent. of the rated load without varying the voltage more than 12 per cent. and without change of excitation. They are proportioned for 100 per cent. momentary overloads.

Exciter Generators.—These are 35 kw. direct-current General Electric machines, and each is of sufficient capacity to supply the entire current, which varies from 45 amperes at 170 volts to 140 amperes at 250 volts. Ninety amperes at 170 volts is also required. They are operated in parallel. These generators have shunt resistance across the series field, adjusted for an overcompounding of 2 per cent. The series field is designed for 5 per cent. overcompounding without shunt resistance.

Motor Generator Set. — As the main power circuits are all alternating, direct current is supplied for the cranes by a motor generator set, also supplied by the General Electric Company. The set consists of a 60-cycle 3-phase alternating motor of 900 r.p.m. and 480 volts and a multipolar 250-volt direct-current generator.

Transformers.—The transformers are located in a fireproof vault, with 8-in. brick walls, in the basement of the engine room. There are three 200-kw. 60-cycle 480 to 2,300 volt transformers. These are capable of carrying 200 kw. for one hour when supplied with air through ducts of 2 sq. ft. area without the use of the blower set; the rise of temperature is required not to exceed 55 degs. Cent. under these conditions. The blower set has a capacity of 2,700 cu. ft. of free air per minute, delivered at a pressure of 0.75 oz. It is driven by a 480-volt 60-cycle 3-phase 1 h.p. induction motor. The air ducts are arranged to be used with natural as well as artificial draft.

The transformers are for the lighting circuits and the motor driving the coal storage plant, this being 3,500 ft. from the powerhouse. All the other circuits are of 480 volts for power, the motors operating at 440 volts.

Switchboard.—This plant is up to date in having a switchboard house, which removes the main switchboard from the powerhouse, rendering it necessary to provide merely a station board near the main generators. This switchboard house was built for use in connection with an outside current supply, which was depended on for such shop motors and lighting as were installed before the erection of the new powerhouse.

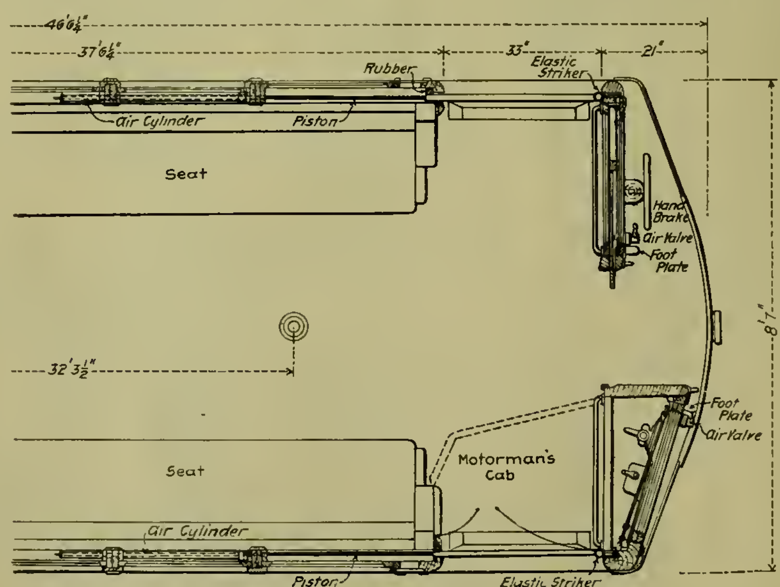
The two air compressors are cross-compounds, with 16-in. and 27-in. steam cylinders, 24-in. and 14-in. air cylinders, with 18-in. stroke and with a capacity of 1,225 cu. ft. of free air per minute each.

The mechanical and electrical features of the power station were designed and executed by Mr. Edwin B. Katte, electrical engineer, under the general supervision of Mr. H. Fernstrom, chief engineer of the company.

NEW CARS FOR ELEVATED SERVICE.

Boston Elevated Railroad.

Realizing the necessity for improving car construction for the purpose of rapidly loading and unloading passengers, a new arrangement of car end has been adopted in 24 new cars built for this road by the St. Louis Car Company. The earlier cars were all built like those in use on the Brooklyn Bridge, with end platforms (partly vestibuled by the cab doors) and wide centre side doors. These centre doors are used for egress of passengers during rush hours, the end doors being used at such times for entrance only. This requires additional platform attendants to open the side doors from the outside at every station. Crowds entering the end doors find an obstruction at the constricted entrance, and there is great difficulty, as on the Manhattan Elevated, in closing the swinging platform gates against the pressure of the crowds on the platforms. In the new cars the platforms form part of the car itself, and are not separated from the body by either doors or partitions. The vestibules form the ends of the car. Pneumatically-operated sliding doors take the place of the swinging iron gates, and these slide into the car siding, where they are entirely out of the way. The center side doors are retained, they are 40 ins. wide and are used as before. Sliding doors are provided at the ends of the vestibules, but these are narrow, being for the



Plan of End of New Cars.

Looking Across Vestibule.

New Car for the Boston Elevated.

use of the trainmen only. To form the motorman's cab two doors are arranged to enclose a corner of the vestibule. One of these swings against the vestibule, protecting the controller and air brake devices and the other, which is narrower, swings against the end of the adjacent seat. To open the sliding doors the trainmen step on a lever, which releases a lock, and then by means of another lever, air is applied to a cylinder in the upper framing, the piston rod of which operates the door. To avoid shock and to permit of releasing clothing which may be caught in the door a rubber cushion is provided, which closes the door opening.

The side doors are used as exits from 6.30 to 10.30 a. m. every day and from 3 to 8 p. m., except on Saturdays and Sundays. They are used from 12 noon to 11.30 p. m. on Saturdays and from noon to 10.30 p. m. on Sundays. One of the engravings shows the sign at the center of the car giving information as to the exits which the passengers are to use.

The average length of main line stops with the present equipment during the rush hours is 20 and 21 seconds, ranging from 13 to 30 seconds. Owing to the fact that the more important stations are used for both elevated and surface traffic no separate record is ordinarily kept of the elevated passengers. On

Interior of Car Showing End and Doors at Sides.

several occasions counts have been made on days that were believed to represent normal conditions and not exceptionally heavy riding. The largest number leaving elevated trains in any one hour was 8,557, one day last spring, at the Sullivan Square Station between 5 and 6 p. m. The largest number leaving any of the stations in an hour was 7,333 on the same day at Sullivan Square, between 7 and 8 a. m. These crowds were handled in four-car trains at the rate of thirty trains per hour. These interesting figures show the size of the problem and the importance of ready ingress and egress to and from the cars.

If any improvement may be made whereby 10 seconds may be saved in the average delay at each station the total saving in time would permit of running one additional train on the line. The possibilities of improvement through the use of these new cars has not been estimated, but they are expected to help materially in accelerating the service.

Railroad Accidents.—According to the statistics of the Interstate Commerce Commission for the year ending June 30, 1904, there were 55,130 casualties, 3,787 persons killed and 51,343 injured on the railroads of the United States. This is an increase of 5,599 casualties over the previous year, or 233 killed and 5,366 injured. These figures do not include highway crossings accidents or those to trespassers or persons walking along the tracks, in shops remote from the railroad or to employes not actually on duty.

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

Editorial Correspondence.

London, England.

Midland Shops at Derby.

It might be unfair if I said that the Derby shops are the most interesting in England. I shall say, however, that of the shops which I visited these impressed me most as indicating the possibilities of improvement and development of a very old plant. This road will get the utmost from its present facilities and then will be ready to invest in a new plant. After visiting Derby, many opinions with respect to shop practice formed in England required modification, and if I find another shop which interests me more I shall give it high praise. It was my good fortune to be conducted by Mr. Cecil Paget, works manager, whom many of the readers of this journal have met in the United States. The Midland has a total mileage of 2,300 and is second in England in this respect. It is marvelously compact, with a trunk line about 310 miles long from London to Carlisle. Its train mileage amounts to about 45,000,000 per year, its locomotives number 2,900 and the repairs center at Derby. The plant occupies about 80 acres. Those desiring to make a comparison between these shops and ours may find the following figures of interest:

Derby Shops.

	Area Sq. Ft.
Machine and fitting shops	54,000
Smith shop No. 19	21,600
Smith shop No. 20	4,600
Erecting shop	67,500
Wheel turning shop	9,813
Wheel press shop	15,214
Axle shop	10,867
Tire and plate shop	24,656
Boiler shop (3 buildings)	84,949
Pits in erecting shop	50
Pits for examination	12
Spaces for boilers under repairs	10
Average output of erecting shop in locomotives per week undergoing heavy repairs	23

I greatly regret the necessity for hurrying through these interesting shops. This plant may be quite thoroughly gone over without going out of doors but once. This is an important matter in a shop with a capacity of 100 locomotives per month for heavy repairs. The buildings are exceedingly well lighted and if they were sufficiently high for good crane service they would be satisfactory for many years more. This is an excellent example of an old plant which is being systematically but gradually modernized. The plan is to make the most out of existing facilities before undertaking expensive new ones. In the development the most vitally important factors are being considered first and the improvements seem to be very thoroughly planned. Without any extensive changes in the organization, the individual output of the workmen has been practically revolutionized by liberal and broad-minded administration of piecework. It is generally believed that English workmen cannot be hurried, but certainly the pace in these shops is fast enough to put many of our own shops to shame. In these shops there are plenty of blue chips under the machines and improved tool steels are being introduced rapidly. The cutting speeds are not high, but this will come gradually. By a combination of improvements applied during the past three or four years the present erecting shop has doubled its output and now does 30 per cent. more work than was formerly done in two erecting shops. Much of this is due to piecework treatment, under which the men have in some cases quite doubled their day rates. It is a pleasure to come into contact with such an effort as this. It is not by any means complete, but Derby will soon be a place for American motive power men to visit with special profit.

Piece rates are never changed here unless justified by a change in machinery or method. Then they are sometimes changed radically. Jigs and templates are extensively used. The standardization of the locomotives and the interchangeability of parts plays an important part in this, and one would expect to find many jigs used on a road having a large number of locomotives of comparatively few individual types.

An excellent example of jig work was noticed in connection with the bolt holes for frames and cylinders. The frames and cylinders for the largest passenger engines are all drilled before the parts go to the erecting shop and when put together the holes are not even reamed. The writer saw this work himself and with surprise. This sort of thing has reduced the cost of erection of new locomotives within a short time in the ratio of 30 to 12. At Derby very little hand fitting is done. Links and motion work connections are lapped to perfect fitting by machinery. While milling is not as extensive here as at Crewe, much of the rodwork is done in this way. I saw eccentric straps milled out on a circular milling machine in piles of three, this process having reduced the cost of the job to one-seventh that of boring on the lathe. For this work built-up cutters are used. Fluted side rods are finished complete on each side by special cutters which face the rod and cut the channels in the same operation. In this shop no milling in two cuts was seen. There were no roughing cuts on the milling machines; but finished cuts only. This is because the works manager does not believe milling to be profitable when a roughing and a finishing cut are taken.

Here was seen the nearest approach to an American tool room with special men grinding tools on a piecework schedule and with annunciators and boys to serve the men at the machines.

This erecting shop is the only one the writer has seen over here having "catacombs" under it. Most effective use is made of large rooms excavated below the erecting shop floor where the small parts of engines are stored after being repaired and while waiting to be wanted by the erecting gangs. An enormous amount of shelving and wall space is thus provided, situated near the engines and admirably arranged and used. Every part may be quickly located by a record book which is indexed. Brake fittings, whistles, valves, cocks and all small parts are stored here and nothing of the sort is to be seen in spaces which could possibly be used for anything else. The gangways in English shops are always too narrow, but this besement helps in a remarkable way at Derby.

These notes are also written in a first class "carriage" on a first class road—the road will not be named because of the pass kindly given by the general manager. It is both rough and rocky and there is no difficulty in counting the rail joints. Mr. Vreeland, of New York, in remarking on the high speeds on foreign roads, told of going 80 miles an hour; 40 miles per hour straight away, 20 miles in vertical and 20 miles in lateral vibration. This must be the road which he referred to (it is not the Midland) and I must revise a previous statement that English track is uniformly good. It is not.

Returning to Derby shop matters, the staybolt fitting is very carefully done. The stays are apparently of nearly pure copper. They are carefully threaded on automatic machines and are most carefully driven in the fireboxes. Here is a good pointer for our own practice, for staybolts are no longer a source of anxiety to the Midland officials. This seems to be due chiefly to careful fitting of the staybolts in the holes in the sheets. The dies and taps are closely watched and carefuly standardized. Bolts varying more than 0.001 in. in diameter from the absolutely correct size are discarded by a simple test which was new to me. The staybolts are rolled down a little flight of four steps, the treads of which are in form of two rollers. The rollers of the top step are set far enough apart to allow a staybolt 0.001 in. over-size to drop through to the second step. If it is more than 0.001 in. too large it will not go through and is rejected. If it is of the exact size desired it will pass through the second step and if 0.001 in. smaller than this it will pass through the third step. A fourth step is made 0.002 in. smaller than the standard and if a bolt passes these rollers it is rejected. This little affair provides a very satisfactory gauge which has a large capacity of inspection.

It would require more than a few hours to see these works properly. I happened to spend the noon hour looking about, and Mr. Pagel took me into the mess room where perhaps 800 or more of the shop men were enjoying their dinners in comfort. It was an impressive sight. Before I had a look at the appointments furnished by the company for heating coffee, the men began to rap on the tables with their tin cups. Mr. Pagel explained that a speech was wanted. I shall always think that he had a twinkle in his eye as he took me in there. After taking a "snap shot" at the enemy, I escaped unhurt. This messroom plan is a fine thing for the company and for the men. It brings them together as a sort of club at noon and is miles ahead of lunching about the corners of the shop. The Grand Trunk has had a messroom at Montreal for about 40 years. Our railroads at home should take a leaf out of this book because a large proportion of our shop men bring their dinners. It would pay to provide them a clean, comfortable place in which to really enjoy their nooning with a chance to smoke and converse afterward.

Like other English roads, the Midland has simplified in the number of locomotive types and I am told that for 2,500 engines two different designs of slide valves suffice—one is longer than the other in order to provide for different size cylinders, but the ports are all the same size. It is the practice of this road to use rather large cylinders, and small valves; in fact we should say that the locomotives are over-cylindered and under-valved. This road aims to keep the piston speeds of locomotives below 1,000 ft. per minute, and vary the diameter of the driving wheels in accordance with the speed. This works out very well because the very high speed trains are usually comparatively light.

This road is quite partial to the piston valve, and specially those of the Smith type with relieving packing rings which do not require the use of relief valves. The piston valves are small, usually 8¾ ins. in diameter, 10 ins. being the largest. The three-cylinder compounds on this road are giving excellent service, and are very highly spoken of.

Three sizes of boilers suffice for nearly all standard modern engines on this road, including the compounds. The boilers are of two types, the Belpaire and the round top. There are two classes of Belpaire and one round top. In the latter type of standard engines such parts as the boxes and valve gear are interchangeable.

The surprising thing all over England is that with engines over-cylindered and under-valved and under-boilered they give such efficient results. This must be due to the handling. The coal is good and water fairly good. The engines on this road have large nozzles, the cylinders are protected and special attention has been given through admirable experimental work to conditions of combustion, the mixing of the gases in the firebox and to preventing the use of large excess of air. In a test between Nottingham and London a mean sample of smokebox gas taken throughout the two hours' trip gave the following:

Carbonic acid	13.74
Nitrogen	83.10
Oxygen	3.16

The mixing of the gases is obtained by the combination of deflector from the firedoor and the firebrick arch. Great care in the adjustment of locomotives is everywhere apparent and we have much to learn in England in the matter of efficient operation of small engines. Feeling that I have not done justice to many good features of English shop practice, I must leave this subject, hoping to be able to make a more exhaustive study some day.

As already stated, most English engines are not hard worked. From these we have little to learn, but those which are hauling trains in competitive express service are doing wonders, in view of their weight and small heating surfaces. This vigorous passenger competition is playing an important part in English railroad practice and is likely to be far reaching in its effects. For example, the east and west coast lines have struggled in the matter of speed. They will soon apply the same tactics in things which go to make trains heavier. In fact, they have already done so, and this has brought the corridor carriages. Competition has led to a large number of fast, direct trains with long runs without intermediate stops, and this cannot fail to seriously hamper freight service. This already constitutes a problem which must worry general managers not a little.

The very large proportion of private cars constitutes another problem which only an association of the railroads can solve. These private interests must be reckoned with in any attempt to introduce improvements in cars. The Caledonian is getting excellent service with its large capacity steel frame coal cars (illustrated several years ago in this journal), but they are used chiefly for handling coal for the use of the locomotives. Mr. McIntosh is now introducing hopper-bottom cars for this service. The steel frame cars have done so well that they are practically never seen at the shops. The Midland is also using 30-ton steel coal cars of the gondola type.

Because trains in England are light and because of the fact that the "ton mile" is not in the dictionary of English railroad men, it must not be thought that freight service is not improving from the standpoint of cost of service. The following figures from the *Statist* do not show the mileage or the tonnage, but they indicate a marked improvement in three years:

EARNINGS PER FREIGHT TRAIN MILE IN PENCE.

	1900.	1903.
Lancashire & Yorkshire	110.09	127.5
North Eastern	83.45	104.4
London & North Western	82.05	98.7
Midland	65.52	74.4
Great Central	48.62	68.2
Great Eastern	57.67	68.0
Great Western	59.81	67.3
Great Northern	57.89	68.1

In estimating the value of these records it is absolutely necessary to know the mileage and tonnage, and here is where we are a century or two ahead of England. In the matter of knowing the cost in terms of work done English roads are exceedingly deficient.

Practice in Great Britain with respect to rails and rail fastenings is amusing. When the double head rail and cast iron chair were introduced it was supposed that the rails when worn could be turned over in the chairs and a double life of the rail secured. The discovery of the fallacy of this idea did not lead to a change in the shape of the rail. It remains in the double headed form and the chair is retained, with its wooden wedge. It is true that the chair makes an excellent tie plate, but why the expense of this construction should be perpetuated is unaccountable.

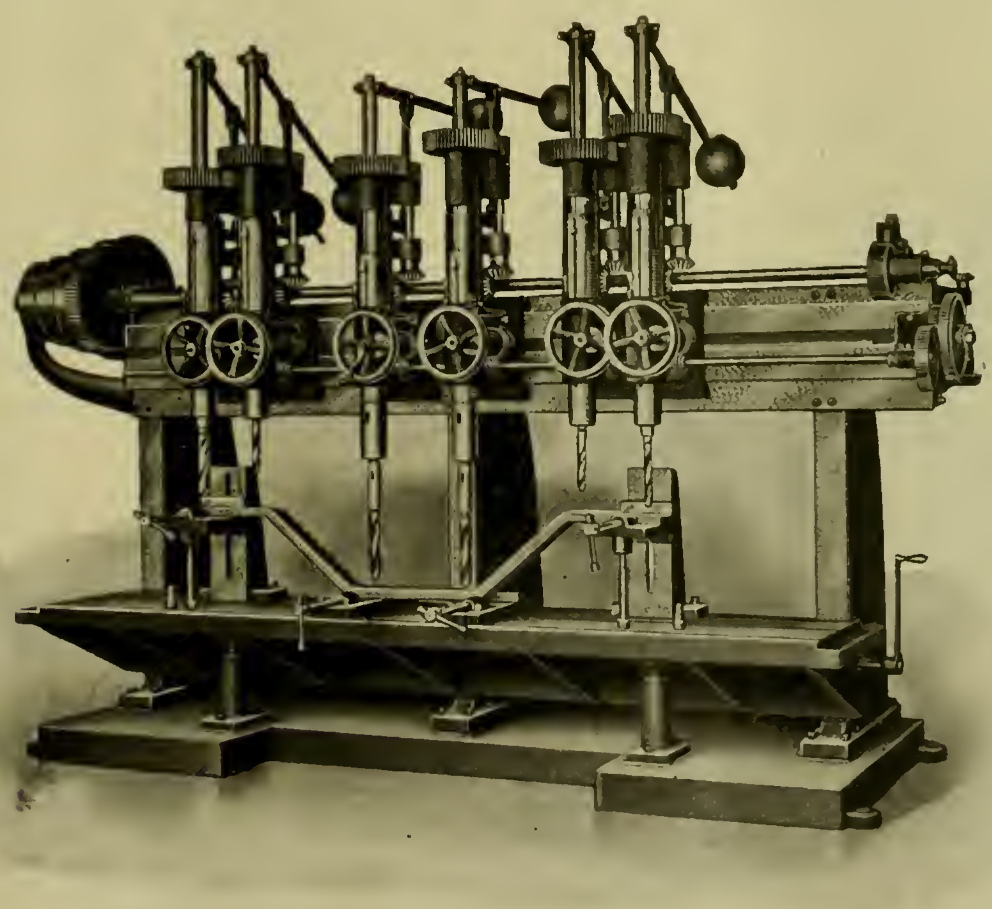
I may not write more from England and therefore take this opportunity to express grateful thanks for the uniformly generous courtesies extended by English railway officials whom I found to be without exception gentlemen of the highest type and most hospitable.

Perhaps a word to those visiting English railroad officials for the first time may be helpful. Naturally these gentlemen are very busy. They work under considerable pressure and they take great care of their time. I found it desirable to send letters of introduction in advance asking for an interview, and invariably found a pleasant reception and the officials with desks clear, ready for a talk. They, however, will not allow themselves to be interrupted as Americans do and they are quite right in this. G. M. B.

(To be continued.)

MULTIPLE DRILL WITH ARCH BAR FIXTURES.

This drill has six spindles, and for railroad shop use can be furnished with arch bar fixtures, as shown in the photograph, and when thus equipped can give an output of drilled arch bars nearly equal to any standard arch bar drill on the market. On page 266 of the July, 1904, number of this journal is illustrated a standard arch bar drill made by the same company. As many of the railroad shops do not have enough of this class of work to keep a machine steadily employed, Foote, Burt & Company have arranged their No. 5 independent feed multiple drill to take the adjustable arch bar fixtures, and when these are not required they can readily be removed and the machine can be used for any other class of car or locomotive work, such as drilling brake levers, truck frames, steam chest covers, straps, etc., running the six spindles with one operator and thus very materially decreasing the cost of turning out the work.



Multiple Drill With Arch Bar Fixture—Foote, Burt & Company.

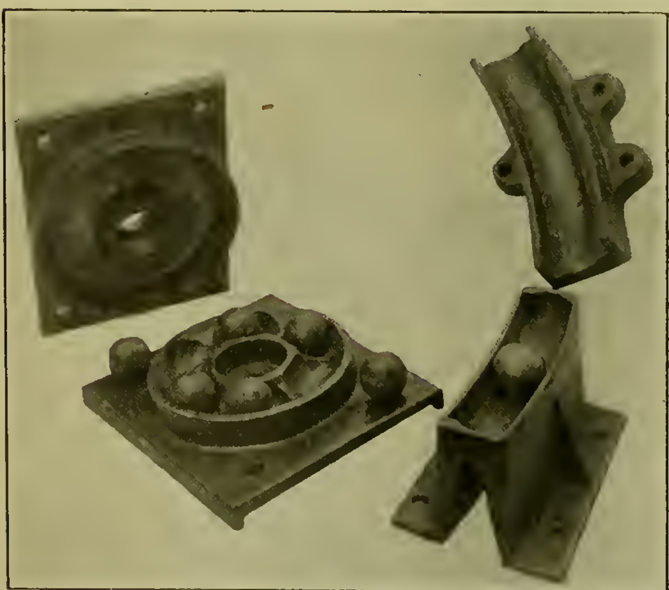
Two of these machines in the works of a well-known concern, and with ordinary standard twist drills, which on this class of work require grinding about eight times a day, and with the arch bars handled by hand, are drilling complete about 85 Pennsylvania Railroad standard 100,000-lb. arch bars per day of 10 hours on each machine. With Novo twist drills and an air hoist for handling the arch bars the output could be considerably increased.

Each head is independently adjustable along the rail without loosening bolts or set screws. The minimum distance between the centre of any two heads is 8 ins., and the greatest centre to centre distance of the outside spindles is 97 ins. Each head is operated by a clutch for both the motion and feed, and thus any spindle can be started or stopped without reference to the other spindles. Three changes of positive feed are provided, and an automatic knock-off permits the feed to be thrown out at any predetermined depth. The table is 24 ins. wide, 121½ ins. long, and adjusts vertically on uprights 14 ins. The maximum distance from the nose of the spindle to the top of the table is 26 ins., and from the face of the upright to the centre of the spindle is 12⅛ ins. The drill weighs complete about 12,000 lbs., and is made by Foote, Burt & Company, of Cleveland.

BALL BEARING CENTER PLATES AND SIDE BEARINGS.

That great advantages would result from the use of frictionless center plates and side bearings under freight cars is apparent. The question is, Can such devices be produced at a reasonable cost to stand the severe service they would be subjected to? They would have to be simple, substantial and such that they would require no attention after being placed under the car. A device that meets the above conditions and at the same time can be used with any type of truck or body bolster construction has been experimented with and developed on the Pittsburg & Lake Erie Railroad during the past seven years with remarkable results.

Wheel flange wear on cars equipped with the device has been practically eliminated. The line cut shows the outline of the flange and tread of four wheels of a truck which ran for 81 months under a 60,000-lb. capacity wooden gondola car equipped with the device, making in that time approximately 50,000 miles. The treads are badly worn, but the flanges show very little wear. In passing through the McKees Rocks freight yards of the company the writer recently examined the wheels under 25 steel gondola cars equipped with this device which had been in service 3 years or more and only 2 wheels out of the 200 showed any perceptible signs of flange wear and those two were but slightly worn, considering the time they had been in service.

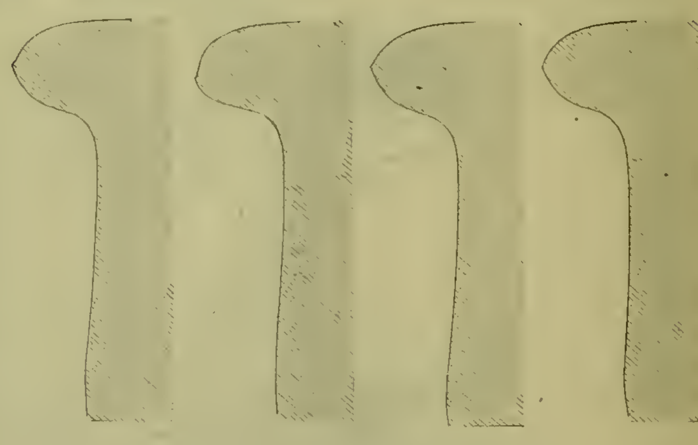


Hartman Ball Bearing Center Plates and Side Bearings.

It naturally follows that the wear of the rail flange will be reduced in a like ratio and that less power will be required to haul trains of cars thus equipped. Practical experience and dynamometer tests which have been made from time to time indicate that the train resistance is considerably decreased by the use of these ball bearing center plates and side bearings. A very elaborate dynamometer test was recently made on the Erie Railroad in which representatives from the test departments of the Erie R. R., B. & O. R. R., P. R. R., L. S. & M. S. Ry. and P. & L. E. R. R. participated. The test was made over a distance of 32 miles, but it was decided to base the calculations on a stretch of 10 miles where it was thought the most accurate data were obtained. On this 10 miles there was an average up grade of 0.36 per cent., with only 31 per cent. of straight track. The minimum curve was 45 min., the maximum 4 deg. 45 min. and there were 8 reverse curves. At one point there was a stretch of 3 miles of constant curvature in which there were 4 reverse curves and at another point in a distance of 1 mile of constant curvature there were 3 reverse curves formed by two 4-deg. and two 3-deg. curves. Nine trains, each made up of steel cars of 100,000 lbs. capacity, were tested. Five of the trains, average weight 1,801 tons, consisted of 25 cars each which were equipped with plain center plates and side bearings; 3 trains, average weight 1,733 tons, were made up of 25 cars each which were equipped with ball bearing center plates and side bearings; 1 train of 2,114 tons made up of 30 cars equipped with the ball bearings. The same engine crew and locomotive were used for all the tests. The maximum rating of the locomotive over the division was 1,750 tons. The weather conditions were very uniform; variation in temperature did not exceed 5 deg.

The average train resistance for the flat center plate and side bearing trains was 13.64 lbs. per ton, and for the ball bearing trains 12.14 lbs. per ton—or a decrease of 11 per cent., due to use of ball bearings. Correcting for grade gives a resistance on the level of 6.33 lbs. per ton for the flat center plate and side bearing trains, and 4.93 lbs. per ton for the ball bearing trains, or a decrease of resistance due to use of ball bearings of 22.1 per cent. The water consumption observations confirm these results.

One of the blast furnaces in Pittsburg has a rather steep incline leading to a trestle for unloading ore. Part of the lower end of the incline is on a 25-deg. curve and the level track at the foot of it has a 17-deg. reverse curve and then a long 17-deg. curve. After cars are unloaded they are allowed to drift down the incline, and cars equipped with ball bearings travel on the average more than twice as far as those equipped with plain center plates and side bearings.



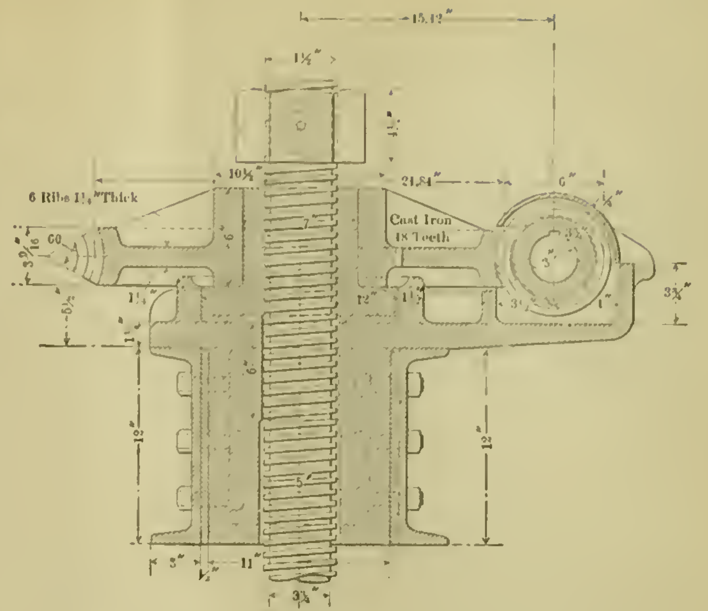
Outline of Wheels Which Run 81 Months Under Car Equipped With Ball Bearings.

Other tests of these bearings are described on page 45 of the February, 1902, and pages 263-4 of the August, 1902, issues of this journal.

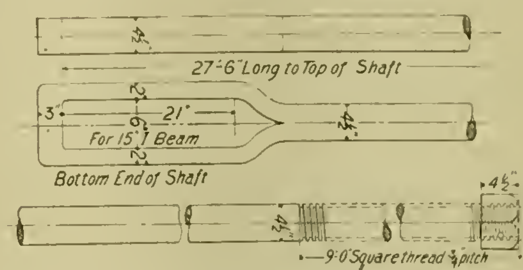
The construction of the ball bearing center plates and side bearings is shown in the photograph. The balls are 2½ ins. in diameter, made of drop forged steel of .55 carbon. The center plates are of drop forged steel of about .25 carbon. The top plate has a plain groove 13-16 in. deep, and the bottom plate has six pockets as shown. These pockets are so constructed that as the truck turns the balls travel up a very slight incline, and the truck will thus easily regain its normal position when it strikes a tangent. The ordinary center plates and side bearings offer so much resistance to turning that after the car leaves a curve the wheel flanges will grind on the rail for a considerable distance. The grooves and pockets in the center plates are made so that the balls fit in them snugly and have a good bearing. The side bearings are of malleable iron, and are applied with from ¼ to ⅜ in. clearance on each side. They are equipped with one ball each; the upper one has a plain groove and the lower one a long pocket. As they merely act as balances, they do not carry any great load. The construction of the bearings is such that the balls cannot be thrown out and lost.

No trouble has been experienced with dirt gathering in the bearings and interfering with the action of the balls. The center plates and side bearings under one of the cars were recently packed tight with granulated slag, but it was found that the balls actually forced it out, and that it did not interfere with them. The action of the balls is such that they seem to rotate in all directions, and do not wear out of round.

About 7,600 cars are now equipped with these bearings, which are known as the Hartman Ball Bearing Centre Plates and Side Bearings, and which are controlled by the Anti-Friction Bearing Company of Pittsburg.



DETAILS FOR NUT AND SCREW FOR LOCOMOTIVE HOIST.



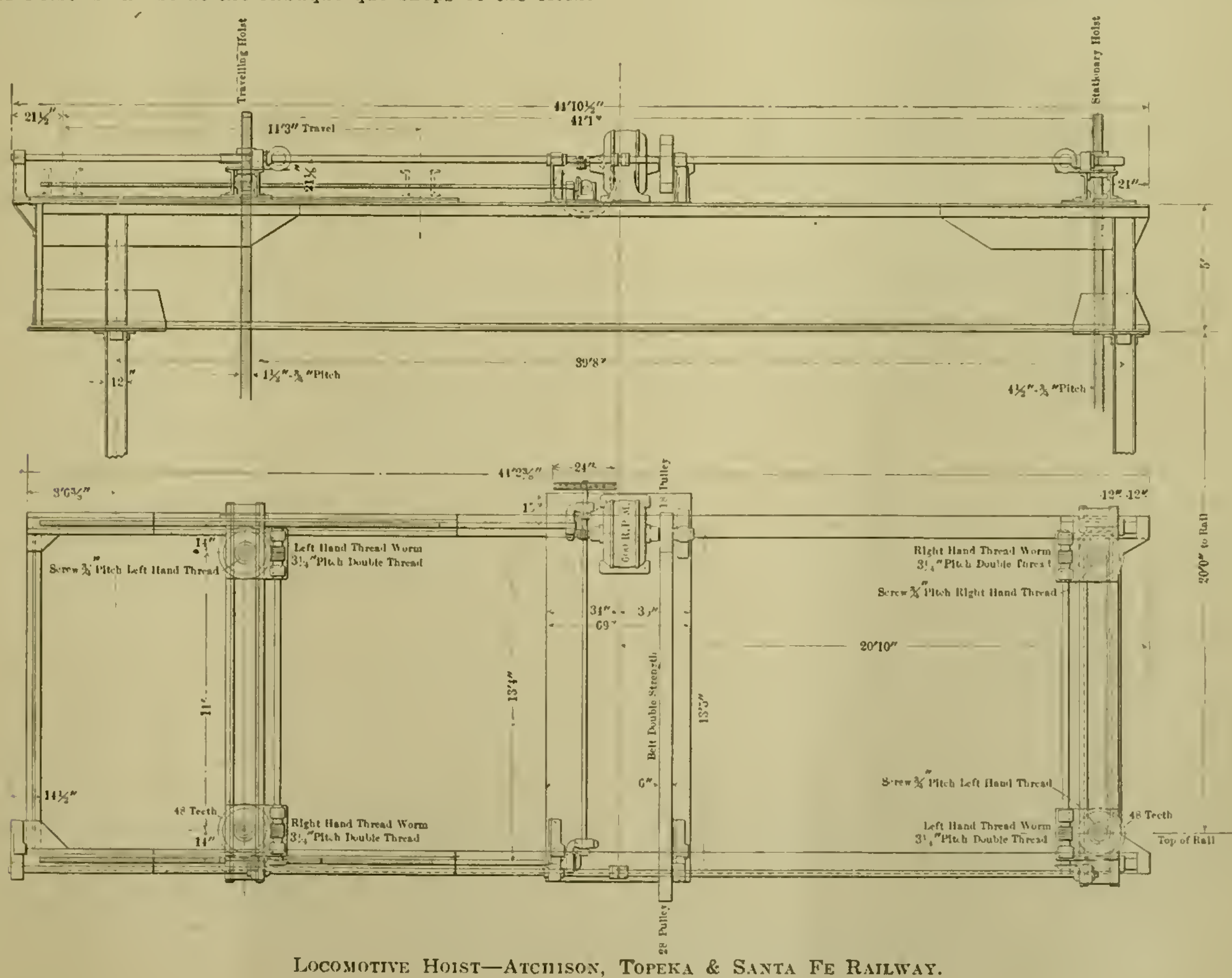
LOOP HANGER FOR LOCOMOTIVE HOIST.

ELECTRIC LOCOMOTIVE HOIST.

ATCHISON, TOPEKA AND SANTA FE RAILWAY.

While its construction does not involve special originality this hoist is a good example of labor saving machinery which is well adapted for use at shops where for any reason it is not advisable to install powerful traveling cranes.

This hoist is in use at the Albuquerque shops of the Atchi-



LOCOMOTIVE HOIST—ATCHISON, TOPEKA & SANTA FE RAILWAY.

son, Topeka & Santa Fe, and a similar one is to be installed at San Bernardino, Cal. Neither of these shops have crane service, but both are equipped with electric power. The capacity of the hoist is 200,000 lbs. and it is driven by a 30 h.p. motor. The frame is built up of structural shapes, with a horizontal length of 39 ft. 8 ins. between the posts, the width across the track being 13 ft. The arrangement of the motor drive is shown in the engraving. One end of the hoist is fixed in position, while the crossrail at the other end may be moved along the structure through a travel of 14 ft. 3 ins. in order to accommodate locomotives of various lengths. This crossrail is traversed by screws driven by a hand wheel and chain reaching down to the floor of the shop. The motor is mounted on the upper part of the frame and, by means of a belt, drives a long shaft extending the full length of the frame on the other side. At the fixed end miter gears drive a cross shaft carrying two worms, meshing with worm wheels at the corner of the hoist. The moveable crossrail also carries a cross shaft driven from the main shaft through a miter gear which is carried on a portion of the shaft which is splined for the traveling of the gear. Thus at the four corners of the hoist worm wheels are driven in either direction by the motor. These worm wheels are also nuts receiving long screw rods by which the locomotives are raised. The lower ends of these rods terminate in forged loops which are made large enough to receive crossbars of 15-in. "I" beams which are passed under the locomotive frames for lifting. Details of the loops and also of the worms and worm wheels, with the thrust collars and lifting screws, are shown. The latter detail also shows the construction of one of the crossrails in section.

The motor is a 30 h.p. variable speed, induction type, controlled by resistance in the revolving winding, and furnished, as was all of the electrical machinery of this plant, by the General Electric Company.

VARIABLE SPEED MOTORS IN RAILWAY MACHINE SHOPS.

BY J. C. STEEN.

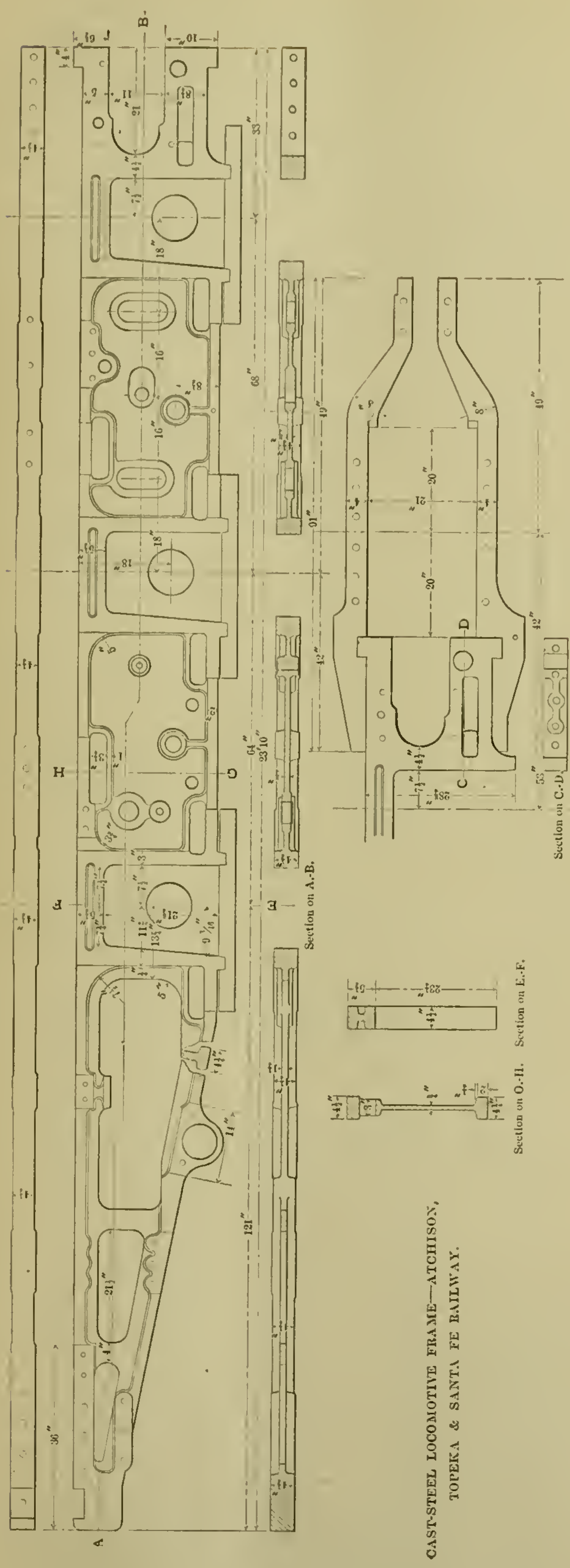
After considering the advantages of the variable speed motor in a general way, it remains to consider more specifically its adaptability for driving the various machines found in the railway machine shop. There are so many different types of machines and some of them are used for such a variety of purposes, that it is necessary to consider almost every machine separately. To better show the advantages of a well-selected motor equipment as applied to the machine tool, it may be well to consider first the disadvantages of the usual method of driving by means of stepped pulleys and belts. The term "stepped pulley" is here used in preference to the more common term of cone pulley, or cone. In order to transmit the driving power required in the successful operation of modern machine tools it is necessary to use pulleys either of a large diameter or with a wide belt surface. In many cases, the diameter of the driving pulley is limited or fixed by the nature of the machine upon which it is used. The belt width may also be limited by the number of steps of the pulley in order to secure as large a number of speeds as possible, or by adopting such a width as can readily be shifted from one step to another. A belt that is light enough to be shifted easily may be too light to transmit sufficient power, while on the other hand a belt heavy enough for driving purposes may be very hard to shift. It is frequently the case that much time is lost because the operator will not change the belt position, when by so doing he might secure a higher cutting speed. It is true that in many instances where the cuts are quite short the time saved would not justify stopping the machine long enough to shift the belt, but if by some ready means of adjustment the desired increase in speed could be quickly obtained then in such cases a saving in time by the use of the increased speed could be effected. When the work involves cutting upon different diameters and at different rates of speed, every minute saved by reason of operating at an increased rate of speed is that much gained.

The worst feature, however, in connection with the use of stepped pulleys is not the difficulty of shifting the belt, but is the comparatively large difference or jump between the different steps of the pulley or in other words, the large variation between the speeds when the belt is changed from one step to another. To illustrate this, consider the pulley and gearing of a 24-in. lathe. A representative machine of this class may have a pulley the extreme steps of which will be in the ratio of 8 to 1, and it will probably have a back gear ratio of about 12 to 1. By this is meant that the range of speeds as effected by the use of the belt upon the extreme steps of the pulley will be in the ratio of 8 to 1 and that the range of speeds with the belt in any given position with the back gear in and out will be as 12 to 1. With this arrangement, and using a 5-step pulley, the diameters at which the cutting speed is uniform will be in about this proportion: 24 ins., 14 ins., 8.5 ins., 5 ins. and 3 ins. with the back gear in; and 2 ins., 1.25 ins., .75 in., .42 in. and .25 in. with the back gear out. With the lathe arranged for any given cutting speed, it is obvious that for any other diameters than those corresponding to the different belt positions the speed will be at either a higher or lower rate of cutting than that for which the machine is arranged.

Consider a piece of facing work with the cut started at a diameter of 24 ins. at as high a rate of cutting speed as is possible for that particular job, then the work will be run at a gradually decreasing cutting speed until a diameter of 14 ins. is reached, where by a change in the position of the belt the maximum cutting speed can again be brought into use; and so on through the different diameters until the cut is finished. In this case we have an average loss of time of about 20 per cent., due to decreased cutting speed alone, besides the time lost by making the requisite changes in the positions of the belt. By the use of the variable speed motor and a controller with a suitable number of steps, the speed can be brought up to the maximum by simply moving the controller lever at the proper time without stopping the machine. By such means a possible saving of time of from 12 to 20 per cent. can be effected, the amount of time saved, of course, depending upon the number of speeds provided for in the controller, assuming that it is placed within easy reach of the operator.

The stepped pulley drive is also at a disadvantage when turning shafting of different diameters, or similar work where a maximum speed must be obtained to produce the best results with high speed cutting steel. The increase in cutting speed between any two adjoining belt positions is equal to about 60 per cent. Thus it will be seen that if a piece of work is being turned out at a rate of cutting speed which is 20 per cent. below that which the tool is capable of, the next speed, which is about 60 per cent. higher, may be too high for the tool to stand, so that the machine must go on cutting at a loss of time that might have been utilized had a ready means of securing finer gradations of speed been at hand. Such gradations of speed can be secured by the use of a variable speed motor with a suitable controller. Practical experience has shown, especially since the high speed steels have been introduced, that the limitation of the stepped pulley in this direction causes very much more loss of time than is generally supposed, since it does not give as fine gradations of speed as are required by modern methods. The defects noted in the above cases will apply equally well to many other lathes, and also to such machines as boring mills and other machines where stepped pulleys are now used. That certain defects do exist with the use of pulleys, that necessitate frequent shifting of the belt, is evidenced by the fact that substitutes are offered in a variety of change gear devices to overcome these objections.

For motor driving the variable speed motor with a controller having a comparatively large number of steps seems at the present time to offer the most satisfactory means of securing the large number of cutting speeds called for in some classes of work. Examples of special applications will be treated in articles to follow.



CAST-STEEL LOCOMOTIVE FRAME—ATCHISON, TOPEKA & SANTA FE RAILWAY.

CAST STEEL LOCOMOTIVE FRAMES.

A Rational Design.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

Those who have made the closest study of cast steel for locomotive frames are of the opinion that the design should be made with reference to the fact that the metal is to be cast and is to meet the difficulties of shrinkage and shrinkage stresses. They do not cast a frame of large rectangular sections, exactly of the form of a forged frame. Good steel frames have been cast after the pattern of wrought frames, and that they stand so well in service is the highest testimony to the skill of the foundry, but, after years of experience, no one will claim that there is any advantage in rectangular sections.

In the accompanying engraving a design of cast steel frames for a 0-6-0 switch engine is illustrated. This has been worked out with special reference to the material and its well known tendencies. Tee and I sections prevail, and the fillets are of large radius. Between the driving axle jaws the plate form is used, the metal in the web being ¾ in. thick, with bosses located wherever they are needed. Sections taken along the full length of the cast steel portion are shown in sectional plan. Wrought iron is used for the front section and also for the pedestal binders. Readers may desire to compare this design with that of the Delaware & Hudson Company illustrated in this journal on page 365 in October, 1903.

PAINTING OF STEEL CARS.

Following is a report made before the recent convention of the Master Car and Locomotive Painters' Association:

It is the sense of this association that, in the construction and painting of steel cars, the following points are of vital importance to their preservation:

First—All flash or mill scale, rust, oil, grease and dirt should be entirely removed from all parts entering into the construction of cars before any paint is applied. We believe that this can be best accomplished by the use of the sand blast.

Second—During construction, all overlapping joints, wherever metal is placed upon metal, should be thoroughly coated with a heavy mixture of moisture repelling paint.

Third—The initial painting, being of the greatest importance, should be done in the best possible manner. The first coat should be applied immediately after metal has been sand blasted and before the cleaned surface can accumulate rust.

The material should be of an elastic nature and sufficient time should be allowed between coats for drying. It should be put on evenly in a workmanlike manner.

Fourth—We believe that not less than three coats should be applied to all exterior parts of body, including underframing, and two coats on interior of body; also all parts of trucks except wheels and axles.

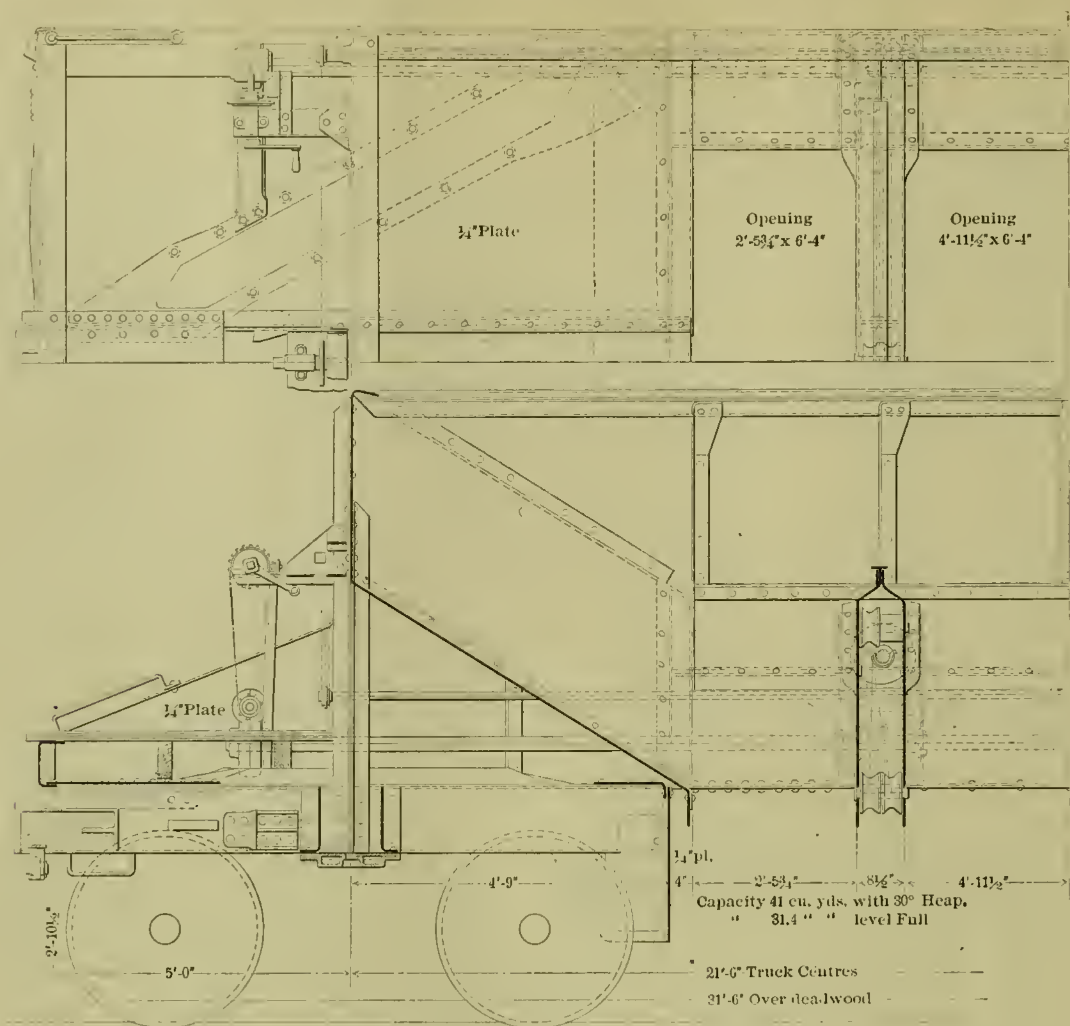
Fifth—We recommend a rigid inspection of the cleaning and painting of cars under construction by competent, practical men, believing this in the line of economy.

Sixth—We would suggest that the abuse of cars in service be stopped by discontinuing the loading of hot slag, billets, etc. Also that the hammering of side sheets and other injurious methods used to facilitate unloading be discouraged.

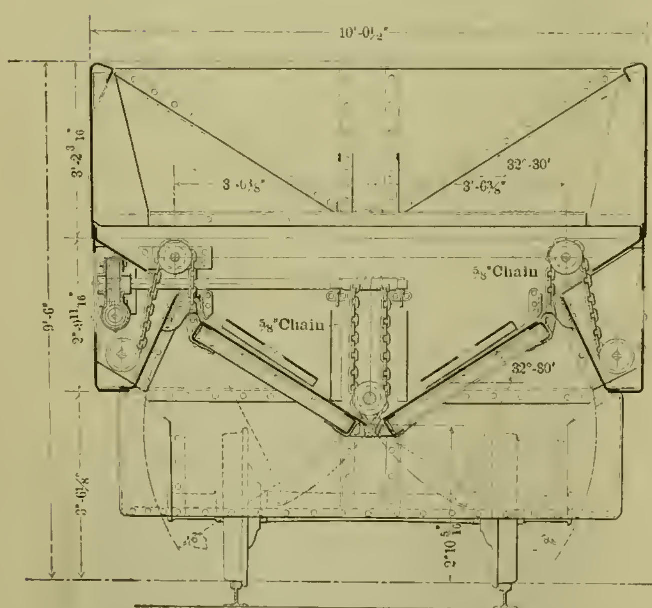
Seventh—In the repainting of cars, all corrosion and loose paint should be removed with steel scrapers and wire brushes or the sand blast, and not less than two coats of an elastic preservative coating applied to all cleaned parts.

As the greatest loss from corrosion is found on the interior parts of coal-carrying cars, we would consider the matter of painting these parts worthy of serious consideration.

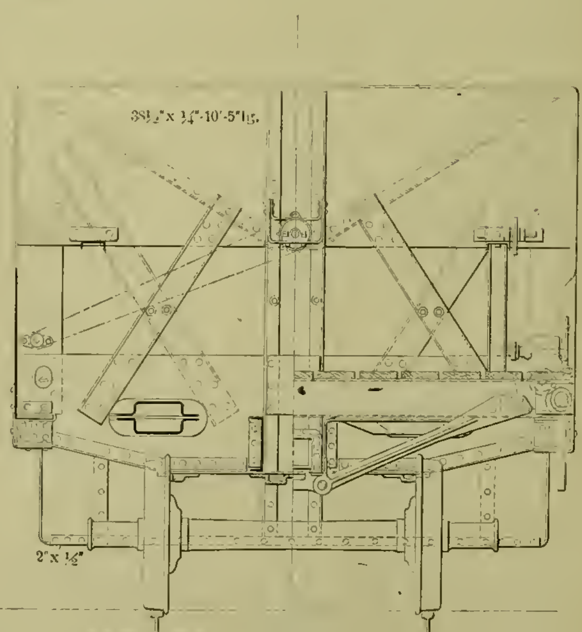
"Cross ties now cost more than twice the expense for rails."—*P. H. Dudley in the Railway Age.*



PARTIAL PLAN AND LONGITUDINAL SECTION.



CROSS-SECTION THROUGH CROSS-BEAMS.



PARTIAL CROSS-SECTION THROUGH PLATFORM AND END VIEW.

SUMMERS GRAVITY DUMP CAR.

THE SUMMERS GRAVITY DUMP CAR.

This car will dump its entire load on either side of the track or part on each side or all of it in the centre. The door openings are large and any load that can be handled by a steam shovel will pass out of them easily. The operator has full control of the flow of the material, as the doors will stand in any intermediate position between closed and full open, and ballast can be distributed in such quantities as desired while the car is in motion can easily dump the load and replace the doors.

Cars of the type illustrated have been in service since last June handling pig iron, broken stone, ashes, coal, blast furnace cinder, gravel and general refuse material. The average time for discharging the load was found to be about one minute. Loads of free running material are usually all out in from

40 to 45 seconds. One man can dump the load and replace the doors inside of two minutes. One of the large steel companies in handling refuse material from their mills found that it cost them about 7.2 cents per cubic yard to unload from the ordinary steel hopper cars. With the Summers car it cost less than this amount to unload the entire contents of 40 cubic yards, the difference being that the Summers car discharged its load to one side of the track where it was wanted, while the hopper car discharged it in the centre of the track and laborers had to rake or shovel it to one side.

Two large doors, which are interchangeable, extend from truck to truck and form the V-shaped bottom. Each door is supported by chains at both its inner and outer edges. The winding shafts for the chains are operated by worm gearing and no latch mechanism is required to hold the doors shut as the worm prevents the shaft from rotating except when operated by the cranks on the platform at the end of the car. The chains which support the outer edges of the two doors are operated independently and thus, if desired, the outer edge of only one door need be lowered and the entire load will be discharged on one side of the car; or the outer edges of both doors can be dropped at the same time and half the load discharged on each side of the car; or the inner edges can be dropped and the entire load be discharged between the tracks. No portion of the car is beyond the clearance lines either with doors open or closed. The various positions which can be taken by the doors are shown by the dotted lines in the cross section, and it will be noted that when the lading is unloaded at the sides it is discharged clear of the tracks. The chains and shafting are protected from the lading by the box construction of the lower side of the girders and by the cross beams. The vertical fender plate at each end of the door opening plows the material away from the track when making a side dump.

The design of the car is unique in that it has no center sills and the entire load and the stresses due to pulling and buffing are carried by the side girders. These side girders are deep and have a large top flange area and a heavy boxlike construction at the bottom. They are securely tied together by the two deep crossbeams. The pulling and buffing stresses are transmitted to the side girders through the diagonal pressed steel stiffeners and the bolster construction. The construction of the diagonal stiffener is clearly shown in the plan view and in the cross section taken near the end of the car through the platform. The draft sills are assisted in resisting the vertical downward component due to buffing forces by the end sill construction. The end sill is riveted at its ends to the extension of the side plate. The coupler carrier of cast steel is held in place by two large pins which fasten it to the cast steel arms which are riveted to the pressed steel end sill channel, thus forming a strong truss.

Mr. Summers' friends were very skeptical when he proposed to build a car without centre sills, but a gondola and a hopper car of his design, without center sills, have been in the most severe service since June, 1902, and have shown no sign of failure.

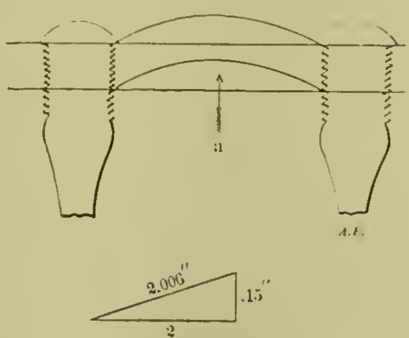
The gravity dump car described above has a capacity of 100,000 lbs., or 40 cubic yards; is 31 ft. 6 ins. long, 9 ft. 6 ins. high and weighs 39,600 lbs. It is patented by Mr. E. W. Summers of Pittsburg.

BULGING AND CRACKING OF FIREBOX SHEETS.

Two explanations are usually advanced to account for the bulging and cracking of firebox sheets in service.

First—That the bulging is caused by gradual burning of sheets in service at points at which the heat is concentrated or at which incrustations form.

Second—That the bulging and cracking is caused by the strain put upon the sheet by the contraction of the mud ring, while the upper portion of the firebox is still hot, the unequal strain causing the sheets to bulge and crack.



THE BULGING OF FIREBOX SHEETS.

No doubt cracking and bulging will result from either or both of these causes, though in very few instances are the sheets subject to a slow process of burning, for tests of metal cut from the bulges show very little deterioration. When the strains induced by the expansion and contraction of the sheets are considered, surprise is excited, not because the sheets crack, but because they do not always crack. If the sheet rapidly transmits the heat to the water and assumes the same temperature—about 375 degs.—the expansion between stays of 4-in. centers would be $375 \times .000007 \times 4 = .012$ in. This is apparently slight, but if the stays held the plate perfectly rigid it would cause the plate to bulge $\sqrt{2.006^2 - 2^2} = .15$ in. The metal would be strained beyond its elastic limit and would be permanently deformed. The pressure equivalent to this amount of bulging on a ⅜-in. plate with stays 4-in. centers has been shown by the United States Testing Board to be about 1,400 lbs. per square inch. When the boiler is cooled the load is removed and the sheet contracts, putting the fibers at "a" in compression. It is for this reason, namely that the sheets are alternately in a state of tension and compression, that the cracks frequently start from the water side. Anything that causes the localization of heat at one point, such as an arch, or that prevents the rapid transmission of heat, such as scale or poor circulation, will greatly increase these strains, for under such conditions the fire side of the sheet may be of a higher temperature than the water side. The fire side would therefore expand more than the water side and bulge the sheet toward the inside of the box. It is because the side of the firebox transmits heat less effectually than the crown sheet that the cracking is largely confined to the side sheets.

If one portion of a side sheet is suddenly cooled at 75 deg. while another portion is at 375 degs., this would be equivalent to inducing a tensile strain or direct pull of an amount above the elastic limit of the material, or about 30,000 lbs. per square inch of metal, and it would be but a question of a short time when a plate so strained would bulge and crack. The stretch per inch required to pass the elastic limit can be determined by Hook's Law, $E = \frac{p}{e} = 28,000,000$, if $p = 28,000$ at the elastic limit the stretch per inch would be .001 in. If, therefore, a firebox 10 ft. long is cooled so that one portion of the side sheet contracts .12 in. more than an adjacent portion, the steel will be strained to its elastic limit, and the repetition of these strains would soon rupture the plate. A crack so produced can start either from the water side or from the fire side, for sudden cooling not only induces tensile stresses such as these, but also stresses in flexure by bulging a plate rigidly held. These stresses are of about the same amount as those produced by the method first considered, but they are much more harmful in that they are suddenly applied. The probabilities are that cracks following bulges caused in service will start from the water side, whereas those caused by sudden cooling in washing out may start either on the firebox or water side.

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

"A gas pipe and a drift will make a tight enough locomotive flue if the conditions are favorable when a tube of gold, diamond studded, cannot be made tight if the conditions are unfavorable," said a prominent superintendent of motive power to the writer who recently asked concerning his practice in flues. This official has had a hard time with flues because of the way his locomotives are overloaded, and he says that there is no way to overcome the difficulty except to reduce the weight on driving wheels so that locomotives cannot start loads which are too heavy for their boilers. There is food for reflection in this suggestion.

IMPROVEMENT IN ROUNDHOUSE EQUIPMENT.

To empty a locomotive boiler, do 18 minutes' work on the boiler, fill it, fire up and get the engine out of the house under its own steam at a pressure of 75 lbs., and do all this in 80 minutes, is a notable achievement, which has an important bearing upon future roundhouse practice and locomotive operation. How this is done at the McKees Rocks roundhouse of the Pittsburg & Lake Erie is described in a paper by Mr. A. R. Raymer, which appears in this issue. Mr. Raymer has done a signal service to the railroads of this country in the development of this system of boiler filling, washing and blowing out, in which the water for filling the boilers is brought to a high temperature by heat which would otherwise be wasted. The system has already been used long enough to demonstrate its success, but its possibilities for accelerating service at locomotive terminals and for reducing boiler repairs are probably by no means fully stated in the paper. Because the roundhouse is the key to the chief question of locomotive operation, any factor tending to improve facilities for prompt movement, as this does, should have immediate recognition by railroad managements.

PASSENGER CAR VENTILATION.

To Dr. Charles B. Dudley, chemist of the Pennsylvania Railroad, the credit for the greatest improvement in passenger car ventilation is due. With the assistance of the staff of his own and other departments he has pursued investigations during the past ten years which have resulted in the adoption and general use by the Pennsylvania Railroad of a system which has proved satisfactory and successful.

Through elaborate experiments the principles of the problem were established and the possibilities determined. Then a system was planned and put into experimental service with such success as to lead to its application to 800 passenger cars on the lines east of Pittsburgh, to its use on all new cars, and application to the older equipment as it passes through the shops. It has also been applied to 200 cars on the Pennsylvania Lines west of Pittsburg and to some of the equipment of the Baltimore & Ohio and other roads.

The system has not yet been applied to sleeping cars, but at the present time it marks the most important development in the improvement of car ventilation.

Dr. Dudley has just issued a pamphlet illustrating and describing the system, which contains the substance of his valuable articles in the AMERICAN ENGINEER in June, 1900, page 191, and June, 1901, page 177, and bringing the practice down to date as it is applied to the large number of cars referred to. The preliminary investigation and application were so thorough as to render few changes necessary, and Dr. Dudley's articles, written three and four years ago, very closely represent present practice as it is being introduced on a large scale to-day.

SHOP SUPERINTENDENTS AND MASTER MECHANICS

Superintendent of Shops is a title which is growing more frequent in the lists of mechanical officials of railways. It is becoming more necessary to divide and specialize the responsibilities of the subordinate mechanical officials most important in such a way as to permit of the possibility of administering their work to advantage. The time for expecting a master mechanic of a division to look after a large shop employing 3,000 men, properly supervise the work of engineers and firemen on the road, adequately direct running repairs and handling engines at three or four large roundhouses, and at the same time spend from one-third to one half of his time in entertaining grievance committees, has passed and will never return. In the old days, one man could do all this for a 200-mile division and readily maintain the standards which were set for him. It is beyond the capacity of any one to meet the requirements of such a division on a busy railroad to-day. The wisest course, and one which is rapidly growing in favor, is to divide the work so that the maintenance and operation of locomotives on the road is entirely separate from the problems of the shop. While one officer may be held responsible for the whole and may be called master mechanic, the superintendent of the shop is an absolute necessity.

The situation is clearly represented in the cost of a modern railroad shop, and the amount of investment involved in mistakes in construction, arrangement, equipment, organization and operation. It is very difficult today to find master mechanics who can handle both branches of their work equally well, and there are sufficient indications of the importance of considering them entirely separately.

There is also another side to this question, which applies on all roads with sufficient business to justify the separation. In educating men for higher positions those who are to take charge as superintendents of shops must have their training in the shops, and those for outside operation must have their training in connection with the roundhouse. A man in control of both will either be a good road man and weak as to shops, or a good shopman and deficient as to the road service. Road work is distasteful to many shop men, and is not good ground for preparing shop superintendents. With the separa tion of the responsibility the locomotive engineer has an opportunity to become master mechanic in charge of a division through the line of promotion to road foreman of engines and roundhouse foreman. The machinist in the shops may work up through the grades of foreman and general foreman to become the head of a plant. The divisional scheme promises a valuable advantage in offering means for training men in different lines for something better, and this is an important element for consideration of plans for meeting present conditions and improving service. Of course, this discussion concerns only the organizations which obtain on roads on which the motive power department has charge of the engineers and firemen.

EDUCATION FOR SHOPMEN AND ENGINEMEN.

A request for a list of books, information concerning valve motion models and suggestions helpful in inaugurating a school, has just been received from members representing a lodge of the organization of the mechanical employees of a well known railroad. The letter modestly apologizes for the trouble caused and expresses the earnest purpose of the lodge to improve by special study of the locomotive in order to increase the value of the service of its members. Who could consider it "trouble" to help in any possible way men who show such a spirit and desire to advance? The officials of any railroad should be ready to meet such a desire for knowledge with the greatest alacrity and with every possible encouragement, as will be done in this case.

But why wait for the men themselves to open such a question? Why should not every railroad take the initiative and then meet the men more than half way in such a far-reaching matter? It would cost perhaps a couple of hundred dollars to provide an attractive reading room for shopmen and enginemen at every locomotive terminal. Good valve motion models, a few good books and the best periodical literature could be provided for almost nothing, and the men would doubtless be anxious to contribute to the cost. In the case of the lodge mentioned, the men ask nothing but advice. They propose to bear the whole expense of a school, and the lodge will pay the bill.

Suppose the cost of the model and books and room to amount to $2,500 per year for ten roundhouses on a large road where a thousand or more well intentioned men would congregate. Suppose ten firemen only should make a careful study of combustion and as many engineers should study boiler construction, these men alone would pay several thousand per cent. interest on the investment by the improvement of their work and care of their employers' property.

At the recent conventions at Saratoga the mention of the "Fireman" brought many speakers to their feet to say that it is impossible to secure good men to fire big modern locomotives. Not long ago a railroad president said that it was impossible to get the right sort of men to run big locomotives. It may therefore be accepted as a fact that something must be done or the advantages of the big locomotive will be lost. What better opportunity for improvement offers than that of education? What better indication could be found for the need of education when the demand comes from the men themselves?

This is a subject of transcendent importance to the American railroads, and one in which directors should take a vital interest. They cannot afford to miss such an opportunity as lies before them through education. The writer ventures the prediction that railroads meeting this demand unreservedly and unstintingly will have more educational committees and fewer grievance committees.

In these paragraphs books and reading rooms are suggested. Why stop short of well equipped and well conducted schools?

Railroads should be builders of men as well as of tracks, locomotives and cars. They can not find competent men ready made, and the difficulties are increasing. If the Master Mechanics' and Master Car Builders' Associations should also become Master Men Builders' Associations they would meet a great need of the times. They should build shop men, foremen, firemen, engineers and all kinds of men. The British Admiralty a generation ago found it necessary to educate its own men, and now the educational work is placed under the direction of an official who has no other responsibilities. Our railroads must do something of this kind, through schools of their own or through co-operating with existing educational facilities.

AN IMPORTANT VIEW OF ELECTRIC TRACTION APPLIED TO STEAM ROADS.

The problem of applying electricity to steam railroads has been attracting considerable attention, not alone from visionaries, but from men in active charge of the steam roads. The following is one of the most calm and intelligent expressions that we have seen on this subject and comes from Mr. Bion J. Arnold, whose opinion on this question is most highly regarded.

The amount of energy transmitted to any great distance and used by electric cars that have been put in use until recently has been small when compared with the amount of energy that it takes to propel a steam railroad train of 500 tons or 600 tons weight at the speeds ordinarily made by such trains. It may be taken as axiomatic that, when investment is taken into consideration, power cannot be produced in a steam central station, under conditions that exist to-day, and transmitted any great distance to a single electrically-propelled train requiring from 1,000 to 2,000 h.p. to keep it in motion, as cheaply as a steam locomotive, hitched directly in front of the train, will produce the power necessary for its propulsion. Therefore, there must be other reasons than the expected economy in power production, to warrant the adoption of electricity on a trunk line railway, unless it can be shown that the trains are frequent enough to make the saving in the cost of producing power greater than the increased fixed charges made necessary by the increased investment due to the adoption of electricity.

That electricity will be generally used on our main railway terminals, and ultimately on our main through lines for passenger and freight service, I am convinced, but I do not anticipate that it will always be adopted on the grounds of economy in operation. Neither do I anticipate that it will come rapidly or through the voluntary acts of the owners of steam railroads, except in special instances.

At first the terminals will be equipped for special reasons. Those roads which run through populous countries will either build new roads or acquire, for their own protection, those electric railroads already built and operating in competition with them, and utilize them as feeders to their through line steam trains. The next step will logically be the electrical equipment of the trunk lines between the cities already having electrical terminals.

With the terminals and main lines equipped electrically and the desire on the part of the public for more prompt and effective freight service, resembling that which is given by the steam roads in England and on the Continent, due to the great density of population, there will be developed a great high-class freight service, conducted in light, swiftly moving electric trains, which can be quickly divided and distributed over the surface tracks of our smaller cities, or through underground systems similar to that which is now being built in Chicago. Such a system would soon prove indispensable to the public and a source of great profit to the roads, as it is now getting to be to many suburban railways.

Until recently the cost of electrically-equipping a trunk line under the standard direct-current, rotary-converter system has been such as to practically prohibit its adoption, but recent developments in the single-phase alternating-current motor field have made it possible to eliminate a large part of the investment heretofore necessary, and the prospects for the application of electricity to long-distance running are better than ever before.

I do not anticipate that all roads will soon adopt electricity, for the steam locomotive will hold its field in this country for many years to come, but I do expect, judging somewhat from "positive knowledge," a remarkable development soon to begin in the electrical equipment of favorably located steam roads.

These extracts are taken from an address before the International Electrical Congress at St. Louis.

RAYMER'S BOILER WATER CHANGER.

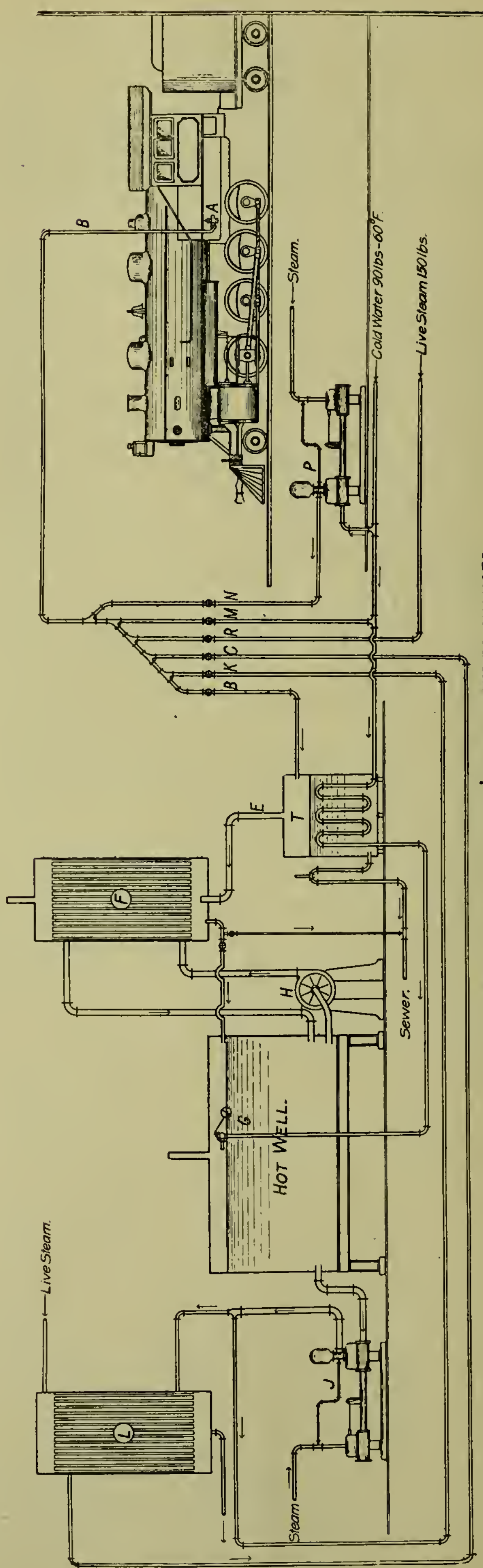
A series of five articles describing the extensive water softening installation on the Pittsburg & Lake Erie Railroad appeared in this journal beginning with the November, 1903, number. An important feature in connection with this installation is the boiler water changer at the McKees Rocks roundhouse. The following description of this is abstracted from a paper read by Mr. A. R. Raymer, assistant chief engineer of the road, before the Western Railway Club.

This plant has been in successful operation since November, 1903, and by it the foul water is removed from locomotive boilers; the heat is saved and used in heating the water for refilling, and the boiler is refilled with water having a temperature of about 300 deg. F.; the whole operation requiring from 20 to 35 minutes, depending on the size of the boiler. If the boiler at the commencement of the operation shows a steam pressure of 100 to 125 lbs. per sq. in., and if the fire is banked, which is desirable, the steam pressure during the process will not fall below about 75 lbs. per sq. in. This water change is made without allowing any steam to escape in the atmosphere, and also without discharging any water on the floor of the roundhouse or into the pits. While it is being done the temperature changes in the boiler are very slight, being not more than 30 deg.

On many and a rapidly increasing number of roads there exist conditions which make it desirable to "change" the water much oftener than it is necessary to remove the plugs to wash out mud or scale. The list of these roads will include those that use water having alkaline and other soluble compounds that are not precipitated in the form of scale in the boilers; others that use waters that make a small quantity of scale that does not cement or adhere to the metal, and lastly the rapidly increasing number that have awakened to the importance and economy of purifying the water, by removing all scale forming solids and mud in suspension, before the water is delivered to the locomotive boilers. The condition of the water on the P. & L. E. R. R. is such that it is necessary to remove the plugs for washing only once in from 20 to 45 days; during this time the water is changed whenever necessary, or on an average of about once each five days.

The benefits resulting from the use of treated water, in comparison with the conditions existing when the locomotive feed water was used in the raw condition as pumped from the rivers, are clearly shown by a few facts taken from the records. *a.* Number of trains given up on the road on account of leaking boilers during August, 1902, 27; during August, 1904, 2. *b.* Number of trains that had to reduce the loading by setting off cars, on account of boilers leaking, during August, 1902, 13; for August, 1904, none. *c.* Number of through trains during August, 1902, with delays of 1 hour or more, that had locomotives changed at McKees Rocks, on account of boilers leaking, 31; for August, 1904, 3. Similar comparisons can be made from results already obtained which show enormous advantages in favor of using purified water, in the increased life of flues, fireboxes, etc., in the reduction of boilermakers' wages and in the increased service obtained from the locomotives and the reduction of the amount of fuel used.

By use of the plant here described, locomotives requiring a change of water have their fires cleaned in the usual way and are sent to roundhouse preferably with fires banked and steam pressure at about 100 to 125 lbs. Blowoff cocks have been placed on the left side of the firebox near the bottom. An overhead 2½-in. blowoff pipe is located between engine pits, with a pipe coupling located about 6½ ft. above the floor and opposite the blowoff cock in boiler, when the locomotive is in proper position in roundhouse. The other end of the blowoff pipe con-



DIAGRAMMATIC VIEW OF RAYMER'S BOILER WATER CHANGER.

nects with a manifold on the wall of roundhouse (see diagram). A flexible pipe with necessary joints, gauge, drip cock and extension pipes for reaching blowoff cocks is mounted on a light truck for convenience of operation. This minutes. When the water is all blown from boiler the blowoff cock, and connected therewith, and also with the blowoff pipe overhead, after which the valves are opened and the water in the boiler is forced out by the steam pressure in 10 to 20 minutes. When the water is all blown from boiler the blowoff valve in the manifold is closed and the superheated water (at temperature of 300 deg. F., and with pressure of 125 lbs.) valve is opened in same manifold and the boiler is quickly refilled with this pure water, after which the valves are closed and the flexible pipe truck is disconnected and removed. During this process there remains in the boiler a steam pressure of about 75 lbs. after foul water is fully removed and the pure water is forced in against this pressure.

Manifolds are placed on the roundhouse wall, one for each of as many pits as it may be desired to serve; pipe mains are laid under the floor in an accessible trench, one for each branch of the manifold. It has been found desirable to have the manifolds include the following service pipes: Live steam at about 150 lbs. pressure; blowoff pipe; superheated water, at temperature of about 300 deg. F., and with pressure of about 125 lbs.; hot water, at a temperature of about 200 deg. F., that is the hot well temperature, and with a pressure of about 125 lbs.; cold water, at supply temperature, say about 50 deg. F., and at about 90 lbs. pressure; test water, at supply temperature and at any desired pressure up to 300 lbs.

Live steam is used for heating up empty cold boilers, which can be safely done in about 10 minutes, in which time the temperature is changed from cold condition up to about 300 deg. F. The action of the steam on the empty boiler shell is uniform throughout its mass and consequently causes no unequal expansion, and therefore no bad results. Live steam is also used for increasing the temperature and pressure in a boiler full of water and under low steam pressure. The blowoff pipe from the manifold is used to convey blown-off water and steam to the blowoff tank. Superheated water is used for refilling boilers when water is changed and for filling empty boilers after they have been warmed up by use of live steam. Hot water is used for filling boilers when hydrostatic test is to be applied by test water at proper pressure; hot water is also used to cool down boiler shells quickly and safely. Cold water is used for removing mud, scale, etc., when necessary, by old way of washing. Test water is used as described above for making hydrostatic tests; this is furnished by a pump set to the pressure desired.

The blowoff pipe B (see diagram) attached to blowoff cock A conveys water and steam from boilers to blowoff tank T, which tank is closed and furnished with a pipe E to convey steam to condenser F, and if in excess to the atmosphere; the superheated water and steam blown from the boilers will therefore immediately on arrival at blowoff tank drop to a temperature of 212 deg. and all heat above that amount will pass in form of steam through pipe E to condenser. A hot well is located near and below the condenser; it is kept full of pure water from the supply by means of a float valve G. This supply water for hot well flows through a coil in the blowoff tank, thereby extracting considerable heat from the foul water left therein, reducing its temperature below 212 deg. A centrifugal pump H draws water from the hot well and circulates it through the condenser F and back to the hot well, thereby condensing the steam and transferring the heat to water in the hot well. The water of condensation also flows from the condenser to the hot well, or to the sewer as may be desired. A hot water pump J is located below the hot well level and draws water from it and forces it by pipe K to the hot water valve in manifold, and by pipe C through a live steam heater L to the superheated valve in manifold. This pump is set for constant pressure of 125 lbs. and is controlled by a steam pressure regulator. The test pump P is of the usual steam pressure regulated type easily adjusted for the pressures wanted, up to 300 lbs. per sq. in.

Few persons who have not made this work a special study will appreciate the amount of heat lost when an ordinary locomotive boiler is blown off and no attempt made to save it. An ordinary freight locomotive boiler will hold about 2,500 gals. of water when in working condition, and the amount of heat blown off from a boiler of this kind at 100 lbs. pressure will evaporate about 2,700 lbs. of water at 212 deg. F. and this amount of heat along with that saved from the foul water is sufficient to raise the refilling water from an initial temperature of say 60 deg. F. up to 200 deg. F. In delivering this refilling water to the boiler at say 300 deg. F., the additional heat above that of the hot well, which is at about 200 deg. F., is furnished by live steam from stationary boilers. No one will question the economy of drawing heat from a modern power house with stokers and high efficiency boilers rather than trying to heat up locomotive boilers in the old way by smoky fires, with expensive draught furnished by use of compressed air or steam.

Following is a fair example of the time required to change the water in a heavy consolidation locomotive.

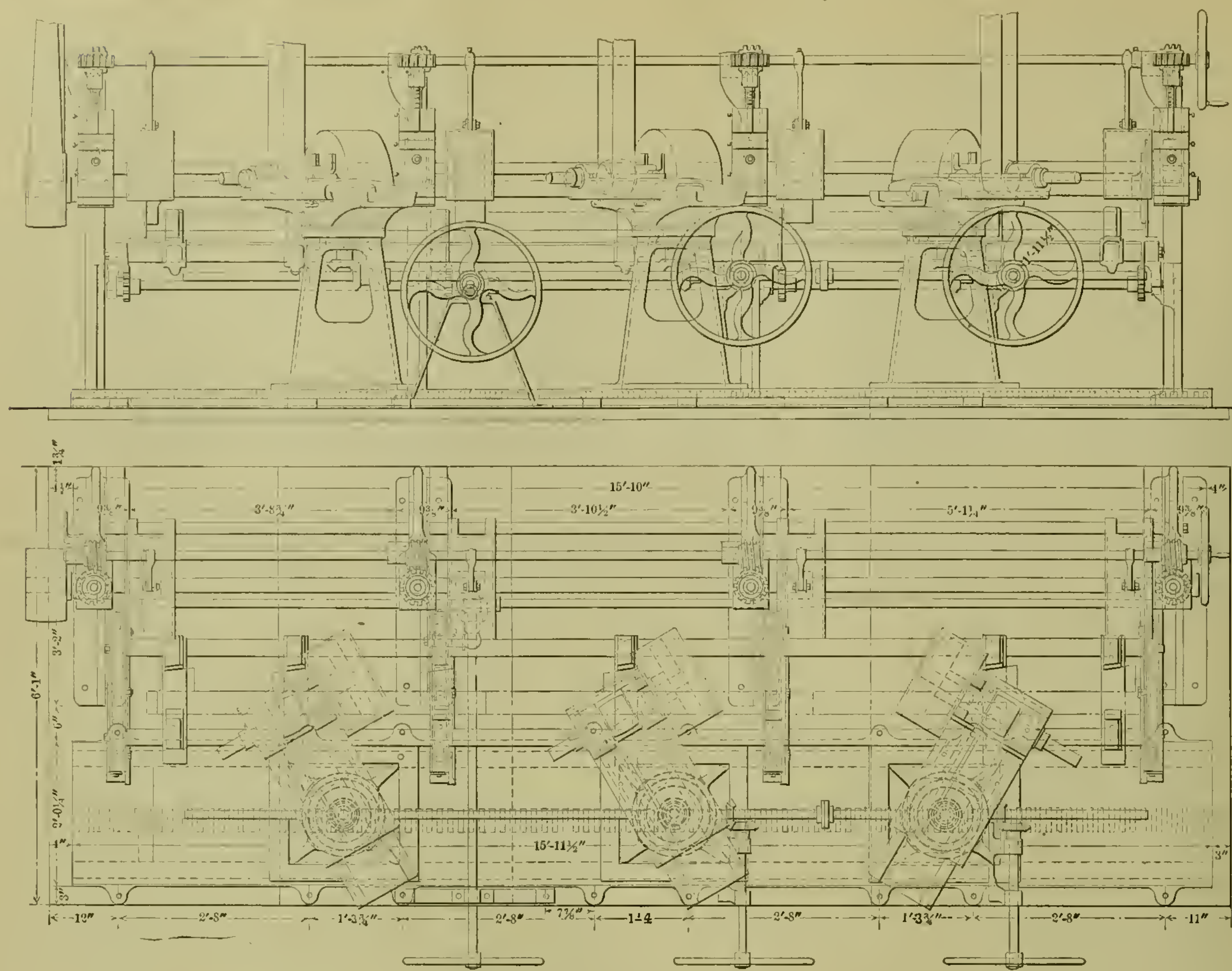
Fire was banked with steam pressure at 112 lbs., water change was made in 37 minutes, and steam pressure did not fall below 50 lbs.

4.00 p. m.	Commenced to blow off water, boiler pressure 112 lbs.
4.24 "	Water all out; boiler pressure 90 lbs.; continued blowing steam.
4.26 "	Stopped blowing; boiler pressure 50 lbs.
4.27 "	Commenced filling with superheated water.
4.37 "	Boiler showed 2 gauges, and pressure of 75 lbs.
4.40 "	Locomotive left roundhouse.

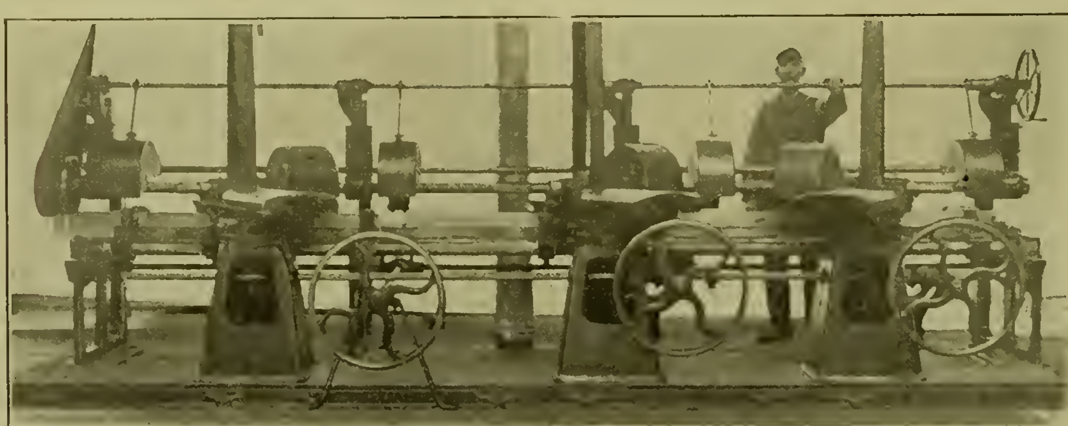
One man in the roundhouse at 18 cents per hour does the work of changing water in boilers, heating and filling boilers, testing, etc., and he can handle two locomotives an hour, if they are delivered to him so that he can operate on two or more at one time. At the McKees Rocks roundhouse there are 10 stalls equipped for the use of this plant, and 4 trucks are used in making the connections to the boilers.

In conclusion, some of the advantages resulting from the use of the above plant have been found to be as follows: Work of filling and emptying boilers and of changing the water is done without causing destructive strains in them. The roundhouse work on boilers is more economically done in regard to labor, fuel and time. Locomotives can be and are maintained in better condition, as work can easily be done when needed, on parts of the boiler, not accessible without removal of the contents. The roundhouse conditions can be much improved, the floor will be cleaner and dryer, and the air will be free from smoke and steam, much to the benefit of the employes and of the structure. Great economy resulting from the amount of heat saved from the water and steam blown out of boilers and used in heating water for other boilers. Convenience of method of making hydrostatic tests of boiler strength, and the thoroughness of the operation results in the boilers being maintained in safer condition. On account of the quick service in roundhouse work, passenger locomotives are run on schedules, with shorter time at terminals, thereby increasing the amount of work that can be done by the locomotives.

Personally, I do not believe that the alternating-current motor will make very serious inroads in the field now occupied by the direct-current railway motor. I do not believe that the direct-current railway system will be changed to any extent into the alternating-current railway system; but, what I expect of the alternating-current railway motor is that it will find and develop a field of its own, that field which the direct-current railway motor cannot reach—interurban service, long-distance service, secondary railway service.—*Dr. C. P. Steinmetz, International Electrical Congress.*



BELT RAIL CHECKING MACHINE.



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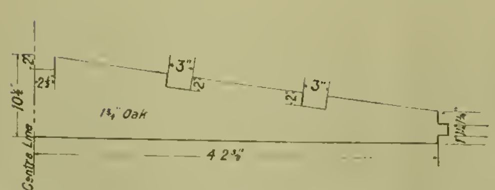
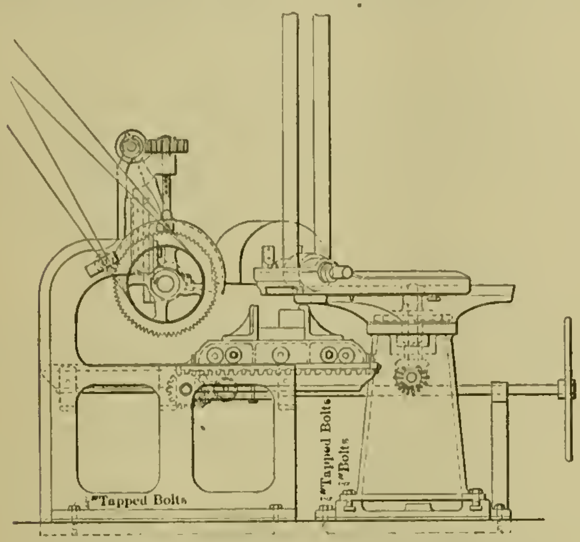


ONE-HALF CARLINE, SHOWING WORK DONE IN ONE OPERATION.

TWO REMARKABLY EFFICIENT WOOD-WORKING TOOLS.

GRAND TRUNK RAILWAY.

In the car shops of the Grand Trunk Railway in Montreal are several wood-working machines, which have been in service for a number of years and embody labor saving principles which are worthy of special attention. Through the courtesy of Mr. William McWood, superintendent car department of this road, drawings and photographs of these machines are shown. The first is a belt rail checking machine. This machine is mounted on a cast iron bed. It saws belt rails to length by means of saws which are mounted on a shaft extending the length of the machine and driven by a belt, shown at the left in the elevation and photographic views. This machine carries three inclined heads for gaining for the braces. These heads are set at the proper angle and are moved across the belt rails by the hand wheels, this work being done in the operation separate from that of the straight gains of the posts. The straight gains are made by cutters placed upon the same shaft with the saws. The photograph shows a belt



Belt Rail Checking Machine—End View.

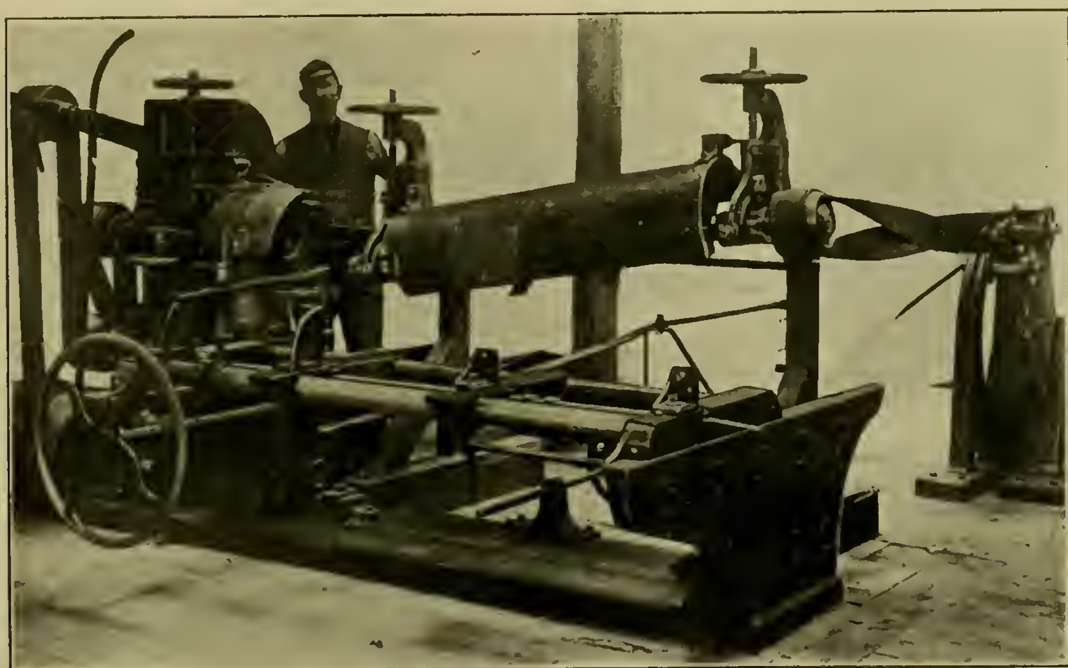
on the other side, to take care of the different slopes each side of the center of the carlins—that is to say, it would be possible to build a machine which would complete the operation in one cut, but as this machine turns out, on an average, 120 carlins per hour, with one man and a helper, it is quite sufficient for present requirements. The changing of knives, or cutters, is accomplished by loosening one bolt in each, and the changes can be readily made, for any requirements, in fifteen minutes. As the photograph shows the machine without carlins in place, a sketch has been added showing the work to which this machine was set when the photograph was taken. It is obvious that the possibilities of this arrangement of machinery, as to variety of work, are very great.

While neither of these machines are new they have never been illustrated, although Mr. McWood has generously supplied drawings to other railroads for construction of similar machinery for use in railroad shops where a large number of cars are built and repaired.

We are indebted to Mr. S. S. Underwood, chief draftsman of the department in Montreal, for informaiton concerning these machines.

CORRUGATED BOILER TUBES AS SPARK RETARDERS.

Interesting information in a letter from a superintendent of motive power who is using spirally corrugated boiler tubes under the very severe conditions imposed in connection with the burning of lignite fuel in locomotives is presented in the following quotations:



Carline Machine.

rail in place, having been sawed to length and gained for posts and braces. Belts for the angle knives, for the brace gains, run to the countershaft with a continuous pulley overhead extending the full length of the machine, in order that any change of angle, or shifting of the knives, may be accomplished without removing the belts. This machine turns out about 220 belt rails in ten hours.

The other machine is a combination tenoning and checking machine for carlins. This machine is illustrated by a photograph only. It consists of an ordinary tenoning machine with the additional shafts and knives shown in the photograph. The driving pulley on the end of the cutter shaft is almost a ball in form. In other words it is excessively crowned to accommodate widely different variations of angles to which the shaft may be set. This machine requires the carlins to be turned end for end, making two operations to finish the piece. This might be avoided by the duplication of the machine

"The spark problem is to us a very serious one. We run through a very dry agricultural country watered by irrigation and through a great deal of grazing country, and in either of these places a fire is a very serious matter. You have, no doubt, read about prairie fires, and if you have not seen them you have gathered that it means a great deal to people adjacent to the burned district.

"Through most of this section of the country we are burning lignite coal. I suppose you are aware that there have been many efforts made by Western railroads to burn this fuel, but with very poor success. I am not egotistical at all when I say I believe we have been more successful in burning this fuel than any one who has tried it and am satisfied that we can make further improvements along this line. One of the chief objections to the use of this coal is the amount of fire that is thrown from the stack. If you have never had any experience with it you can hardly appreciate what this means. It is like burning wood or charcoal with a blast underneath the grates. We have used all sorts of appliances, but the best results are obtained from a big diamond stack with a big cast iron cone and very fine netting 4½ x 4½ mesh. The use of this stack means considerable back pressure, owing to the small nozzle that we have to use to prevent fires by throwing sparks against the cone with force enough to break them up so that all that will come through the fine netting will extinguish before reaching the ground.

"Our aim is to burn this fuel with an open stack and we are just now doing considerable investigating along this line. The engine in which the spirally corrugated tubes are placed is running successfully with an open stack and with a nozzle ⅜ in. larger than any we have been able to run with engines burning the lignite fuel. All the reports coming to me show that this engine throws less fire than any engine we have of the same class that is fitted with diamond stack. These diamond stacks are very expensive to maintain. They cost us approximately $1 a day for repairs and maintenance.

"What happens inside of these tubes I do not pretend to know, but it would seem to me that the sparks must get some kind of a rotary motion similar to a bullet going through a rifle barrel and this may perhaps twist the fire out of them. In any event, that they aid us in this respect we are quite sure and we have ordered sets for more engines of different classes so as to continue our investigations.

"I am getting very much interested in this lignite coal burning, and from sheer obstinacy I suppose, because so many have tried and failed. It means a tremendous amount of money to any railroad company using it. The other roads about here are watching us and telling their managements that our engines burning this fuel will not pull full tonnage, but we are managing to get over the road and make a very fair showing. The coal is 80 per cent. cheaper than bituminous coal in this country, but we burn about 60 per cent. more of it and in that way effect a saving of at least 20 per cent. in fuel and in addition to this do not have to take care of the ash. Perhaps you may be interested in seeing an analysis of this coal.

"Lignite coal analysis: Moisture, 20.6. Volatile matter, 32.4. Fixed carbon, 44.4. Ash, 2.6."

You will note the small amount of ash we have, and when we come to compare handling of this with the handling of other coal that costs the same it should be taken into account. One of the coals that we get on our line has 23.4 per cent. ash.

"I am very much interested in lignite coal burning and if the spiral corrugated tubes have any effect whatever in diminishing the amount of fire thrown from the stack of engines they are just what we want and I hope that the experiments we are making are going to enable us to determine whether or not there is anything in that. After a while I am going to fit up a number of engines with peepholes so we can get a view of the interior of the smokeboxes of some engines with and without these tubes and working hard."

It is to be noted that the increase in power required with the new tool steels is not so great as the increase in output secured. There are numerous instances where the work done has been more than doubled, while the power increase required has not been more than 50 per cent. The average consumption of power by carbon steels is usually 0.05 or 0.06 h.p. per lb. of metal removed per hour, and the new tool steels will require only 0.03 or 0.04 h.p.—*C. H. Benjamin in Cassier's Magazine.*

Pneumatic Tubes for Baggage Checks.—At the Union Station in St. Louis a new system of transferring baggage checks has been installed. Baggage is taken from the train floor to a transfer floor below, by means of 17 special elevators. From here they are delivered to teams or transferred to outgoing trains. Checks are transmitted from the baggage room to 35 separate transfer stations by means of pneumatic tubes, comprising 8 miles of 3-in. brass tubing, capable of carrying 12,000 checks per hour during the rush hours.

COMMUNICATIONS.

TWO FAST RECORDS.

To the Editor:

The boiler for Union engine No. 81, which had been in the boiler shop to have firebox applied, was delivered to the erecting shop at 10.30 a. m. September 1. The erecting shop force, together with lagging and jacket men, worked until 4.50 p. m. in putting the engine and boiler together on the 1st, and from 7 a. m. to 10.15 a. m. on the 2d, at which time the locomotive was completed and delivered to the painters to have painting finished. The painters completed their work at 12 noon.

Time consumed in putting the engine together, 8 hours 45 minutes. Total time, including painting, 10 hours 30 minutes.

D. J. Redding, Master Mechanic.
Pittsburg & Lake Erie Railroad Company.

McKees Rocks, Pa.

To the Editor:

A consolidation engine, No. 840, class W, arrived at our Portsmouth shops on October 1st with tires flattened 6 ins.; it was run into back shop at 5 p. m. the same date and at 6.15 p. m. the wheels were placed in the machine shop ready to be turned. We commenced turning the tires, which were 56 ins. in diameter, on October 2d at 7 a. m. and at 6.05 p. m., 11 hours and 5 minutes later, they were finished; we had to take off ¼ in., therefore reducing the diameter of the tires ½ in. At 6.30 a. m., October 3d, we commenced putting the wheels under the engine and at 11.30 a. m. it was turned over to the roundhouse with steam up and ready to go on its run.

The amount of labor for turning and handling these wheels in machine shop was $3.99½, and in the erecting shop $13.33, or a total labor charge of $17.32½.

I do not think this can be beaten both for the amount of time and labor; if so would like to hear from some one who has done it quicker. These tires could have been turned quicker with less labor if our traveling crane would have handled the wheels to and from the machine.

G. W. Keller, General Foreman.
Norfolk & Western Railway Co.

Portsmouth, Ohio.

REPAIRING CRACKED CYLINDERS.

To the Editor:

In the October issue of your journal appeared an interesting article describing the repairing of a cracked cylinder at the Michigan Central shops, the reading of which reminded me of a novel method recently used at the C. R. R. of N. J. shops, at Ashley, Pa., which deserves recording.

The crack in this instance was in the side of the cylinder, one of the kind usually repaired by applying a piece of boiler plate, secured with patch bolts and made steam tight by caulking the edges of the crack or using some kind of packing. A piece of iron 1¼ ins. thick was turned about 8 ins. in diameter and cut into two semi-circular pieces. These two pieces were fastened by ⅞-in. patch bolts on either side of the crack, with a slight opening between them, and a band of iron was shrunk on over them, thus closing the crack tightly and making a steam-tight joint. The patch did not interfere with the jacket and appeared to make an effective and speedy repair.

Edward B. McCabe.

SPECIAL APPRENTICESHIP.

To the Editor:

So much has been said in your journal of late in regard to the treatment of special apprentices that I want to record the fact that there is one road at least where they are well treated. I finished my course a few months ago and was immediately put on shop improvement work at the maximum rate of pay for machinists. You are at liberty to use this information without my name or the name of the road.

J. K. L.

WEIGHT OF PLATE SPRINGS.

To the Editor:

The following formula may be found useful for estimating the weight of plate springs:

Let l = length of longest plate when straight.
b = width of plate.
t = thickness of plate.
n = number of plates.
w = weight of band.
W = total weight of spring.

Then $W = .18 (l \times b \times t \times n) + w$.

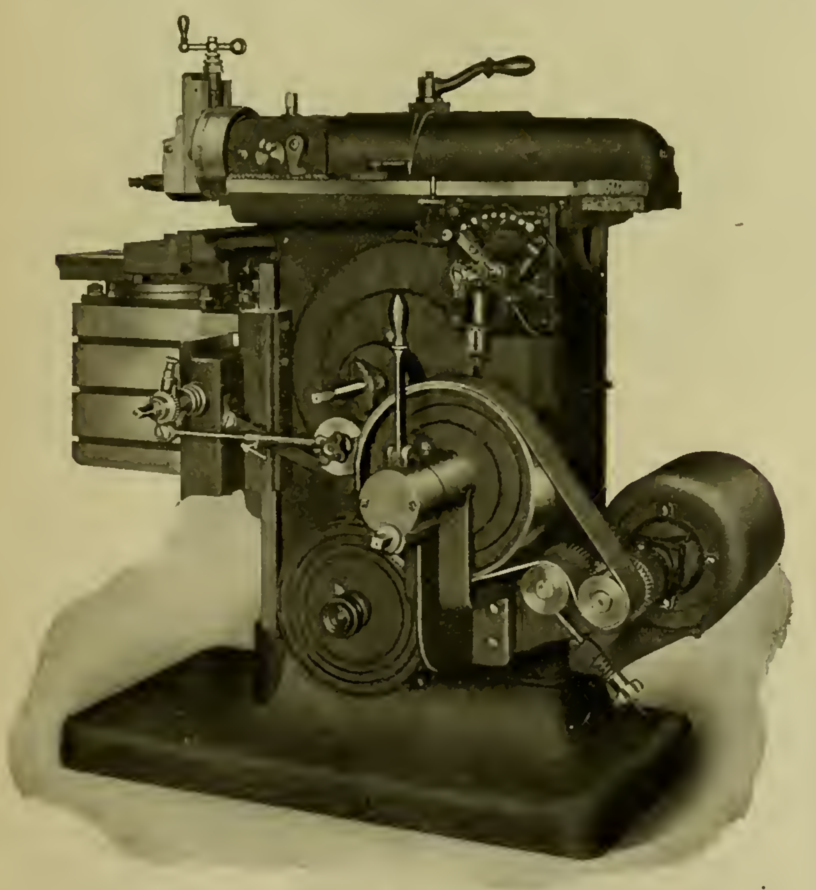
w, the weight of the band can be easily calculated from its dimensions.

In deriving the constant, the actual weights of about 200 springs were used, varying from 150 to 600 lbs. The formula gave a weight within 1½ per cent. of the actual for all springs, and within ½ per cent. of the actual for springs in which the number of long plates was ¼ the total number. The weight of clip ends was found to have practically no effect on the formula.

L. H. SCHENCK.

NEW MOTOR DRIVEN CRANK SHAPER.

The 16-in. crank shaper shown in the half-tone has a two-piece crank motion, which gives a powerful, even cutting speed on the forward stroke and a quick return of 4 to 1. The method of driving from the motor by means of the belt is novel, and practical tests have shown it to be about as positive as gearing or a chain drive. The idler pulley is connected to the armature shaft by gearing, and thus both idler and driving pulley act as drivers. The idler is held on the bell crank, as shown, and can be raised until the belt makes almost a complete wrap about the driving pulley. The motor is a Storey 1½ h. p., variable speed, and the controller furnishes 26 steps by means of field control. As there are two runs of gearing, the ram has a total of 52 speed changes.



16-INCH CRANK SHAPER.—STOCKBRIDGE MACHINE COMPANY.

The ram is of box pattern, and has a bearing in the column 26 ins. long when at full stroke. The stroke can be adjusted from the front of the machine, and an index and pointer showing length of stroke are in plain view. The head which carries the tool has its swivel accurately graduated, and is rigidly clamped. The tool slide has a travel of 6 ins. with automatic feed. The table has a working surface of 10 x 11½ ins. on the top and one side, and has a cross feed of 22 ins., automatic in either direction. It has a vertical movement of 14 ins. by means of bevel gears and a telescopic screw with ball bearings. The vise has a graduated base that can be set to any angle, is clamped to the table by four bolts fitting in the T slots, and can be used on either the side or top of the table. The rocker arm is designed so that a 3-in. shaft can be passed through under the ram for key-seating. This shaper is made by the Stockbridge Machine Company of Worcester, Mass.

LOCOMOTIVE PRACTICE IN FRANCE.

Following is an abstract of a paper by Edouard Sauvage, presented before the International Engineering Congress at St. Louis.

The interest of French locomotive practice is centered in the development of the 4-cylinder compound, which has permitted a marked increase in the weight and speed of the trains. In the majority of these engines the high-pressure cylinders drive one axle, and the low-pressure cylinders another axle, but coupling rods have been preserved between these axles. The only exception is a unique locomotive (No. 701) built in 1885 for the Chemin de Fer du Nord, in which the two axles were not connected. This plan has not been continued. The use of coupling rods began in 1887 on the Paris, Lyons & Mediterranean locomotives. Since 1890 large numbers of such engines have been built or ordered by French railroad companies, and their aggregate number will soon exceed 2,000.

Mallet four-cylinder engines are used on meter-gage lines. These are supported on two separate groups of coupled axles: One group, driven by the high-pressure cylinders, is connected to the locomotive frame in the ordinary way; the other group, driven by the low-pressure cylinders, forms a movable truck, so as to give great flexibility to the engine.

The majority of the compound engines belong to two classes, which may be considered as standards in France: The express locomotive, with four large coupled wheels, of 2 m. (6 ft. 6¾ ins.) diameter or a little more, and the six-coupled locomotive, with diameters of from 1.600 m. to 1.750 m. (5 ft. 2 15-16 ins. to 5 ft. 8⅞ ins.), both being fitted with a truck in front. The six-coupled locomotives are equally fit for goods and for ordinary passenger trains.

The new "Atlantic" (Nos. 3,001-3,008), recently built for the Paris-Orleans by the Société Alsacienne de Constructions Mecaniques, is of special interest as being the most powerful express locomotive yet made for the French lines. The adhesive weight is 36 tonnes (18 tonnes per axle), and it is expected that this weight will be increased to 40 tonnes. Such a change is easy in locomotives of this type.

The following figures, extracted from the dynamometer car records and indicator cards taken during numerous runs of these engines with heavy express trains, give a fair idea of their power:

A length of 13 km. (8 miles) was traversed in 419 seconds, being at a rate of 112 km. an hour (70 miles). The cut-off was at 53 and 65 per cent. respectively, in the high and low-pressure cylinders. The mean drawbar pull, behind the tender, was 2,350 kg. (5,180 lbs.), from which results an average effective horse-power of 972; the mean indicated horse-power was 1,830. The maximum indicated horse-power recorded on these engines was 1,900. (The unit of horse-power used here is 75 kg. × 1 m. in a second, while the English unit is slightly greater.)

On the Nord, "Atlantic" locomotives, with somewhat smaller dimensions, maintain a very fine express service. Average speeds, from end to end, of 90 to 100 km. an hour (56 to 62 miles), are obtained with trains weighing (exclusive of locomotive and tender) 250 to 300 tons. The profile of the lines is generally easy, with somewhat prolonged inclines of 5 mm. per m. (1 in 200), and, in a few places, of 8 mm. per m. (1 in 125). Some of these trains run in connection with boats from England, and, in many instances of bad weather, time lost by the boat has been made up by the train, although the schedule is calculated with a pretty fair speed.

The advantages of the four-cylinder compound system, as resulting from a prolonged practice in France, may be summed up as follows: Economy of coal resulting from the compound system in itself, or increase of power with the same consumption of coal; good utilization of steam at very high pressure, with the simple or piston valve and the old gears; good balance of pistons and other pieces with reciprocating motion; counterweights applied only for revolving parts, thus doing away with vertical variations of pressure and pounding action on rails; ample bearing surfaces for all parts of mechanism, owing to the use of four cylinders with four separate gears and suppression of all undue strains.

It must be added that these compounds possess great elasticity in working, and are as well fitted for moderate as for high speeds, for light or for heavy trains. They remain economical within a wide range of power. In the Paris-Orleans experiments an average steam consumption of 10.5 kg. (23 lbs.) per horse-power in an hour (the power being calculated from the action exerted by the driving wheels on the rail, to compare precisely with what is called the effective power of a stationary engine) has been measured with trains of heavy and also moderate weight.

As regards details of construction, the nearly exclusive use of Serve or ribbed tubes in all new constructions is well worth mentioning. Experiments have proved that the efficiency of a given surface of Serve tubes, taking into account the whole metallic area in contact with hot gases, was about the same as with the same surface of plain tubes; and in practice these tubes have been found durable and free from leakage. They must be kept free from ashes and soot by frequent cleaning with a steam jet and, when necessary, with scrapers.

For valve gears the Walschaerts system has been adopted in many of the French four-cylinder compounds, as well as for ordinary locomotives. This system is quite convenient when the valve is placed above or under the cylinder, and there is a distinct advantage in the use of one eccentric instead of two, for inside as well as for outside cylinders. The whole mechanism is simple and easily kept in order. The distribution of steam effected by the Walschaerts system is particularly good, and quite uniform on both sides of the piston at different points of cut off.

Piston valves are used in some of the latest designs. After the experience of the Eastern, they are preferable to flat valves, chiefly as giving larger ports and so reducing wire-drawing and compression of steam. An economy of coal, as high as 10 per cent., has resulted from their use in some cases.

From prolonged experience and from the unanimity of opinion of all having experience with these engines, it may be taken for granted that the four-cylinder compound system possesses marked advantages, at least under the conditions of service prevailing on main French lines. Thanks to their use, French railroads have been enabled to increase largely the weight and the speed of their trains, for goods as well as for passenger service, without any large increase of coal consumption per kilometer run. In fact, it is rather underestimating the merits of the compounds to say that by their use the weight of trains is increased by one-third with the same cost of fuel over what it was with the best simple engines used before; or, if not the weight, speed is increased, and in many cases both weight and speed.

In other words, the compounds would take a traffic equal to four, against a traffic equal to three, the number of engines and the expenses for fuel and wages remaining the same. The initial cost of the compounds is higher, the expenses for repairs may be somewhat greater, but the increase of traffic is such that the economy is obvious. As regards the cost of repairs, there is still some doubt as to their exact amount, as a very large proportion of the compounds have been running for a few years only, but it must be remarked that the increase of expenses will very likely be due to the boilers working at a high pressure, and it seems that the same pressures would be necessary for simple engines, if they were to compete with compounds.

To this must be added, especially for passenger service, the advantages of greater speed, of more punctuality, and of dispensing in many cases with pilot engines or with supplementary trains. In a mere practical point of view, the French administrations feel satisfied with the great extension they gave to the four-cylinder compound system, from which resulted economy as well as a large improvement in their services.

A complete solution of the problem would require a proof that the same results might not be obtained in some other way. Available data are not sufficient to give such a proof in an incontestable manner; still, it seems difficult to build an ordinary locomotive quite equal in every respect to the latest compounds.

It is clear that simple two-cylinder engines might be made with the same large boiler, and work with the same high-pressure, but it is nearly as clear that, with the ordinary valve gear of the locomotive, steam at such a high pressure cannot be utilized as well as by compounding; there is little doubt that the simple locomotive would require more steam for the same work or give less work for the same quantity of steam. In addition, there is a real difficulty in making all the parts of the simple engine strong enough to stand without undue wear the greatest stresses resulting from the increased pressure on large pistons, although this difficulty may be overcome.

An opinion which seems to prevail is that compound locomotives may be economical during long runs, but that their advantage is lost when they stop and start frequently, owing to the direct admission of steam to the low-pressure cylinders at starting. This opinion is rather too dogmatic, and the question requires some consideration. In many cases, with four-cylinder compounds, the tractive power necessary for starting from rest is obtained without this direct admission, or steam is admitted in that way only for the very first revolution of wheels. The engine is then worked compound, but in full gear for all cylinders. Of course, steam is not so well utilized as with a proper degree of expansion in each cylinder, but, even in that case, the compound compares favorably with a simple locomotive working in full gear.

In conclusion, opinions expressed by men placed at the head of locomotive departments of French railroads will be found of interest. Among others, M. Baudry, locomotive superintendent of the Paris, Lyons & Mediterranean, ended a communication to the Société des Ingenieurs Civils as follows:

"Some people may be of opinion that the importance of the coal saving due to compound locomotives is small, and even vanishes when the prices of coal are very low. That is a mistake, as the saving of coal means really an increased power of the locomotive. In fact, there is no saving of coal for a certain work performed, but there is more work for the same coal consumption; thence result other important savings; less locomotives, less drivers, less firemen, less trains are necessary for a given traffic. These aggregate savings, which do not depend upon the price of coal, greatly exceed, in the majority of cases, the saving of coal proper. If the weight of trains is not increased, then an acceleration in speed is possible, and in that way the construction of more economical locomotives has resulted, during the last few years, in an increase of speed on all French lines."

M. Salomon, locomotive superintendent of the Eastern, writes that:

"Compared to the ordinary locomotive, the compound locomotive has the important advantage of a coal economy, which varies with the nature of the service, but which is, on an average, from 10 to 15 per cent. With the use of four cylinders the symmetry of the engine is preserved, inertia forces are in better equilibrium, the turning force is more uniform, the total work is divided between two axles, and stresses are more evenly distributed on the frame. As a consequence, the mileages between two heavy repairs in the shops has been increased by 50 per cent.

"In my opinion, the use of these locomotives marks an important improvement, which has not been accompanied by any trouble in service; the only objections which have often been made to the use of compound locomotives are want of elasticity in their power, and excessive compression of steam at high speed. As regards the first objection, the use of independent gears for the high and for the low-pressure cylinders allows a satisfactory distribution of steam under very different rates of weight and speed. The second objection vanishes with large clearances and sufficient area of steam passages on the low-pressure cylinders. In this respect piston valves will be quite suitable if they remain sufficiently tight."

CAR WHEEL LATHE.

This machine, specially designed for turning steel tired car wheels by the Pond Works of the Niles-Bement-Pond Company, is able to take complete advantage of the use of the high speed tool steels, due to its smooth, powerful drive and the rigid manner in which the wheels are gripped and this, in addition to the improved facilities provided for placing the wheels in the lathe and removing them, has enabled it to very greatly increase the output over that produced by old methods.

Fig. 1—Rear View of Car Wheel Lathe.—Niles-Bement-Pond Company.

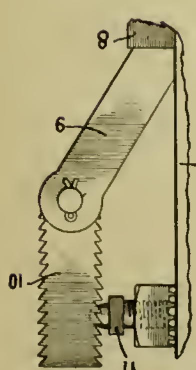


Fig. 2—"Sure Grip" Driver.

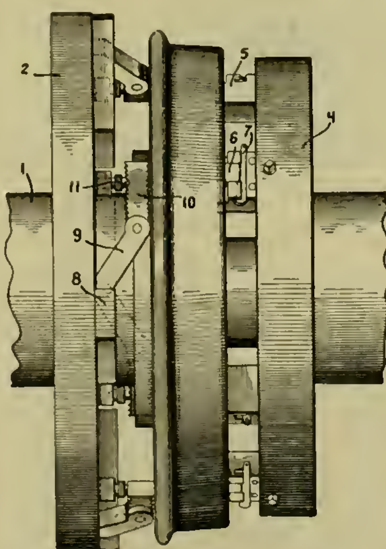


Fig. 3—Application of "Sure Grip" Driver.

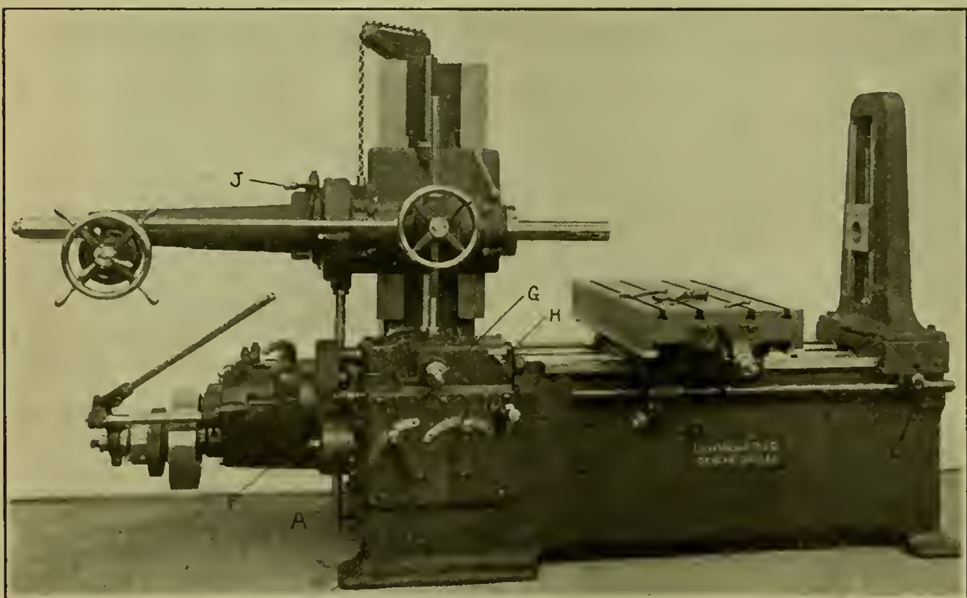
Fig. 4—Chip Taken on 36-inch Midvale Tire.

Fig. 1 is a rear view of the machine and shows a pair of wheels about to be rolled out of the lathe. The large gear from which the section has been removed to allow the wheels to be rolled out, is driven by a worm which runs in oil and which gives a very smooth and powerful motion to the driving plates. In placing wheels in the lathe they are rolled into the position shown, bushings are put on the journals and the tailstocks are brought up. The "Sure Grip" drivers, shown in detail in Fig. 2, are then adjusted as shown in Fig. 3. The chucking jaws in the face plate hold the tires rigidly and by screwing up the set screws of the "Sure Grip" drivers the tires are firmly wedged between the driving plates and the chuck jaws so that the full power of the machine can be utilized. Plain chuck jaws are in most cases sufficient and parts 5, 6 and 7, shown in Fig. 3, which are used to prevent the tire from being crowded off, can be omitted. After the wheels are in place the section of the large gear wheel can easily be slipped into position and is held by a key. The two large bolts, one of which is shown to the left of the section of the gear, are put in place and the nuts tightened. The lathes are set level with the floor so that the wheels can easily be rolled into place and a pit is provided at the front of the machine for the convenience of the operator. With the wheels convenient to the lathe, the actual time of taking out one pair and putting in another should not consume more than 8 to 12 minutes.

This lathe, with an experienced operator and good facilities for getting the wheels to and from it, can turn out from 5 to 7 pairs of wheels per day of 10 hours, or an average of 36 pairs per week. Practical experience has demonstrated that the output is greatest when the feed and cut are a maximum rather than when a high cutting speed is used. Fig. 4 shows a chip taken on a pair of 36-in. Midvale tires, the tool being of Midvale special steel, 3 x 1¼ ins. in section, depth of cut 11-16 in., feed 7-16 in., cutting speed 9 ft. per minute. A tool of self-hardening steel of the above size is large enough to prevent springing or breaking and the large cross section has the advantage of rapidly carrying away the heat generated at the cutting edge.

NEW DESIGN OF HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

This machine, illustrated in the halftone, is of radically different design from the conventional "knee type" of horizontal boring, drilling and milling machine and is constructed with a view to increasing its capacity and usefulness by adapting it for a wider range of work than is usually handled by such machines. The vertical adjustment is made by raising or lowering the spindle head instead of the platen, which on the ordinary type of machine is difficult of adjustment if carrying a heavy load. This allows the use of a vertical power feed for milling purposes which is impossible on the old construction where the platen after it is adjusted must be clamped to the yoke in order to obtain sufficient stiffness. The elevating screws for raising and lowering the spindle head and the outer support for the boring bar are connected by planed bevel gears to the same driving shaft and are therefore automatically kept in alignment. The spindle is of crucible steel and has a long bearing in the sleeve. The front of the sleeve forms a face plate to which the facing head or face milling cutters or other large tools may be attached. The hand wheel on the front of the head gives a slow motion to the spindle and the one to the left a fast motion.



HORIZONTAL BORING, DRILLING AND MILLING MACHINE.—LUCAS MACHINE TOOL COMPANY.

The platen is provided with a power cross feed in order to make the machine complete for milling purposes and thus increase its usefulness and in many cases save the rehandling and resetting of the work. The cross motion of the platen is great enough so that work can often be adjusted on one end of it while the machine is boring a piece on the other end. The yoke is adjusted endwise by turning with a wrench the shaft E, which has on its opposite end a worm hobbed to fit the stationary screw, the screw and worm acting as a rack and pinion. Where it is desired to do work on pieces longer than the nominal capacity of the machine, the outer support for the boring bar can be removed entirely by loosening the four T bolts which hold it to its base. Lateral adjustment of the platen is obtained by turning the shaft D.

The feed motion is taken from the main driving shaft which runs at a much higher speed than the spindle and makes it possible to get a coarse feed without gearing up; the finer feeds being obtained by gearing down. This makes the feeds exceptionally powerful. It also furnishes two series of feeds, one when the spindle back gears are out and one when they are in, the coarser ones being obtained when the spindle back gears are in. The feeds vary from .004 to .283 in. per revolution of the spindle and are controlled by the levers A and B, which furnish 9 changes or 18 different feeds with the spindle back gears in and out. The lever C reverses all feeds. The lever J operates sliding gears which connect the vertical driving shaft to the spindle and are known as the back gears.

G furnishes a vertical hand adjustment for the spindle head. H operates two clutches in the feed box; when it is in one position the feed for the spindle is engaged and that for the table is disengaged; when in the other the feed for the table is engaged and that for the spindle disengaged. The lever F operates the power vertical quick motion for the spindle head up and down.

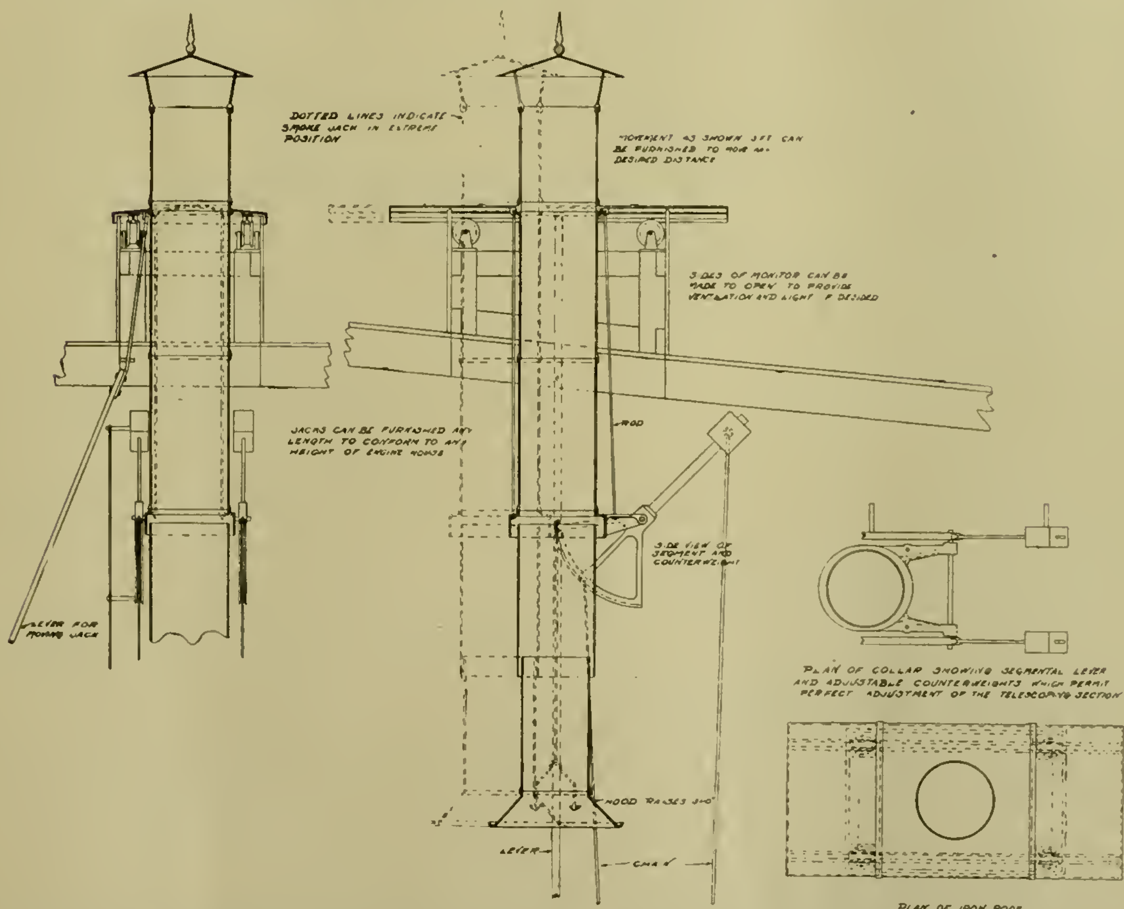
The gear box is bolted on the end of the bed and contains steel cone gears which are manipulated by the two levers shown on top of the box and furnish 6 changes of speed which in combination with the back gears on the spindle head give 12 changes of spindle speed in correct geometrical progression. The driving pulley can be engaged or disengaged by means of a friction clutch which is operated by the long handle placed convenient to the operator. A direct connected motor drive can be applied if desired.

Adjustments of the spindle head outer boring bar support and platen are made by precision screws which are provided with dials graduated to 1-1,000 of an inch, thus allowing holes to be bored and surfaces to be milled an exact distance apart, making it possible to produce interchangeable work without the use of jigs.

The machine is self-contained and the bed, which is of a deep box construction, has 3 feet, is stiff enough to set on any good floor and does not require a special foundation. This machine is made by the Lucas Machine Tool Company of Cleveland, and is known as No. 1 Precision boring, drilling and milling machine. They also make a No. 2 machine of the same general design, but larger in size and better adapted to the class of work it would be required to handle in a railroad shop.

We expect to build a shop or shed with two tracks long enough to hold twenty steel cars each. Before they are taken in on track No. 1 we will remove the scale from the inside with a pneumatic hammer and the paint and rust from the outside with a sand blast. Then as they are run in we propose to paint them with a movable spraying machine suspended above the cars on a track running the length of the shop, using a double hose, so that both sides of the cars can be painted at the same time. After giving them two coats we will put them on track No. 2 for drying and stenciling.—*B. F. Wynn, Master Car and Locomotive Painters' Association.*

ROUNDHOUSE EQUIPPED WITH OVERHEAD CRANES AND MOVABLE TELESCOPIC SMOKE JACKS.



THE DICKINSON MOVABLE SMOKE JACK—TOGETHER WITH THE SMALL SECTION OF ROOF IT HAS A MOVEMENT OF 3 FEET TO ACCOMMODATE ITSELF TO POSITION OF LOCOMOTIVE—ALL PARTS OF CAST-IRON.

ROUNDHOUSE CRANES AND SMOKE JACKS.

Progress during the past five years in the use of heavy locomotives and heavier trains has entirely changed the status of the roundhouse and given to it an importance which it never had before. Instead of merely providing housing for engines, the roundhouse has become a shop for running repairs, and a very important shop, because the satisfactory operation of locomotives is directly dependent upon its efficiency. The roundhouse is to-day, in addition to its other functions, a shop for emergency repairs of a most important character, because terminal delays have become a great item of expense when locomotives are in such great demand as at the present time. The weight of locomotive parts is now so great as to cause not only difficulty and expense but hardship in the roundhouse, where the work is handled in the old way without suitable facilities. A light, overhead crane, which is always ready for use, is one of the best factors for economy which is available for a roundhouse. Lifting by cranes as contrasted with lifting by manual labor is everywhere considered one of the most economical processes for the saving of labor. It has been considered impossible to equip roundhouses with cranes in such a way as to avoid interference with the smoke jacks, because, most of the lifting being at or near the front ends of the engines, the cranes must necessarily be able to pass the jacks. A simple and effective way out of this difficulty is illustrated in the accompanying engravings, showing the construction developed by Mr. Paul Dickinson, of Chicago. The difficulty is met by the use of multi-telescoping jacks, which telescope to an extent permitting them to be raised entirely clear of the crane. The photograph engraving shows a combination of a crane and telescoping jacks arranged in this way. Interlocking appliances prevent contact of the crane with the jacks before the latter are raised out of the way. The crane is locked when the jacks are down, and the jacks are locked when the crane is over the stack. The convenience of this arrangement and the method of operating the jacks and crane from the roundhouse floor are indicated in the engravings.

Last winter developed a weakness in roundhouses which has never before been fully appreciated. Heavy traffic, combined with unusually severe weather, found roundhouses woefully unequal to the demands made upon them, chiefly because a large amount of repair work was required to be done in an atmosphere of steam, gas and smoke. Good work cannot be done quickly under such conditions, and the trouble became serious in the very cold weather. In fact, the greatest necessity for good ventilation comes in cold weather, when the largest amount of roundhouse work is required. Suitable smoke jacks are necessary in order to carry off the smoke. Mr. Dickinson has devoted much time and study to this problem. He finds it necessary that the jacks should fit tightly over the stacks of the locomotives, and it is conceded that if the smoke and gases are carried from the stacks directly out of doors, the largest part of the problem is solved. Because of the difficulty in stopping a locomotive, or "spotting" it exactly under the jacks, and also because of the desirability of being able to move the engine slightly, forward or backward, it is necessary to build the jacks to provide for movement and adjustment along the track, or a great deal of smoke will escape into the house, especially when forced draft is used, and it always is used in firing up and getting ready for going out. This is particularly troublesome when the engine must be moved a few inches to work on rods or pistons. Mr. Dickinson provides for this by moving the jack to conform to the position of the locomotive and insure the passage of the smoke without getting it into the house. The method of construction and the levers for moving it are shown in the engraving. Experiments with various materials for jacks have led to the opinion that cast-iron is most satisfactory. The improvements shown are considered important in roundhouse practice, which will have a marked effect upon roundhouse efficiency and service. Further information may be had from Mr. Paul Dickinson, Security Building, Chicago, Ill.

Will the electric railway replace the steam locomotive?

Perhaps the best answer is that its future is not in the wholesale destruction of existing great systems. It is in the development of a field of its own, with recognized limitations but of vast possibilities. It will fill that field to the practical exclusion of all other methods of transmitting energy; it will operate all street railway systems, and elevated and underground roads; it will prove a valuable auxiliary to trunk systems; but it has not yet sounded the death-knell of the locomotive any more than the dynamo has that of the stationary steam engine. Each has its own legitimate field which will play its proper part in the needs of all civilization.—*Frank J. Sprague, International Electrical Congress.*

PERSONALS.

Mr. H. H. Warner has resigned as master mechanic of the Northern Pacific at Seattle, Washington.

Mr. S. King has resigned as master car builder of the Intercolonial Railway, to become assistant master car builder of the Canadian Pacific.

Mr. Thomas M. Feeley has been appointed master mechanic of the Iowa Central Railway, with headquarters at Marshalltown, Ia., to succeed Mr. W. O. Johnson.

Mr. W. L. Larry has been appointed master mechanic of the New York, New Haven & Hartford Railroad at Taunton, Mass., to succeed Mr. A. W. Twombly.

Mr. A. W. Sullivan has resigned as assistant second vice-president of the Illinois Central to become general manager of the Missouri Pacific, with headquarters at St. Louis, Mo.

Mr. A H. Gairns has been appointed general foreman of the San Bernardino shops of the Atchison, Topeka & Santa Fe Railway at San Bernardino, Cal.

Mr. G. H. Bussing has been promoted from the position of assistant superintendent of motive power to that of superintendent of motive power of the Evansville & Terre Haute.

Mr. C. T. Howe has been appointed master mechanic of the New York, New Haven & Hartford Railroad at South Boston, Mass., to succeed Mr. S. P. Willis.

Mr. P. F. Flavin has been appointed acting master mechanic of the National Railroad of Mexico at Laredo, Texas. He has been foreman of the boiler shop at that place.

Mr. W. F. Girten has been appointed general foreman of car repairs of the Central Railroad of New Jersey, with headquarters at Elizabethport, N. J.

Mr. C. T. Sheldon has been appointed master mechanic of the New York, New Haven & Hartford Railroad at Valley Falls, R. I., to succeed Mr. L. M. Butler.

Mr. William Hassman has been appointed master mechanic of the Peoria & Pekin Union Railroad, with headquarters at Peoria, Ill.

Mr. I. C. Hicks has been appointed master mechanic of the Atchison, Topeka & Sante Fe Railway, with headquarters at Albuquerque, N. Mex.

Mr. R. M. Boldridge has been appointed master mechanic of the Mississippi Central Railroad, with headquarters at Hattiesburg, Miss., to succeed Mr. C. H. Welch, resigned.

Mr. J. A. Edson has been appointed general manager of the Chicago, Cincinnati & Louisville Railroad, with headquarters at Cincinnati, Ohio, to succeed Mr. C. G. Waldo, resigned.

Mr. Charles Gaspar has been appointed mechanical engineer of the Wisconsin Central Railroad, with headquarters at Fond du Lac, Wis. For the past two years his title has been chief draftsman.

Mr. C. F. Richardson has been appointed general road foreman of equipment of the St. Louis & San Francisco, with headquarters at St. Louis, Mo. He has been road foreman of engines of the Baltimore & Ohio.

Mr. Frank Hedley has been appointed general manager of the Interboro Rapid Transit Company of New York, to relieve Mr. E. P. Bryan, who has been vice-president and general manager and who retains the position of vice-president.

Mr. J. A. Hill has been appointed master mechanic of the Lake Erie & Western Railroad, with headquarters at Lima, Ohio, to succeed Mr. William White.

Mr. Clement F. Street has severed his connection with the Wellman-Seaver-Morgan Engineering Company to accept the position of commercial engineer of the Westinghouse Electric & Manufacturing Company, with headquarters in Pittsburg.

Mr. R. Atkinson has resigned as master mechanic of the Philadelphia & Reading at Reading, Pa.

Mr. William White has resigned as master mechanic of the Lake Erie & Western at Lima, Ohio, to enter the service of the Chicago Pneumatic Tool Company.

Mr. S. J. Campbell has been appointed master mechanic of the Chicago, & Alton Railroad, with headquarters at Slater, Mo., to succeed Mr. F. P. Roesch, resigned.

Mr. A. L. Rossetter has been appointed master mechanic of the Chicago, Peoria & St. Louis Railroad of Illinois, with headquarters at Springfield, Ill.

Mr. Charles Wilson has been appointed master mechanic of the Lehigh Valley at Wilkesbarre, Pa., to succeed Mr. F. F. Gaines, resigned.

Mr. John Howard has been appointed superintendent of motive power of the New York Central & Hudson River Railroad in addition to his duties as superintendent of motive power of the Boston & Albany. His headquarters will be at the Grand Central Station, New York.

Mr. F. W. Brazier has been appointed superintendent of rolling stock of the New York Central & Hudson River Railroad. His title for the past six years has been assistant superintendent of rolling stock. His jurisdiction is extended over the Boston & Albany, in addition to the New York Central.

Mr. LeGrand Parish has been appointed assistant superintendent of motive power of the Lake Shore & Michigan Southern Railway, with office in Cleveland. Those who know Mr. Parish and his work will be pleased by his advancement to a position of greater responsibility. He entered the service of the Lake Shore as a clerk in the car department, and his superiors being impressed with his administrative ability, he was soon made foreman of car repairs, serving in that capacity for several years and at two important repair points. About six years ago he was appointed master car builder at Englewood, Ill., where he had charge of the maintenance of car equipment on the western portion of the road, and this position he now leaves to go to Cleveland. He owes his success to thoughtful study of the problems coming before him and to business methods in dealing with them, combined with good judgment of men and unusual ability in managing his subordinates in a way which brings voluntary loyal support from all. This appointment is announced with a conviction that Mr. Parish is only beginning a career of increasing responsibility and recognition.

Mr. Frederick M. Whyte has been appointed general mechanical engineer of the New York Central lines, with headquarters in the Grand Central Station, New York City. He has held the position of mechanical engineer of the New York Central & Hudson River Railroad since August 16, 1899, and is admirably equipped by education and experience for the important work of his new position. Mr. Whyte is 39 years of age, and was graduated from Cornell University in 1889. He entered railroad service in that year, and has been draughtsman in the motive power department of the Lake Shore & Michigan Southern, in the testing department of the Baltimore & Ohio, in the office of the late David L. Barnes in Chicago, was connected with the South Side Elevated Railway and the Northwestern Elevated of that city, and a member of the staff of the *Railroad Gazette* in the same place. In 1897 he was appointed mechanical engineer of the Chicago & Northwestern Railway, and resigned in 1899 to take the position on the New York Central from which he is now promoted. Mr. Whyte's present appointment is an exceedingly important one, and is the only one carrying the title of general mechanical engineer of a system of allied lines. It is a step in the direction of unification of the engineering problems of a system of roads which brings great possibilities of advantage from a standpoint of the business interests of the roads as affected by the mechanical department. Mr. Whyte and the New York Central lines are to be congratulated upon this fitting appointment.

Electric Traction on the Erie.—This road contemplates the application of electric traction to 51 miles of its New Jersey suburban district, with a central power station at Paterson.

Compressed Air Meters.—At the recent Holyoke convention of the New England Waterworks Association a new meter for measuring compressed air was exhibited. A device of this kind, if accurate, would be a valuable aid to the economical use of compressed air in railroad shops.

The adoption of electricity on any trunk line service will be determined by the hard and fast rule of financial necessity. It is my belief that some of the largest expenditures, and those most fruitful of return to those who own the steam railroads of the country to-day, will be in the purchase and control of the competing electric railways which, having in the past acquired franchises of undoubted value, have built up a business which they can hold and which will increase, and many a steam railway will be better off financially and bring bigger returns if it gathers in these franchises and systems and takes to its lines an advantage it will be difficult to duplicate in the future.—*F. J. Sprague, International Electrical Congress.*

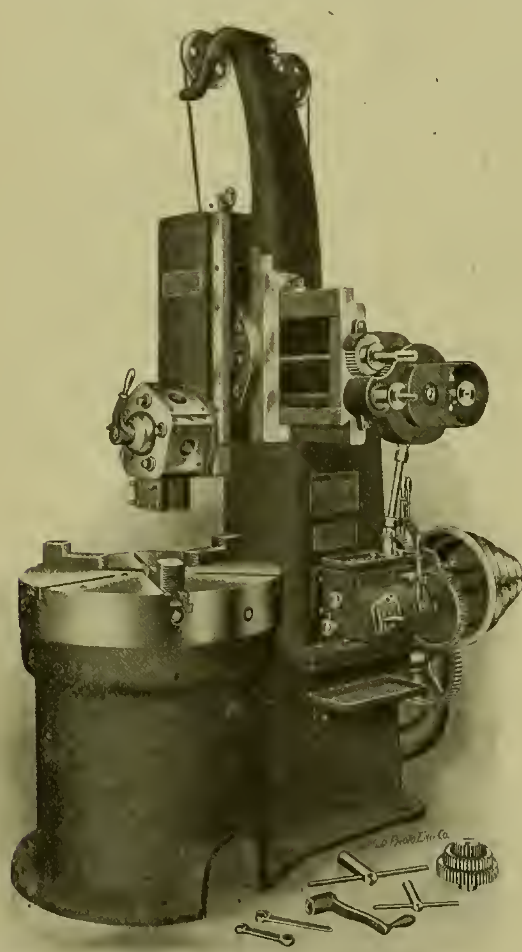
High-Pressure Packing.—A new packing for high-pressure service has been placed on the market by the New Jersey Asbestos Company, of Camden, N. J. It is moulded to shape in steel dies under hydraulic pressure, making it nearly as solid as if of metal, and yet it remains flexible. The rings are made of the same material as the well-known "Gladiator" asbestos metallic packing. They do not burn out or blow out of the stuffing boxes, and a number of prominent railroads are using them on locomotives, where satisfactory packing is specially appreciated. Information concerning these packing rings may be obtained from the manufacturers.

Gold Medal For Rail Joints.—The Jury of Awards of the Louisiana Purchase Exposition has awarded the gold medal for rail fastenings to the Continuous Rail Joint Company of America, for their display made in the Transportation Building, of their rail-joint products. The exhibit shows various types of rail joints produced by patented machinery controlled by the company in this country. Further acknowledgment of the merits of the continuous rail joint is shown in the fact that over 20,000 miles of railroad track has been equipped within the past ten years. The company owns and operates the Albany Iron & Steel Works, at Troy, N. Y. This company is now bringing out a new type of insulated rail joint, and also an electric bonding joint to be placed upon the market. The development of the business has made it necessary to organize a company in Canada for the exclusive use of Canadian patents originally owned by them, and another corporation in London, England. This appliance has already been introduced in many foreign countries. The general offices of the company are at Newark, N. J.

30-INCH BORING AND TURNING MILL.

The boring and turning mill illustrated in the photograph is equipped with a swivel turret head, and presents great possibilities as a time and labor saver on certain classes of work. It swings 32 ins. in diameter and 15½ ins. under the cross rail, and can be furnished with either a three-jaw independent and universal chuck combined, as shown, 30 ins. in diameter or with a plain table, with or without jaws. The face plate is bolted to a large driving gear, which has an outer bearing with an automatic oiling device arranged in the bed to keep the bearing well lubricated. The face plate has eight changes of speed, from 18 to 73 r. p. m., without back gears, and from 2.28 to 9.3 r. p. m. with back gears. The centre spindle is 7 ins. in diameter, 18 ins. long, and is made with an angular bearing to receive side strains, with check nuts on the under side of the spindle to prevent any lifting tendency.

The turret has five sides, 10 ins. across flats, and has five 2 3-16-in. holes. The turret slide has a traverse of 16 ins., and in the swivel head can be set over at any angle up to 30 degrees, and will face 30 ins. in diameter. The mill has a



30-INCH BORING AND TURNING MILL.—BAUSH MACHINE TOOL COMPANY.

Hendey-Norton change gear device on its upright for feeding and thread cutting. Twenty vertical feeds are provided from .0125 to .1666 in. per revolution of the table, and twenty horizontal feeds are provided from .015 to .211 in. per revolution The mill is driven by a cone of large diameter, taking a 3-in. belt, and is so arranged that a motor drive can be applied at any time. The back gears can be changed by means of a lever without the use of a lock nut. The machine weighs 5,900 lbs., and is self-contained, and therefore does not require an expensive foundation. It is made by the Baush Machine Tool Company, Springfield, Mass.

HIGHEST DEVELOPMENT OF AIR BRAKES.

The High Speed Brake.

This country is impressed as it never has been before with the necessity for safeguarding lives and property in transportation and its railroads are earnestly seeking means for meeting the problem of safety of trains. Among these is increased braking capacity, because the limiting conditions of safe speeds lies in the ability to stop quickly. Much is said about phenomenally high speeds of 100 miles per hour and over, but these will not be attained in regular service unless brake practice develops with the increased speeds.

For 40 years of the early history of railroad progress the brake problem was not attacked. Up to 1864 no real improvement in braking was attempted. Since that year progress has been rapid, especially since the first use of the compressed air by Mr. Westinghouse, and now we have in the "High Speed Brake" the greatest development in this field and one which means more for the safety of fast trains than any other appliance now available.

At the St. Louis Exposition this brake is exhibited by the Westinghouse Air Brake Company and the usual applications of apparatus with which all railroad men are familiar have given place to this apparatus which was designed to meet the greatest present need.

The improved brake requires little apparatus in addition to that of the quick action brake, and no change in the mechanism of the latter; but a train-line and auxiliary reservoir pressure of 110 lbs. is employed instead of 70 lbs., the pressure generally used in connection with the quick-action brake. The high speed brake consists of the quick-action air brake apparatus as ordinarily applied to a passenger car, to which is added an automatic reducing valve that is attached to the body of the car adjacent to the air cylinder, to which it is connected by means of a pipe. This reducing valve is so constructed that it remains inert in all service applications of the brake unless at any time the brake cylinder pressure becomes greater than 60 lbs., in which event the valve operates to discharge promptly from the brake cylinder as much air as necessary to restrict the cylinder pressure to that intended. In an emergency application of the brakes the violent admission of a large volume of air to the brake cylinder raises the pressure more rapidly than it can be discharged through the port of the reducing valve, and the air is discharged from the brake cylinder in such a manner that it does not become reduced to 60 lbs. until the speed of the train has been very materially checked. On emergency application, the high train line and auxiliary pressures fill the brake cylinders almost instantly with air at about 85 lbs. pressure, thereby giving a pressure of the brake shoes upon the wheels about 40 per cent. greater than that realized by the use of the quick-action brake alone. The air pressure immediately begins to escape from each brake cylinder through the automatic reducing valve, continuing to do so until the cylinder pressure is reduced to 60 lbs., which is thereafter maintained until the brakes are released by the engineer.

On account of the high pressure carried with this brake, a full service application of the brake will leave the pressure in the auxiliary reservoir at nearly 100 lbs.; in fact, 3 full service applications can be made without recharging the auxiliary reservoirs, and there will still remain sufficient air pressure for an emergency stop equal to that of ordinary practice. These advantages, coupled with such a restricted brake cylinder pressure for all service applications of the brake that wheel sliding is avoided, require no further comments to insure recognition of their importance in materially advancing the art of train stopping.

The high speed equipment for a locomotive requires but few parts in addition to the quick-action apparatus and the simple movement of 1 or 2 cock handles to convert the brakes from quick action to high speed, or vice versa, thus making entirely practical the operation of either type without delay or inconvenience. That the brake, with which over 24,500 locomotives and passenger cars have been equipped, has proven its utility as a positive and material advancement in air brake practice must be patent to all who visit the exhibit and familiarize themselves with its possibilities to accomplish results hitherto unattainable, and that its merits and value are rapidly becoming recognized by railways is apparent from the large number of locomotives and cars in daily service provided with the apparatus. To the layman the term "high speed" is to some extent a misnomer, for while the impression is conveyed that the brake is intended to be used only on trains scheduled at high continuous speeds, its meritorious features can be utilized to distinct advantage on all trains operating on a more moderate schedule but frequently attaining speeds such as that for which the high speed brake was primarily intended. The practicable solution of the important question of train control has been a prime factor in the establishment of fast passenger schedules, and the whole exhibit is an interesting example of the Westinghouse Air Brake Company's policy of harmonizing all of its improvements with its equipment already in service by simple and effective attachments to former standards.

In describing the "Schenectady Superheater Locomotive" on page 339 of the September number, savings of 33 per cent. were mentioned as having been effected by a superheater on the Canadian Pacific Railway. This record was made with a Schmidt superheater.

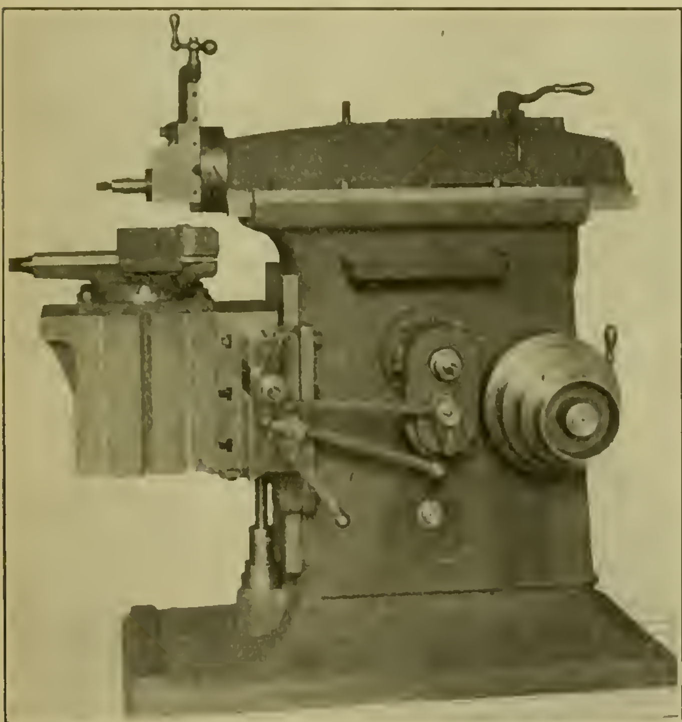


FIG. 1.—16-IN. CRANK SHAPER.—QUEEN CITY MACHINE TOOL COMPANY.

M. C. B. LETTER BALLOT.—The letter ballot, which closed September 25, resulted in the adoption of all the recommendations made at the convention of last June except three. These concerned the distance between the centre of bolsters and the base of the sill, the height and width of cars on high trucks and the lettering on end fascia boards.

LOCOMOTIVE BOILER STEEL AND TUBES.—The result of the letter ballot by the Master Mechanics' Association on the recommendations offered at the convention of last June is announced by Secretary Taylor to be in the affirmative with respect to boiler steel, firebox steel and boiler tubes of steel and iron.

A POWERFUL CRANK SHAPER.

A 16-in. crank shaper designed for heavy work, and with a view to durability, is shown in Figs. 1 and 2. In addition to the substantial design of the various parts, the details of the rocker arm construction are of special interest. The rocker arm is connected to the ram by a link, which allows a more direct pull than does the ordinary design of crank shaper, and gives a very even cutting speed. Wear of the crank shoe can be compensated for by adjusting the screws shown in Fig. 2.

A back gear ratio of 20 to 1 is provided, change from one run of gearing to the other being made by a lever, which throws either one of two gears, keyed to a sleeve which slides on the driving shaft, in or out of mesh with gears on the back shaft. The ram has a bearing of 30¼ x 10 ins., and is designed so that the section gradually increases in strength, and is strongest at the point where the leverage is greatest, which is when the cutting tool is at its extreme forward position.

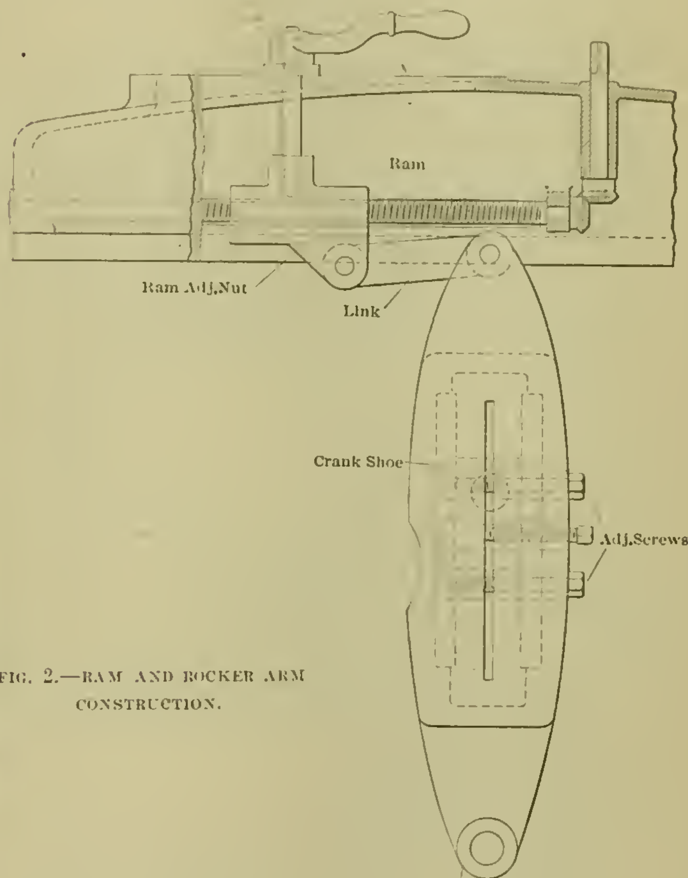


FIG. 2.—RAM AND ROCKER ARM CONSTRUCTION.

Length of stroke and position of the ram can be changed without leaving the work and while the tool is in motion or at rest. The rail is 9 ins. long, and has 1½ ins. top wearing surfaces. The cross traverse is 21 ins., and the screw has a graduated collar. Vertical adjustment is effected by bevel gears, which are protected from dirt and chips, and are provided with ball bearings and operate the telescopic screw.

The table, in addition to the T slots on top and sides, has a V for holding shafts and similar work vertically, and can readily be detached from the saddle. An extension provides for a broad clamping surface, utilizing the full length of the stroke. The vise has a base that can be firmly bolted to top or sides of table, and the swivel is held to this base by two steel planer head bolts. The head swivel is held in the same manner; both are graduated, and can be set to any angle, quickly and accurately. A down feed screw to the head is provided with a graduated collar. A large opening under the ram provides for key-seating of shafts or similar work of any length. This shaper is manufactured by the Queen City Machine Tool Company of Cincinnati.

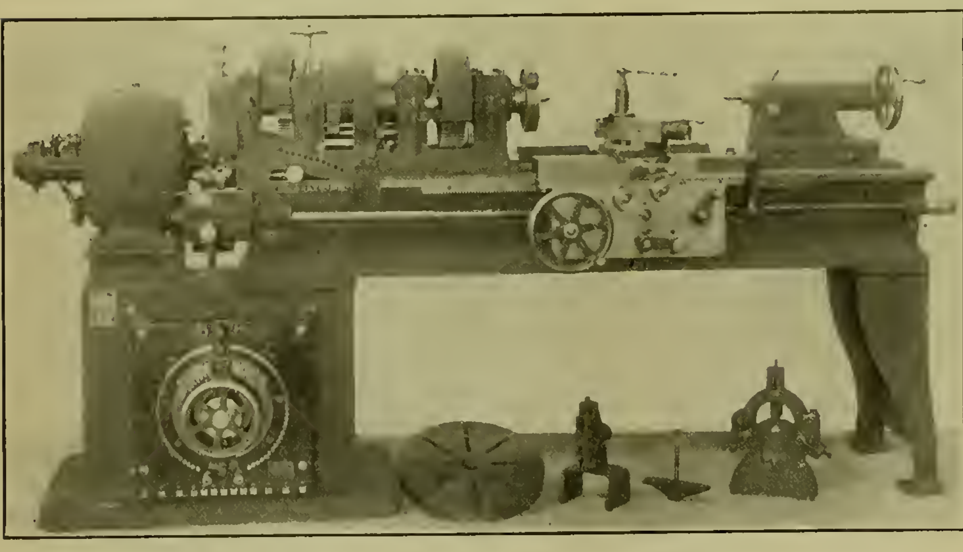
MOTOR DRIVEN LATHE.

The photographs illustrate a simple and substantial motor application to a Lodge & Shipley 16-in. engine lathe. The lathe is equipped with their improved headstock, which is designed for high speeds and heavy cuts, and is the same as the one described on page 313 of the August issue of this journal, except that it is arranged for the motor drive. The motor is supported as shown.

On an extension of the armature shaft is a sleeve, to which two gears are keyed. The handwheel slides this sleeve along the shaft and throws either gear in mesh with the corresponding gear on the short auxiliary shaft according to the speed desired.

The patent head furnishes three speed changes, which in combination with the two driving shaft speeds furnish 6 mechanical speed changes. This in combination with a North-

REAR VIEW OF LODGE & SHIPLEY LATHE SHOWING MOTOR APPLICATION.



16-INCH MOTOR DRIVEN LATHE.—LODGE & SHIPLEY MACHINE TOOL COMPANY.

ern 2½ h. p. variable speed motor gives a wide range of speed. As regularly made, the controller is operated from the carriage, and not as shown. If desired, the lathe can be furnished with a pulley suitably supported in place of the motor, so that it can be operated directly from the line shaft with six changes of spindle speed.

DRAINAGE ENGINEER.—The United States Civil Service Commission will hold an examination November 22-23, 1904, for an engineer in connection with the irrigation and drainage investigations in the Office of Experiment Stations, Department of Agriculture, the salary being from $1,500 to $2,000 per annum, according to qualifications. Applicants should apply to the United States Civil Service Commission, Washington, D. C., for application form No. 1,312 and other particulars.

OTTO GAS ENGINE EXHIBIT,

The exhibit of the Otto Gas Engine Works of Philadelphia, Pa., at the St. Louis Exposition occupies the largest space ever devoted to the exhibition of gas and gasoline engines exclusively in this country. The general display at their exhibit is characteristic of the high grade of the engines which they build. There are seventeen engines shown for general and special work, eleven of which are fitted up and running, ranging in sizes from 2 to 140 h.p.

There are several novelties of more than ordinary interest, including a 40-h.p. horizontal single-cylinder engine as shown directly connected to a Diehl generator. The engine is of their special electric light type, which is fitted with their rotary ball governor which regulates the charges taken, or fuel consumed, according to work done; sometimes called "hit and miss" governing. The regulation of this engine gives a variation in voltage not exceeding 2 per cent. with engine carrying anywhere from full load down to but a few lights. The claims made for this engine are, being a single-cylinder type, it requires less attention and is very much simpler in construction than an engine having a multiplication of cylinders in order to get the regulation for electric light purposes. Most users desire an engine which does not require constant attention, which condition this single-cylinder direct-connected type fulfils. Besides, with this method of governing, the idle running gas consumption is less than 18 per cent. of full load consumption, which is decidedly more economical than a so-called throttling governing engine, or one having a multiplication of cylinders, and this adapts itself to many situations where the load during many hours at a time is light. Under these conditions the most economical running is obtained.

The two largest types of engines show latest design for large engine construction, being fitted with their own self starters, the method of starting being to set the engine at the point of ignition and pump a charge into the cylinder with a hand pump. After the cylinder is charged it is cut off by a hand lever, and a somewhat greater pressure is pumped into a vessel which is part of the starter. When sufficient pressure is pumped, the hand lever is opened, allowing the greater pressure in the vessel to come in contact with the engine piston, which slowly turns the engine over when the igniter snaps and a charge is ignited. This gives the flywheel sufficient momentum when the next charge is drawn in by the engine in the regular way. The method of starting insures against failure to start, as it is not dependent upon an air supply stored by the engine when running, and annoyances caused when air is exhausted.

All these engines are fitted with patent electric igniters, having both movable and stationary electrodes, mounted in a phosphor bronze flange, said to be infringed upon by every maker of internal combustion engines using electric igniters.

They also show one of the portable gasoline type of engines used for farming purposes, also a hoisting engine which is very compact and has many points of advantage. The marine type, vertical two-cylinder engine is of the same construction as many of this and larger sizes which they have built for submarine boats. Two types of pumping engines are shown, with vertical and horizontal pumps, direct geared to the engine, making a very compact design. There is also a 10-h.p. engine belted direct to a generator. The space is very brilliantly lighted by arc and incandescent lamps, which are being operated by engines in the exhibit.

The company also exhibit a number of awards, gold and silver medals, which they have received. Their engines have been exhibited at all the prominent expositions, and they claim the distinction of having over one hundred gold and silver medals, and numerous awards and diplomas, leading in the number of awards made over any other piece of machinery that was ever exhibited.

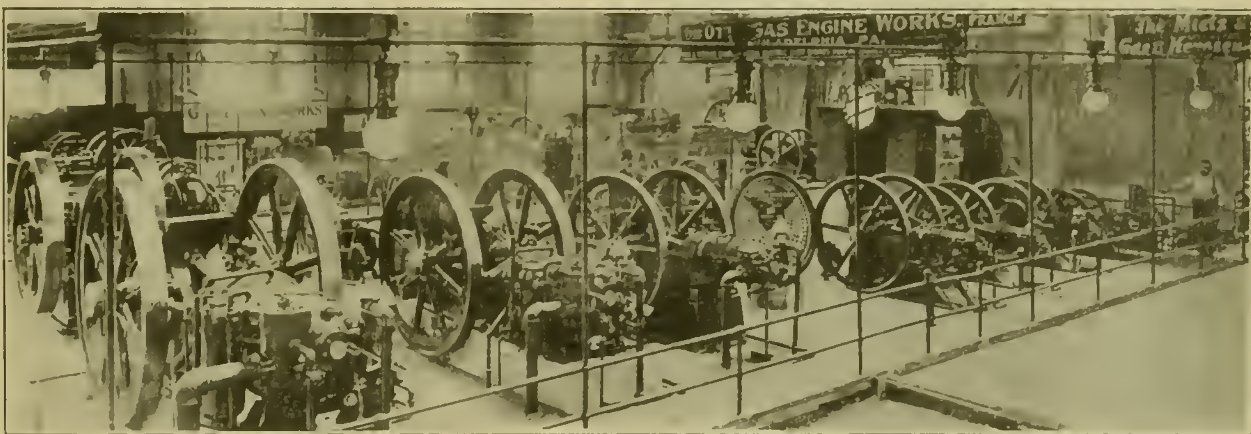
HIGH SPEED TOOL TESTS AT THE EXPOSITION.

On October 12 a meeting at which 14 of the high-grade steel makers of the world were represented either in person or by proxy, was held in the Palace of Machinery, with Mr. E. S. Kiger as chairman, and rules and regulations governing a steel test to take place on September 10 at Block 9, Machinery Hall, were adopted. On September 10 only three of the makers, including Edgar Allen & Company, Ltd., Hugo Reisinger, maker of the Victoria steel, and the McInnes Steel Company, were prepared to participate in the test. Three other makes were tested under protest. The jury of awards has not yet made known its decision.

The rules adopted to govern the test were as follows: Size of tools to be 1½ ins. x 2¼ ins. by 1 in., to fit Armstrong tool holders. A certain form of William Sellers Company tool to be selected as the tool to be used by each contestant, and all tools to be ground on a William Sellers Company grinder. Each contestant to have his tools forged on the Exposition grounds. The number of tools be limited\to two forged tools and two for Armstrong tool holders. The cut to be ¾ in. deep or a 1½ ins. reduction, 3-16 in. feed, at a cutting speed of 100 ft. per minute, to be run as long as the tool will stand up and retain the proper cutting edge, which shall be determined by the judges. For the second tool used, the speeds and feeds to be determined by a majority of the judges.

The falling down of tools to be determined when it loses size of cut. If a tool breaks between the cutting point and the tool post it shall determine the life of that particular tool, and if the second tool breaks between the aforesaid points, it shall terminate the test of that particular brand of steel. The various brands of steel offered for test shall be the same as offered on the market regularly for sale. Tools, when forged, tempered and ground, must be turned over to the committee. No preliminary test to be permitted before the official test. A committee of five was appointed, with Mr. Edwin R. Kent as chairman, to take charge of tools before and after tests, examine steel and see to the forging and grinding and other preliminary matters. But one brand of steel to be entered in the contest by any one representative. Tool No. T 363 adopted as the shape of tool to be used. The names of different contestants to be placed in an envelope, and the first one drawn shall decide the first steel to be tested, etc. Every contestant to be furnished with a complete record of each steel tested, said records and reports to be signed by each of the judges. Mr. C. Edwin Search, of Milwaukee, Wis., to be extended an invitation to serve as judge in behalf of the steel men In case it is not convenient for Mr. Search to serve, Mr. J. B. Barnes, of the Wabash Railroad, to be selected in his stead. That a committee of three, if in the city, should constitute a quorum, and the committee shall meet on August 20 at 2 p. m. to close all entries in the test and such other business as may come before it.

The tests were made on a Putnam lathe driven by a Northern variable speed motor.



OTTO GAS ENGINE EXHIBIT AT ST. LOUIS EXPOSITION.

RELATION OF WINDOW-AREA TO FLOOR SPACE.

A somewhat informal, though careful, effort has been made at Cornell University to determine a general statement of the relative proportion between window-openings and their position, and the floor-area and the depth of the rooms to be lighted. The data, says *Keith's Magazine*, were intended to apply to the problem of securing an adequate supply of natural light in the lecture-rooms on all ordinary days between 8 a. m. and 5 p. m., under the climatic conditions which prevail in Ithaca, N. Y.

Information was secured which was based on actual experience in six buildings on the Cornell Campus, and referred to rooms lighted from one side only. From the statements submitted by the professors in charge of the work in the several buildings the following data have been compiled regarding sixteen rooms adequately lighted, and nine rooms in which the light is "nearly sufficient."

Number of Rooms.	Total Area, Floor.	Windows.	
	Feet.	Feet.	Ratio.
Sufficient 16	10,466	2,000	1,000:191
Nearly so 9	5,392	799	1,000:146

Average Depth of Room.	Average Height Window Tops.	Ratio.
22 ft. 1 in.	11 ft. 9 in.	1,000:538
20 ft. 6 in.	10 ft. 2 in.	1,000:495

All these rooms are alike in having unobstructed light; no building stands before the windows.

A peculiar relation which should be observed is that the well-lighted rooms have an average of 654 sq. ft. of floor-area and 22 ft. 1 in. deep, while those whose light is "nearly sufficient" are smaller and shallower, being 599 sq. ft. area and 20 ft. 6 ins. deep.

One explanation of this unexpected result is found in the figures relative to the positions of the windows. In the well-lighted rooms the window-tops average 11 ft. 9 ins. above the floor and 1 ft. 6 ins. below the ceiling; in the other rooms they are 1 ft. 7 ins. nearer the floor and 11 ins. farther from the ceilings.

The conclusions to which this local experience leads are these:

(1) There should be at least 150 ft. of window-space in each 1,000 sq. ft. of floor space in rooms which, in use and location, are similar to those here described and are lighted only from one side.

Therefore an office 15x25 should have at least 56 sq. ft. of window-space and a class-room 30x40 should have at least 180 sq. ft. of unobstructed lighting surface.

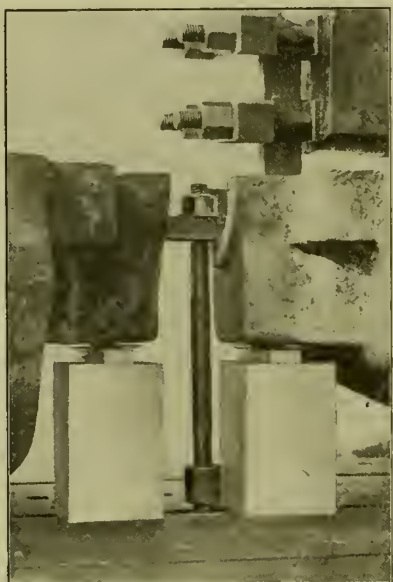
(2) The proportion between the height of the window-tops and the depth of the room lighted should be at least 500 to 1,000, or, in other words, the distance from the floor to the window-tops should be one-half the depth of the room to be lighted.

These figures support the old principle that "top-light" is the best; the nearer the window-tops come to the ceiling the more efficient will be the lighting to be secured from a given surface. Care should be taken that overhanging lintels be not allowed to obstruct the light.

T-BOLT HEADS FOR RAPID CHUCKING.

While the high-speed tool steels have done much to reduce the time of turning out work on machine tools, in many cases as great or greater savings can be made by increasing the facilities for chucking or clamping down work. In railroad shops, where the work is general in character and different classes of work are often handled in the same machine during the course of the day, considerable time is lost in cleaning out T slots, and hunting blocks, clamps, bolts, etc. The T bolt head here described was developed in a large shop, where difficulty was experienced due to breakage of T bolts, the necessity for carrying a number of different lengths in order to meet the various conditions, and where time was often lost due to the necessity of having new bolts of a special length forged. The T bolt heads shown are drop forged from high carbon steel and case hardened, and are practically indestructible. A number of studs of different lengths can be made to fit them at a small expense, and in case of breakage can easily be renewed. The underside of the heads are turned, to present a smooth surface to the slots, to prevent wearing or breaking them out. The shape of the head is such that it is unnecessary to clean out the entire slot in order to use them, and they can be placed after the work is set on the machine. The larger half-tone shows one of Lang's T bolt heads on a 72-in. planer. The bolt had to be of exact length, so as not to interfere with the cutting tool, and the stud was threaded while the work was being leveled, and enough time saved over the time required to make an ordinary T bolt to more than pay for the T bolt head. In many cases work can be clamped through cored holes or slots where it is impossible to get an ordinary T bolt. The heads are made to fit all standard slots, from a No. 0 milling machine to a 20-ft. boring mill, and are tapped from ½ to 1¼ ins. with either U. S. S. T. or Whitworth threads. They are made by the G. R. Lang Company of Cincinnati.

LANG'S T-BOLT HEAD.



APPLICATION OF LANG'S T-BOLT HEAD.

LUBRICATING GREASES.

In a paper on the "Analysis of Lubricating Greases," read before the Pittsburg section of the American Chemical Society, Mr. P. H. Conradson stated that he generally submitted greases to the following tests and analysis which enabled him to form a good idea of the quanity and composition.

1. Consistency of the grease. Soft, medium or hard.
2. Color. Dark or light, etc.
3. Odor. Tarry, asphaltic or resinous, etc. Oftimes the odor of the grease gives quite an indication as to the nature of at least some of the materials that may be present, principally tarry matter or rosin oils.
4. Softening point. The temperature at which the grease begins to become soft, when carefully warmed and heated.
5. Incipient melting point. The temperature at which the grease begins to partially melt, oftentimes with separation of the oily or fatty matter from the soap and mineral matter.
6. Melting point. The temperature at which the grease is completely melted.
7. Flashing point. The temperature at which inflammable vapors are given off, indicated by applying a small flame.
8. Burning point. The temperature at which the grease begins to burn, when flame is applied.
9. Note. If the grease foams or swells and spatters during heating it indicates the presence of more or less water.

Some greases when heated to make the above tests, foam and swell much, until the water is driven off, others remain quiet and melt uniformly, others again partly melt at a comparative low temperature, with the separation of the soaps in solid lumps, or the settling out of the mineral matter to the bottom of the vessel.

ANALYSIS OF SAMPLES OF GREASES.

	No. 1.	No. 2.	No. 3.
Color	Dirty Yellow	Dark	Dirty Yellow
Odor	Rosin	....	Rosin
Consistency	Very soft	Hard	Medium
Softening point	....	225 deg. F.	160 deg. F.
Melting point	Flows at 85 deg. F	415 deg. F.	250 deg. F.
Flashing point	385 deg. F.	540 deg. F.	350 deg. F.
Burning point	450 deg. F.	....	400 deg. F.
Soda soaps	....	55.31 per cent.	....
Lime, magnesia soaps	5.68 per cent.	....	13.12 per cent
Mineral or hydrocarbon oils	91.95 per cent.	32.32 per cent.	84.00 per cent.
Water	2.37 per cent.	14.51 per cent.	2.00 per cent.
Grav. of separated oil	23.5 deg. B.	....	Trace lime
Free mineral matter	....	Little graphite	23.0 deg. B.

Behavior in heating.—Greases foam some. Nos. 2 and 3 have a tendency to separate into oil and lumps of soap.

The mineral oil in No. 2 is a thick, heavy at ordinary temperature, nearly solid, dark colored oil.

Mineral oils in Nos. 1 and 3, yellow colored. These two greases are compounded with rosin oils.

The single-phase motor is the one thing presented at the present time as the solution of the general railway problem. It has all the advantages of the direct-current motor in the variable speeds; it has the advantage of the alternating-current system in the use of any voltage desired, and the variable voltage applied to the motor, and thus adjustable speed, and it also has the advantage of control that can be obtained without sparking. —*B. G. Lamme, International Electrical Congress.*

BOOKS AND PAMPHLETS.

Reinforced Concrete. By A. W. Buel and C. F. Hill. The Engineering News Publishing Company, 220 Broadway, New York. 434 pages. Price, $5.00.

The above book is a timely production and will fill a very real need among American users of reinforced concrete, as it concentrates in one volume many of the recent formulæ dealing with this much-used material, and describes in detail the different forms of construction now in vogue. The work is divided into three sections: Part I, from the pen of Mr. Buel, is entitled "Methods of Calculation," and Parts II and III, by Mr. Hill, are styled respectively "Representative Structures" and "Methods of Construction." In Part I considerable space is given to the methods of development of several of the more familiar formulæ for concrete steel beams, and reports of numerous tests upon both beams and columns are quoted. Methods of treatment of retaining walls, dams, tanks, conduits and chimneys are also given, and one long and very valuable chapter is devoted to arch bridges and their abutments. Part II consists of a careful description of a large number of examples of actual construction, both in this country and abroad, and covers nearly all the uses to which reinforced concrete has so far been put. Part III is the shortest, but by no means the least valuable, for it gives much practical information concerning methods of handling the material, and of building forms, centres and the like. The text throughout the book is copiously illustrated, and the volume is worthy of a wide circulation not only among engineers and architects, but also concrete contractors.

"Cement Age."—The September number of the *Cement Age* is notable in presenting articles from engineers of the New York Rapid Transit Commission on the use of concrete in the subway. Concrete offers a great advantage in permitting unskilled labor to be substituted for the skilled labor which would be required for brick laying. This had an important bearing upon the cost and celerity of the work on the subway in addition to the advantages of monolithic construction offered by concrete.

Storage Air Brake System.—The system of storage air brakes used on the cars of the St. Louis Transit Company is described in a pamphlet issued jointly by the Westinghouse Traction Brake Company and the Ingersoll-Sergeant Drill Company. It describes and illustrates the compressors, the storage facilities, the brake and presents tests made in practice.

Valves.—Special catalogue No. 100 has just been issued by the Crane Company of Chicago describing their very complete line of pop safety valves, water relief valves and boiler trimmings. They have also sent out a small pamphlet illustrating their exhibits in the Machinery Hall and Transportation Building at the St. Louis Exposition.

"A B C" Engines.—The American Blower Company of Detroit have just issued the following bulletins: 162 describing their "A B C" type F high-speed vertical engine; 163 describing their type B "A B C" vertical engine with "marine" type frame, and type C which is designed for direct connection to mechanical draft outfits; 164 describing their type I "A B C" horizontal engine.

Tractive Power Chart.—This chart, 15 by 20 ins. in size, is printed on tough paper and affords a convenient method of quickly finding the tractive power of a locomotive. Published by the Derry-Collard Company, 256 Broadway, New York. Price, 50 cents.

Wm. Sellers & Company, Inc.—A pamphlet just issued describes their exhibits at the St. Louis Exposition, which include a 96-in. planer with pneumatic clutches for reversing, universal tool grinding and shaping machines, improved drill grinding machine, their well known improved and self acting injector for railroad and high-class stationary service, the 80,000-lb. traction dynamometer in the Pennsylvania Railroad exhibit, cranes, shafting details, etc.

Variable Speed Motors.—Northern Electrical Manufacturing Company's Bulletin 37 describes and illustrates application of their single voltage variable speed motors to a number of different machine tools. These motors do not require any wiring other than that required by constant speed motors. A Gould & Eberhardt shaper exhibited at St. Louis is driven by one of them which has a speed variation of more than 5 to 1 and is operated from a two-wire single voltage circuit. A characteristic curve of this type of Northern motor shows that the horse-power is practically constant for all speeds.

The Standard Steel Car Company of Pittsburg has just issued a new booklet containing complete descriptive matter, together with a number of handsome illustrations of their two new solid forged, steel equalizer bar trucks for electric railways, manufactured at their works, Butler, Pa. The book is 6 x 9 inches in size and finely printed on plate paper with cover stamped in gold. The illustrations show the new arrangement of joining the journal boxes rigidly to the equalizer bars, and the machine finishing of the journal boxes and bearings. This booklet will prove of great interest to all electric railway managers, and the company will send a copy immediately upon request to their general office, 1127 Frick Building, Pittsburg, Pa. These trucks are now on exhibition at the World's Fair, St. Louis, Transportation Building, Aisle E, Post 45.

Chuck for Flat Drills.—Described in a pamphlet issued by the George R. Rich Manufacturing Company of Chicago. Device is specialy adapted to drill holes 1 ins. or less in length, and is guaranteed to run at a speed four times as fast as a twist drill.

Lathes.—The R. K. Le Blond Machine Tool Company of Cincinnati have just issued a catalogue describing their lathes. The construction is considered in detail and a number of motor applications are shown.

Maine Sports.—In mentioning in a general way the various portions of Maine's territory, starting at Bemis as an egress, one can enter the famous Rangeley and Dead River regions—the Dead River separating them. Here both deer and moose are found, while foxes and game birds are particularly plentiful. Proceeding in the comfortable Pullman cars from Boston, one can go through to Greenville, from where departure may be made for the great surrounding section. Following from the northerly end of Moosehead the west branch of the Penobscot, the entire territory is infested with deer and moose. It becomes the herding ground for the moose in their wandering from Canada. Mount Katahdin, reached by water or land, is a delightful camping ground. The mountain is 5,000 ft. high, and in its thick forests moose seek refuge. From here, by canoe, it is possible to journey to the main line of the Bangor & Aroostook Railroad, the heralded territory. From the stations of this road alone, last year, over 3,786 deer and 232 moose were shipped in the open season. Here one often encounters bears, wildcats, loupcerviers, and woodcock and partridge are found in abundance. Mount Katahdin is easily reached from here by means of Norcross and Stacyville. The newest station of Maine's sporting grounds in that portion reached by the Washington County Railroad. It is a dense wilderness of vast size, and as yet never penetrated except by lumbermen and straggling sportsmen. In portions of New Hampshire and Vermont good sport may be secured, and some sportsmen prefer the wild tracts of New Brunswick and Nova Scotia. In order to get a detailed description of the hunting region, send a two-cent stamp to the General Passenger Department, Boston & Maine Railroad, Boston, for their illustrated booklet, "Fishing and Hunting." Accompanying will be mailed a booklet of the condensed Fish and Game Laws of all Northern New England and Canada.

NOTES.

Erie Heating Company.—This company has moved into its new offices at 225 Railway Exchange Building, Chicago, where correspondence should now be addressed instead of 34 West Monroe street.

Locomotive Appliance Company.—At a meeting of the board of directors held September 26 the following officers were elected: Mr. Ira C. Hubbell, president; Messrs. W. C. Squire, Clarence N. Howard and J. J. McCarthy, vice-presidents; Mr. J. B. Allfree, consulting engineer; Mr. E. B. Lathrop, treasurer, and W. H. England, secretary.

Paint for Steel Work.—Dixon's silica-graphite paint was used to preserve the structural steel work of the new St. Regis Hotel, the new boathouse of the United States Naval Academy at Annapolis, the new Wabash terminal station in Pittsburgh, the North-German Lloyd terminal and other recently completed structures of note in this country.

Crocker-Wheeler Company.—The Crocker-Wheeler standard railway type electric generators compound wound for 550 volts, used in the Intramural Railway power plant at the St. Louis Exposition, and the engines which drive them are for sale, delivery to be made early in January. Six of the generators are driven by steam engines of different makes and one by a water wheel. Bulletin 49, issued by the above company, describes and illustrates the engines and generators.

Northern Electrical Manufacturing Company.—This company recently shipped to the New York Edison Company a 60-kw. balancing set for its Waterside station and 34 two-wire variable speed field control motors, to be directly coupled to blowers for cooling the transformers at sub-stations. They also shipped 9 small motors to be installed in sub-stations of the Brooklyn Rapid Transit Company. This make a total of 75 Northern motors, aggregating 1,500 h. p., now in use by these two companies.

Lindenthal Side Bearings.—These bearings were described in a paper read read recently by Mr. Gustav Lindenthal before the New York Railroad Club. They have been in successful service for several years. Mr. Charles F. Pierce has been appointed sales agent, with office at 45 Cedar street, New York City.

Warner & Swasey Company.—This company has an extensive and well arranged exhibit at the St. Louis Exposition which includes their Nos. 1 and 2 hollow hexagon turret lathes arranged with belt and motor drive; Nos. 1, 2 and 5 turret screw machines, 16-in. forming turret lathe, 16 and 24-in. universal turret lathes, 2-spindle valve milling machine and horizontal boring machine.

B. F. Sturtevant Company.—The increasing demand for mechanical draft continues, not only in the United States, but in other countries. The power plant for the new shops of the Mexican Central Railway Company, at Aguascalientes, Mexico, contains a Sturtevant induced draft apparatus, consisting of two steel-plate fans, each driven by a Sturtevant vertical engine. Each fan is capable of maintaining a draft pressure in the flue connection of each boiler equal to ¾ of an inch of water when handling all the gases of combustion burning 35,000 lbs. of coal per hour with a flue temperature of 600 degrees Fahr. The ring oiling fan bearings next to the fan are water-jacketed to prevent overheating. A counterbalanced sliding damper permits either fan to be cut off from the flues or both may be operated at the same time. The engines are provided with regulating valves which automatically control the steam pressure.

Allis-Chalmers Company Awards.—From the department of publicity of this company the following, concerning the awards at the St. Louis Exposition, has been received: The 5,000 horsepower engine popularly known as the "Big Reliable," and the huge generator built by this company's electrical department—otherwise known as the Bullock Electric Manufacturing Company—each won a grand prize. In the Departmentof Mines and Metallurgy the Allis-Chalmers exhibit was also awarded a grand prize, the highest honor given by the international jurors. Among other features of this mining exhibit, and contributing to the success which won the highest award, are the famous style "K" Gates gyratory rock and ore breakers, the Overstrom concentrating table, the Allis-Chalmers style "A" and "B" crushing rolls, the Gates ball and tube mills, and the heavy 6-foot Huntington mill, known as the "Anaconda" type, manufactured only by this company. The Bullock Electric Manufacturing Company's grand prize also covered all their alternators, synchronous motors, direct current generators and motors, and rotary convertors. In addition, the Bullock system of multiple-voltage control of motors won a gold medal.

What a Car Cleaner Should Do.—A passenger car new from the builders or the paint shop is beautiful—but remains so only a few weeks when in service. The varnish is there under the dirt, and the light dirt only can be easily removed. After a year's service the varnish is still good, in fact, it is preserved by the dirt. Then a "car cleaner" is applied, and if the cleaner is of cheap material it is necessary to use force and abrasives in order to remove the dirt. This cleans the car, but it destroys the varnish, leaving a dull, flat surface which will catch the dirt more quickly and hold it more effectively than before. For this reason cleaners have been given up by some roads in favor of water and brushes. A satisfactory car cleaner should remove the dirt quickly without scouring or demanding hard muscular labor. It should leave a polished surface after being well wiped with dry waste and should leave the varnish intact. The cleaner should renew the life, color and elasticity of the varnish, and should leave in the body of the varnish a certain amount of filler to prevent moisture from entering. With such a cleaner the car should return to service in condition to carry no more dirt than when first turned out. Every application of such a cleaner must benefit the varnish by feeding and strengthening its body. Such a cleaner is believed to be available from the Beacon Paint & Varnish Preservative Company, 1313 Vine street, Philadelphia.

Mr. Clement F. Street has been appointed commercial engineer of the Westinghouse Electric & Manufacturing Company to handle work in connection with steam railroads. Mr. Street is well known among railroad men, and is well qualified to take charge of this important branch of the Westinghouse work. He has had a wide experience in the railroad field, gained through connection with many important interests, and his selection by the Westinghouse Electric & Manufacturing Company is a high compliment to his ability as an engineer. Mr. Street's career began in the service of the Buckeye Engine Works, of Salem, Ohio, where he served six years—three years as an apprentice to the machine trade and three years in the drafting room. Leaving this company, he became connected with the Johnston Company, of Johnstown, Pa., where he spent two years as chief draftsman. The next two years were spent in the engineering department of the E. P. Allis Company. He resigned this position to assume one of greater responsibility with the Chicago, Milwaukee & St. Paul Railway. After four years of service with the latter company as chief draftsman in the motive power department, he entered the journalistic field on the staff of the *Railway Review*, of Chicago. While connected with the *Review* he spent the years of 1894 and 1895 traveling around the world as engineer of the Commission World's Transportation of the Field Columbian Museum, of Chicago. Upon his return he made an exhaustive report to the commission upon the railroads of North Africa, Egypt, Ceylon, India, Burmah, Siam, Java, Australia and Japan. Upon retiring from this work he became manager of the railway department of the Dayton Malleable Iron Company, of Dayton, Ohio. His latest field of activity has been with the Wellman-Seaver-Morgan Company, of Cleveland, Ohio, in the capacity of manager of their railway department, which position he has just resigned. Mr. Street has not only devoted many years to careful study of the requirements of railroads, but has thoroughly familiarized himself with actual shop practice as well. He is a member of the American Society of Mechanical Engineers, the Western Railway Club and the Railway Master Mechanics' Association.

The heating and ventilating of large, high studded rooms in passenger terminal stations constitutes a problem in the solution of which practice as applied in buildings involving large auditoriums, may be advantageously considered. A recent example of up-to-date heating and ventilation equipment is that of the new First Church of Christ, Scientist, in New York City. This building is attracting wide attention among architects and engineers because of the completeness of its equipment. It has two 100 h.p. boilers, each of which is sufficient, alone, to supply all the steam needed in the coldest weather, and a coal storage capacity of 200 tons is provided. Two 6 ft. Sturtevant fans, driven by 15 h.p. C. and C. motors, draw air from a point 100 ft. above the ground, and, after forcing it through steam coils in 5 sections, deliver it to a plenum chamber between the ceiling of the basement and the main floor. Fresh, warm air is delivered from here through ducts to registers at the end of each seat and in the side aisles. Hollow construction is also applied to the galleries and a uniform supply delivered through 200 registers. In addition to this system, direct radiators are placed immediately under the sills of all the windows; these are for the purpose of neutralizing the cold down draft which would otherwise come from the windows. Two large ornamental exhaust registers are placed in the ceiling of the auditorium, through which a 6 ft. Blackman exhaust fan draws air for discharge above the roof. The space between the arched ceiling and the roof serves as an exhaust duct. With these facilities the entire volume of air is changed four times every hour. The upper floors are warmed and ventilated in the same way, but the primary coils for direct radiators are supplemented in some cases by superheaters at the bases of the flues which conduct the air to the remote parts of the building. All of the controlling dampers are operated by chains leading to the engine room. Direct radiation is used in vestibules, stair and passage ways. A Johnson thermostatic system controls the temperature. The engine room is provided with two Worthington steam pumps, a self-acting house pump, two Loomis-Manning filters, three pumps for the drainage sumps, an Otis hydraulic ash hoist, switchboard and a workshop with a lathe and facilities for machinery repairs. Three electric elevators were furnished by the Marine Engine & Machine Company. Each 20-passenger elevator is driven by a 35 h.p. Crocker-Wheeler motor and a small 6 passenger elevator at the 96th street entrance is driven by a 25 h.p. motor of the same type, the elevator speed being 300 ft. per minute. A Sturtevant fan, driven by a General Electric motor through a regulating rheostat, supplies air for the organ. All the electric power is taken from the Edison mains.

(Established 1832.)
AMERICAN ENGINEER AND RAILROAD JOURNAL.

DECEMBER, 1904.

CONTENTS.

ANGUS LOCOMOTIVE AND CAR SHOPS, MONTREAL

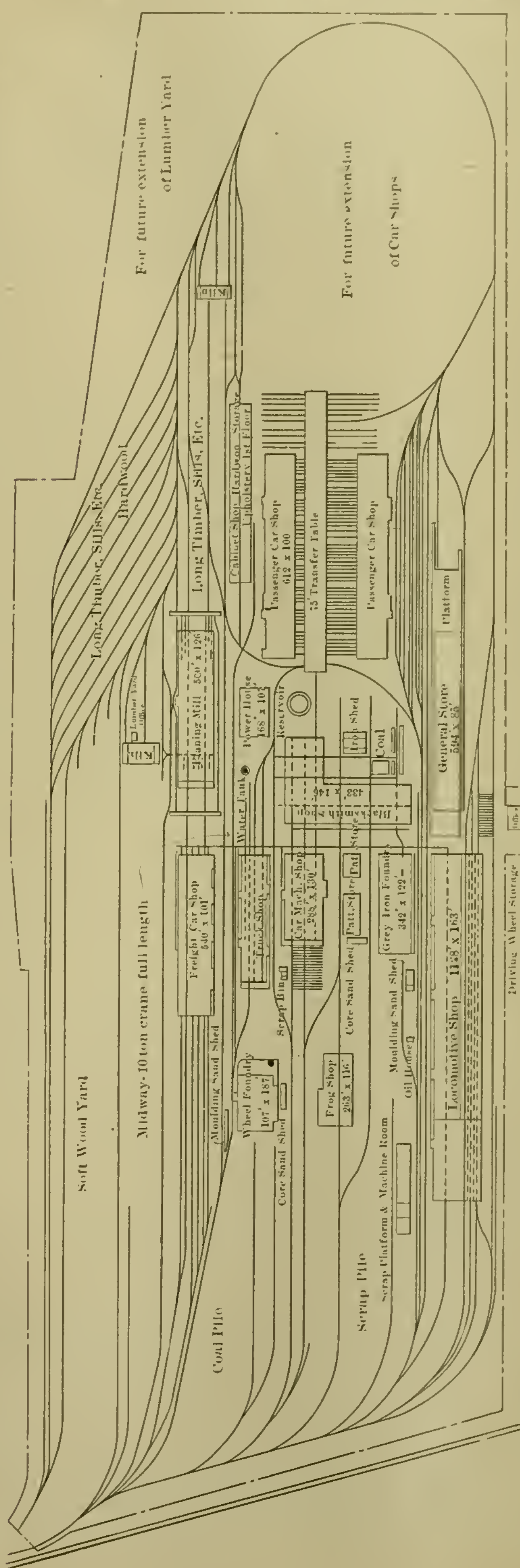
Canadian Pacific Railway.

I.

General Arrangement.

This is the largest railroad shop plant ever built and put into service at one time. It is interesting, because it involved a problem of combining construction as well as repairs of a large number of locomotives and cars, and the broad-minded and liberal plan of the works is exceedingly creditable to the road and to the engineers in charge. The plan and the construction should be carefully studied by those who have to do with the construction or operation of railroad shops. It is an engineer's plant on a magnificent scale, combining an excellent arrangement of well-constructed buildings, liberal provision for 100 per cent. extension of every building and unprecedented facilities for the storage and movement of material. There is no more interesting and instructive shop installation on the American continent.

Angus shops, situated within the city limits of Montreal, will provide for the maintenance of about 500 locomotives for the Eastern lines, the heavy repairs of from 5 to 10 per month may easily be increased to maintain 700 locomotives and build 100 new ones per year. The gray iron foundry has a capacity of 75 tons and the car wheel foundry 300 chilled cast-iron wheels per day. These and new shops nearly completed at Winnipeg, Manitoba, of about one-third of this capacity, will



ANGUS LOCOMOTIVE AND CAR SHOPS, MONTREAL—CANADIAN PACIFIC RAILWAY.

H. H. Vaughan, *Superintendent of Motive Power.* Henry Goldmark, *Engineer of Shop Construction.*

for the Western lines, the building of 50 new locomotives per year, the construction of about 30 freight cars per day, and of 100 passenger equipment cars per year. The capacity put this road in an excellent position with respect to shop facilities.

The plant tract covers 200 acres. There are 20 acres of roofs and 28 miles of standard gauge tracks in the yards. Of these 6 miles are inside of the buildings. There are over 20 buildings, the largest being the locomotive shop, 162 by 1,166 ft., with the other buildings in proportion.

A 75-ft. "midway," served by a 10-ton electric traveling crane, forms the main channel of the plant. About this the various buildings are arranged with a view of the relative importance of the transportation of material to each, considering both the volume and weight. In general, the locomotive material goes south and car material north, or directly across the midway. There should be no doubling of material on its previous tracks.

The locomotive group is at the south end of the midway. At one corner is the locomotive shop, comprising the erecting, machine, tender, boiler and smaller departments in one building, the arrangement of which will be carefully presented later. This shop takes material from the storehouse, blacksmith shop and foundry. It has all other contributing departments under its own roof. Opposite is the storehouse, built in three sections, one for locomotive parts and supplies at the midway end, the center is for general stores for all parts of the line and the east end provides for the car shops and other stores which are easily transported. Next to the locomotive shop is the gray iron foundry, with its out-of-door, overhead traveling crane delivering material from the stock piles to the charging platform on one end and finished castings to the midway crane on the other. This building was placed close to the locomotive shop, because of the weight of the castings going to that department. Opposite the gray iron foundry is the blacksmith shop, with two wings in L shape, in order to separate the locomotive and car department deliveries without making the building too long. This shop is admirably located to deliver a large amount of car material to the truck and car machine shops opposite and to the locomotive shop. The pattern shop and fireproof pattern storage are near the foundry. The car machine shop is located with reference to the car wing of the blacksmith shop, and it is also near the foundry. The truck shop takes material from the car machine and blacksmith shops, and passes it on in the form of finished trucks to the freight car shop. While the passenger car shops take material from the car machine shops, it is not in sufficient volume to necessitate a nearer location. To build 30 freight cars per day material must be received in volume from its sources of supply, mainly the truck shop and planing mill. Because of the volume of wheel movement the wheel foundry was placed back of the truck shop, and far enough away for a large storage capacity for finished wheels. These pass through the truck shop, coming out in the finished trucks on the midway.

As the freight car shop is an assembling plant for large volumes of material; it was given most careful attention in order to secure delivery in as direct lines as possible. Finished lumber passes directly across the midway from the planing mill, with room for storage between the mill and the midway. A small transfer table facilitates the delivery. This space may be roofed over later, because of the heavy snowfall at this latitude. Straight-line movement is further conserved from the lumber storage to the mill, and the mill was made easily accessible from the passenger car shops. Because of the relatively smaller volume of material going into passenger cars, this movement does not need to be as direct and short as in the case of the freight car shop. Long material for passenger cars backs out of the mill for transfer over the connecting tracks, while short material comes from the side of the mill, near the west end, thus following straight lines through the machines of the mill.

With most of the power distribution on an alternating current basis, the power house was not placed at the center of the plant. It was more important to put it near the mill and cabinet shop, because about 18 tons of coal per day are saved by the use of shavings from these buildings. The shavings exhaust system is the most complete ever put into a railroad shop plant, for which credit is due the Sturtevant people as well as the engineers of the road. Aside from the use of the shavings, the mill requires more power than any department except the locomotive shop, which added a reason for this location of the power house.

Whereas freight car construction divides into about 90 per cent. of material to 10 per cent. of labor, that of passenger cars is in reverse proportion. A car remains but one day in the former and perhaps three months in the latter, if it is a sleeper or a diner. These facts led to the location of the passenger car shops in positions of general convenience. Two long shops, with a transfer table between them, provide for all the passenger car work except that done in the cabinet shop, which, by the way, is the only building about the plant which is evidently too small. Space between the transfer table and the shops on either side provides for the storage of trucks on the north side and for passenger cars outside the building on the south side. Light repairs may be made to coaches on these tracks. A yard for the storage of coaches is located south of the passenger car shops.

A shop for making frogs, switches and switch stands for the entire road is independently located west of the midway. This building receives some material from the blacksmith shop, but not in large volume.

The buildings were concentrated where they were wanted with reference to each other in a track plan which combines longitudinal and transverse tracks, the midway serving as a long transfer table, with tracks on the ground as well as a 10-ton overhead crane. This is very nicely worked out. A system of scrap bins, sheds and racks completes the plan. The open scrap bins are on an elevated platform, with the shears and scales housed in the center. It is likely that the bins will be roofed over later. This department is provided for the sale of scrap material exclusively.

A novel arrangement of platform scales will be put in later. This consists of a 60-ton scale 15 ft. long and a 100-ton scale 60 ft. long on the same track, with a space of one foot between them. On these scales the heaviest locomotive or the longest car may be weighed.

The construction of the shops began about two years ago, and they were put into service last August with the principal departments turning out a normal output from the first.

The plans and construction were carried out under the direction of Mr. E. H. McHenry, formerly chief engineer of the road, and Mr. Henry Goldmark, engineer of shop construction. Mr. Max Toltz served as consulting engineer for the equipment, and Mr. G. B. Mitchell as resident engineer of construction and installation.

The next article will show features of the buildings.

GAS ENGINE REGULATION.

In conclusion, the points brought out in this paper may be summed up somewhat as follows: Regulation of angular velocity through any one complete cycle of operations can be adjusted in gas engines to as small limits with as great certainty as in steam engines, but the problem requires possibly a more experienced man and greater care in application for it involves more variables. The results, however, can be made as good as for steam if not better. Regulation of speed, or constancy of revolutions per minute, is a thing which calls for a method of governing first and afterwards the application of well known principles already developed for steam work. The actual design of the governor mechanism to produce effects on mean effort quickly and certainly is not an easy thing, and there is a wide field here for both the inventor and the designer which the author feels is not yet filled—*Dr. C. E. Lucke, before New York Railroad Club.*

ECONOMICAL TRAIN OPERATION.

BY G. R. HENDERSON.

PART III.

(Cost of Operation Continued.)

We have so far examined the effect of a continual rise and also the crossing of a summit but in many parts of the country we have simply an undulating profile. Let us now consider a division 150 miles long as before, with both terminals at the same elevation and the track an average level, except in three places, where we will suppose that there are up and down grades ten miles long each, the incline in all cases being 26 ft. per mile, or one-half of 1 per cent. We shall therefore have, in a trip over the division, 30 miles of up grade, 30 miles of down grade, and 90 miles of approximately level track. It is probable that on this section a lighter locomotive will be in use, somewhat as per the following specification:

TEN-WHEEL LOCOMOTIVE.

Theoretical tractive force...	37,500 lbs.
Available tractive force.....	30,000 lbs.
Diameter of drivers............	68 ins.
Area of grate..................	37 sq. ft.
Weight of engine and tender..	130 tons

This will necessitate constructing a new diagram for determining the coal burned at various speeds and with different loads. This has been done in Fig. 2. The maximum rate per hour will be 37 × 200 = say 7,500 lbs. of coal per hour. The dotted lines show the consumption per mile, as before. The rising grades being so short, there will be no good object attained by loading the engine so that a high speed can be maintained on these portions, as all the speed desired can be made on the down grades and the levels. At 5 miles an hour, the gross load on these grades would be $\frac{30,000}{10+5}$ = 2,000 tons, and at 10 miles an hour $\frac{30,000}{10+5\frac{1}{2}}$ = 1,950 tons, or the net loading back of tender would be 2,000 — 130 = 1,870 tons, and 1,950—130 = 1,820 tons. In Fig. 2 the broken lines give the resistance of 1,900, 1,950 and 2,000 tons gross on a level, and also on a ½ per cent. rising gradient, and the combinations of load and speed, taken in connection with the dotted lines, will give the corresponding coal consumption per mile, under the conditions considered. As before, we will assume that no coal is used while running down hill.

We are now ready to construct a tabulated statement as previously for a variety of schedules, but the calculation will be rather more complicated than before. The different combinations of loads and speeds which we shall now study are shown below:

No.	Gross weight. Tons.	Speed uphill. m. p. h.	Speed downhill. m. p. h.	Speed on level. m. p. h.
1.	2,000	5	25	10
2.	1,950	10	25	10
3.	2,000	5	25	15
4.	2,000	5	25	25
5.	1,950	10	25	25

We will construct Table C on this basis. Lines 2 and 3 give the gross and net weight, respectively, as per the different schedules, and these values, multiplied by 150 (the length of the division in miles) give the ton mileage of the trip.

The time between terminals is figured as follows:

SCHEDULE 1.

30 miles uphill at 5 miles per hour, require.............	6 hours
30 miles downhill at 25 miles per hour require............	1.2 hours
90 miles on level at 10 miles per hour require............	9.0 hours
Add 20 per cent. for delays, etc.........................	3.3 hours
Total time between terminals............................	19.5 hours

The average speed is therefore $\frac{150}{19.5}$ = 7.7 miles per hour.

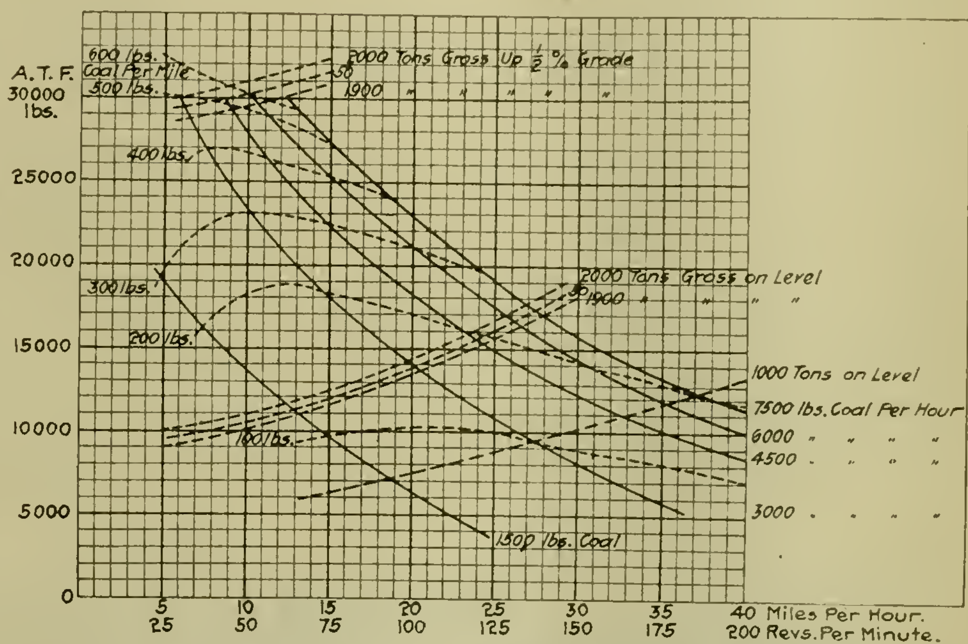


FIG. 2.—COAL CONSUMPTION OF 10-WHEEL LOCOMOTIVE (130 TONS WEIGHT).

TABLE C.

1.	Schedule of trip	1	2	3	4	5
2.	Weight of train, gross tons	2,000	1,950	2,000	2,000	1,950
3.	Weight of train, net tons	1,870	1,820	1,870	1,870	1,820
4.	Ton miles per trip, back of tender	280,000	273,000	280,000	280,000	273,000
5.	Time between terminals, including layouts	19.5 hrs.	15.8 hrs.	15.8 hrs.	13.0 hrs.	9.4 hrs.
6.	Average speed between terminals, miles per hour	7.7	9.5	9.5	11.5	16 0
7.	Coal burned, as calculated	....	....	....	....	....
8.	Coal burned per trip, lbs.	25,800	28,350	26,250	31,800	36,900
9.	Cost of coal per trip, at $2 a ton	$25.80	$28.35	$26.25	$31.80	$36.90
10.	Locomotive supplies per trip, at 1½ cents per mile	2.25	2.25	2.25	2.25	2.25
11.	Train supplies per trip, at 1½ cents per mile	2.25	2.25	2.25	2.25	2.25
12.	Repairs to locomotive at 8 cents per 1,000 ton miles	22.40	21.84	22.40	22.40	21.84
13.	Repairs to cars at 15 cents per 1,000 ton miles	42.00	40.95	42.00	42.00	40.95
14.	Pay of enginemen, per schedule	13.65	11.20	11.20	10.50	10.50
15.	Pay of trainmen, per schedule	15.70	12.72	12.72	12.08	12.08
16.	Roundhouse labor at $2 a trip	2.00	2.00	2.00	2.00	2.00
17.	Interest on locomotive and caboose at 8½ cents per hour	2.08	1.77	1.77	1.53	1.22
18.	Total cost of trip, charges 9 to 17	$128.13	$123.33	$122.84	$129.81	$129.99
19.	Cost per 1,000 ton miles hauled	.45	.45	.44	.46½	.47½
20.	Ton miles hauled per month	8,228,000	9,450,000	9,700,000	11,200,000	13,650,000
21.	Lbs. coal per 100 ton miles	9.2	10.4	9.4	12.4	13.5

The remaining schedules are figured in the same manner and are given on lines 5 and 6.

The coal consumption is figured in a similar manner to the time, as follows:

SCHEDULE 1.

	Lbs.
30 miles uphill, 2,000 tons, at 5 m. p. h., 500 lbs. per mile....	15,000
30 miles downhill, 2,000 tons, at 25 m. p. h....................	
90 miles on level, 2,000 tons, at 10 m. p. h., 120 lbs. per mile..	10,800
Total coal for trip..	25,800

SCHEDULE 2.

	Lbs.
30 miles uphill, 1,950 tons, at 10 m.p.h., 600 lbs., per mile....	18,000
90 miles on level, 1,950 tons, at 10 m.p.h., 115 lbs. per mile....	10,350
Total coal for trip....	28,350

SCHEDULE 3.

	Lbs.
30 miles uphill, 2,000 tons, at 5 m.p.h., 500 lbs. per mile......	15,000
90 miles on level, 2,000 tons, at 15 m.p.h., 125 lbs. per mile....	11,250
Total coal for trip....	26,250

SCHEDULE 4.

	Lbs.
30 miles uphill, 2,000 tons, at 5 m.p.h., 500 lbs. per mile......	15,000
90 miles on level, 2,000 tons, at 25 m.p.h., 220 lbs. per mile....	19,800
Total coal for trip....	34,800

SCHEDULE 5.

	Lbs.
30 miles uphill, 1,950 tons, at 10 m.p.h., 600 lbs. per mile....	18,000
90 miles on level, 1,950 tons, at 25 m.p.h., 210 lbs. per mile....	18,900
Total coal for trip....	36,900

Lines 8 and 9 show the amount and cost of coal burned per trip. The other engine supplies and the train supplies are the same as in the previous cases, viz., 1.5 cents per mile, and are set down on lines 10 and 11.

Repairs are figured as before: 8 cents per 1,000 ton miles for locomotive and 15 cents for cars. Line 14, pay of engineers, is figured at 70 cents an hour for Schedule 1; at 150 miles and 1 hour overtime for Schedules 2 and 3, as the time was 0.8 over the time needed at 10 miles an hour. For Schedules 4 and 5 the 150 miles alone have to be paid for, as the average speed exceeds 10 miles an hour. For line 15, pay of trainmen, the same explanation holds good, except that according to the schedule of pay, numbers 2 and 3 are figured at 80.5 cents per hour for 15.8 hours. Roundhouse labor is still considered at $2 per turn or trip, as shown on line 16. As the 10-wheel engine will cost about 15 per cent. less than the heavier consolidation, interest will be charged at 8½ cents per hour, instead of 10 cents, as before, and 5 hours will be added to each value of line 5 in order to compute this charge. Thus, for Schedule 1, time between terminals is assumed at 19.5 hours, and, with time used in turning, makes 24.5 hours to a trip. and 24.5 × .085 = 2.08 per trip; the other schedules being computed in the same manner.

In line 18 we have the total cost of one trip, and it will be seen that there is little difference between the various schedules, although there is a great difference in the amount of work done during the month by the locomotive, Schedule 5 handling over 50 per cent. more traffic than Schedule 1, with a small increase in cost per ton mile.

(To be concluded.)

FREIGHT LOCOMOTIVES WITH SUPERHEATERS 2-8-0 TYPE.

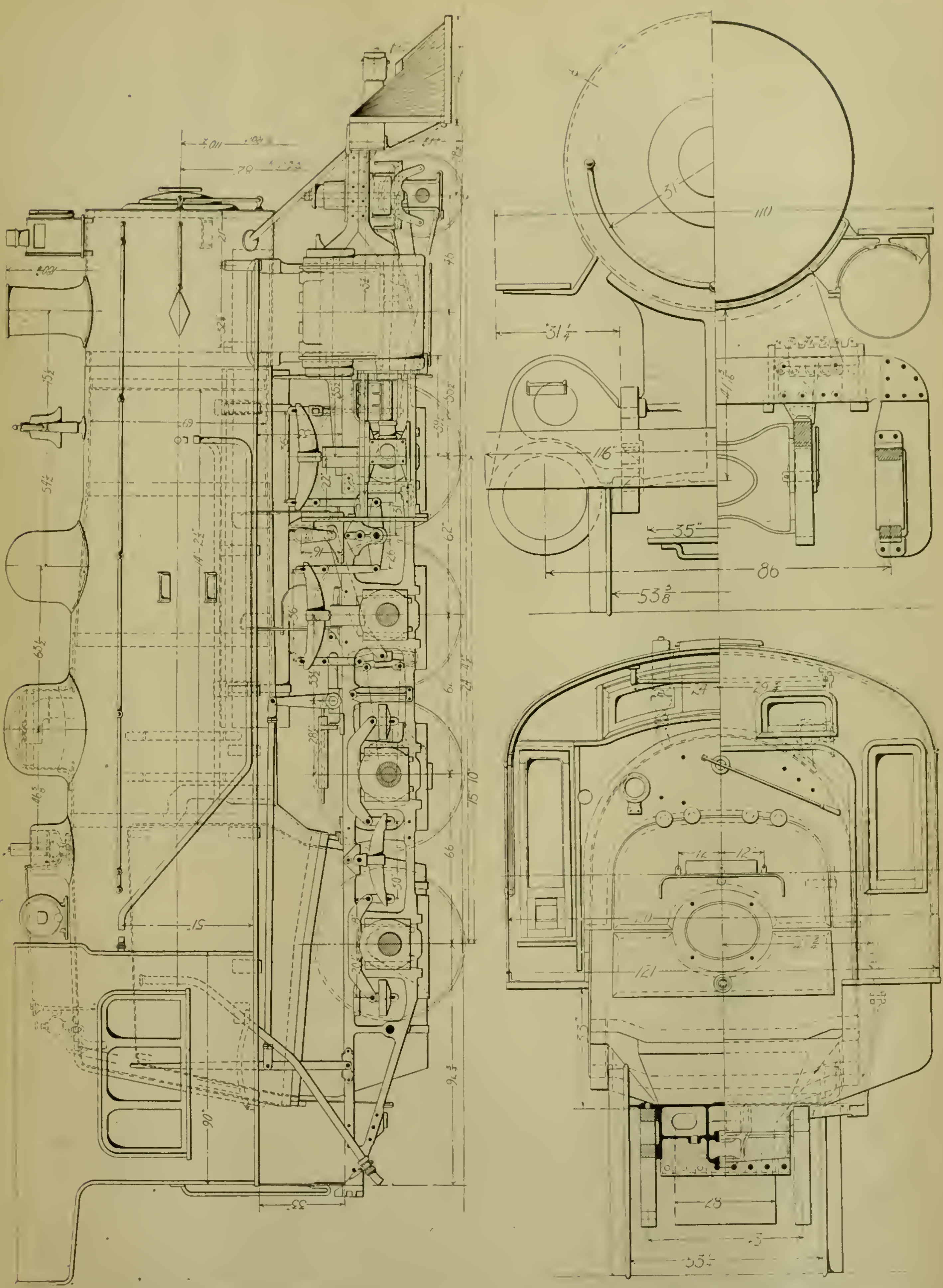
THE CANADIAN PACIFIC RAILWAY.

Recently the Canadian Pacific Railway ordered ten 2—8—0 freight locomotives from the Canadian Locomotive Company of Kingston, with Schmidt fire tube superheaters, eleven from the Locomotive & Machine Company of Montreal, ten of which had Schmidt fire tube superheaters and one of the Cole type; also twenty locomotives were ordered from the American Locomotive Company with Cole superheaters. These were all built from the same drawings, and the order of twenty has been completed by the American Locomotive Company at the Schenectady Works, the first engine being completed thirty days after the date of placing the order. Through the courtesy of Mr. H. H. Vaughan, superintendent of motive power of the Canadian Pacific Railway, illustrations of these engines are presented. The drawings were prepared at Schenectady under the direction of Mr. Vaughan, and the execution of this order in so short a time is in itself a remarkable achievement, which is referred to elsewhere in this issue.

This is an able freight locomotive of not excessive weight, with the boiler capacity augmented by the superheater. Apart from this it involves no experimental feature whatever. The reader will be reminded in this description of the Class C design of the Lake Shore & Michigan Southern Railway (AMERICAN ENGINEER, January, 1904, page 12). The frames are braced diagonally by means of a steel casting at the rear pedestals of the forward drivers. They are braced again by a substantial casting at the front end of the mud ring. Among other good details are double suspension of the links, very long rocker boxes, three-point suspension leading trucks, liberal tube spacing with tubes at 2¾-in. centers at both ends. The circulation is also assisted by ample water spacing around the firebox. These locomotives have grates sloping towards the center to give as deep a throat as possible within the available limits. Outside piston valves are used in connection with double-bar frames, which, while slightly increasing the weight, will, it is hoped, tend to reduce the breakage of frames. The pedestal binders are exceedingly heavy, with lugs 2¼ ins. deep. While ample heating surface is provided, no attempt was made to increase it at the expense of circulation about the firebox and among the tubes, or by an excessive height of the crown sheet. In general, more weight has been allotted to the machinery of this engine than is usual, and a high factor of adhesion (4.3) has been employed in an endeavor to obtain an engine which should be as free as possible from failures and breakdowns rather than one of the utmost capacity for its weight. The tender is designed to bring all of the coal to the fireman, with the sides of the greatest permissible height and fitted with iron coal gates. The center sills are heavy 13-in. channels and the side sills standard 10-in. channels. The draft castings are of cast steel, with Sessions-Standard friction draft gear at the rear end.

FREIGHT LOCOMOTIVES WITH SCHENECTADY SUPERHEATERS—CANADIAN PACIFIC RAILWAY.

H. H. VAUGHAN, *Superintendent of Motive Power.* AMERICAN LOCOMOTIVE COMPANY, SCHENECTADY WORKS, *Builders.*



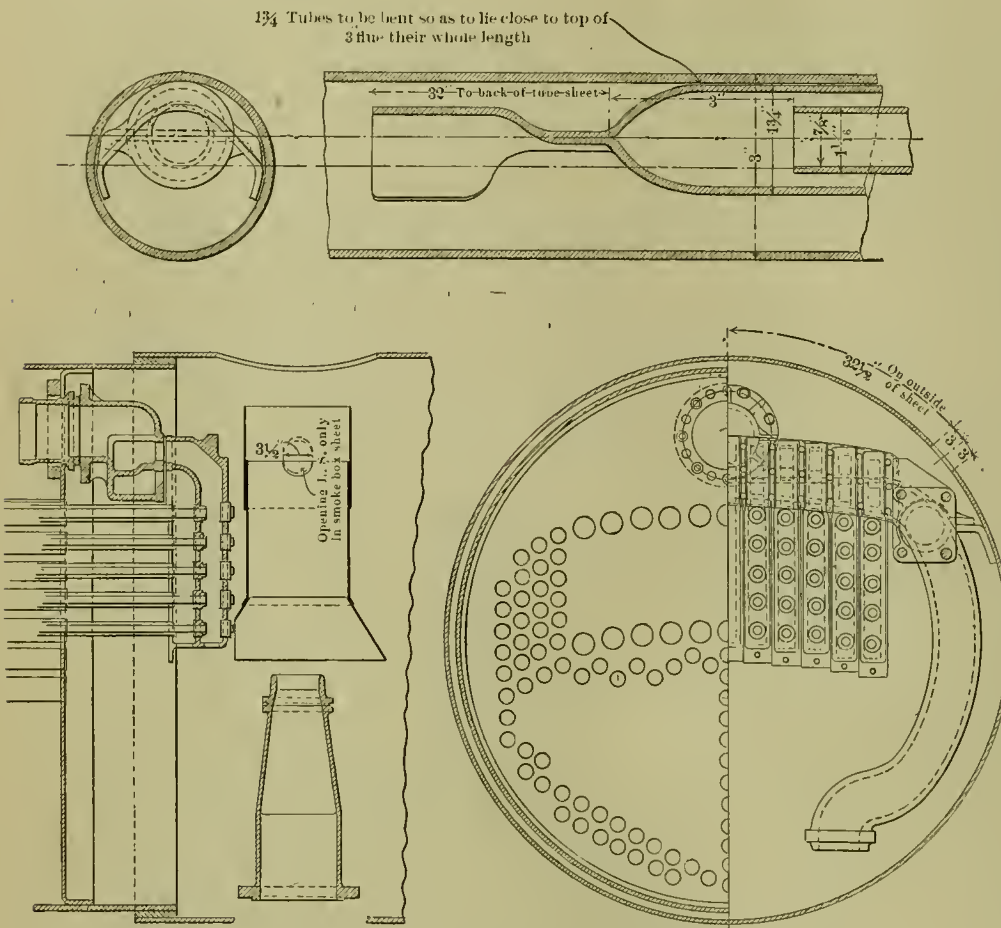
FREIGHT LOCOMOTIVE WITH SCHENECTADY SUPERHEATER—CANADIAN PACIFIC RAILWAY.

H. H. VAUGHAN, *Superintendent of Motive Power.* AMERICAN LOCOMOTIVE COMPANY, SCHENECTADY WORKS, *Builders.*

THE SUPERHEATER.

The chief feature of interest about this engine is the superheater; not because of its absolute novelty, but because it marks the first extensive use of the principle on the American continent.

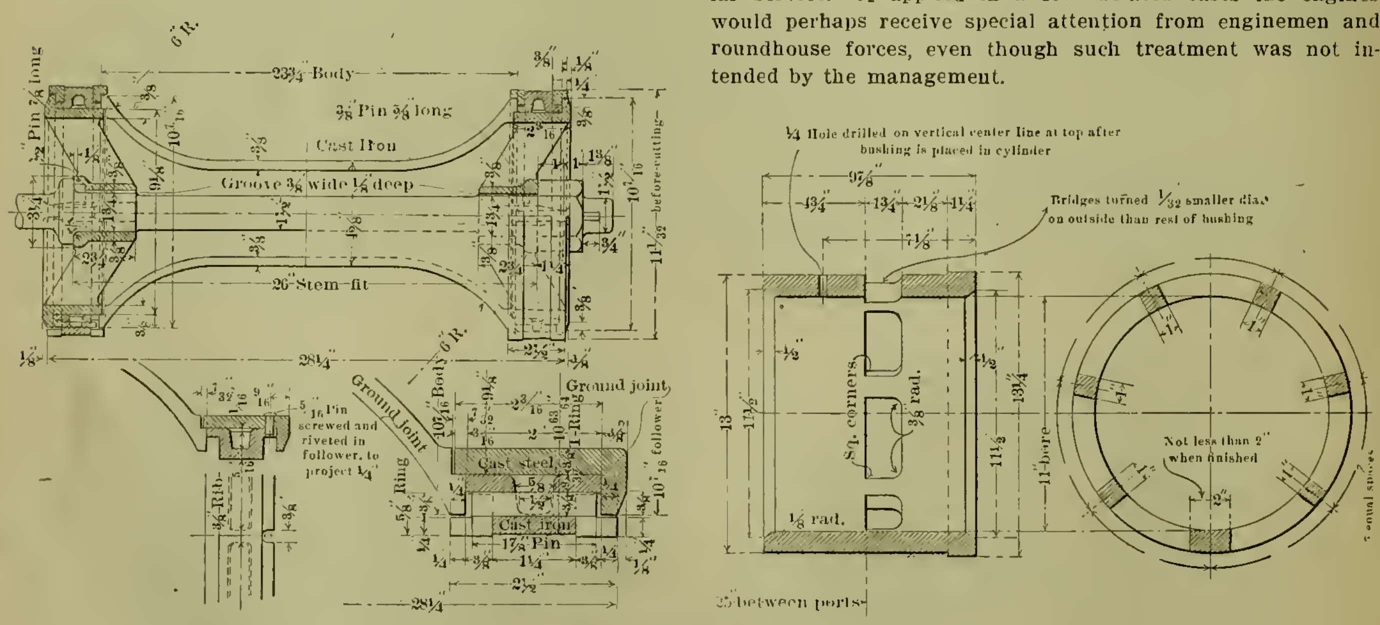
The superheater was first introduced on the Canadian Pacific about three years ago, when Mr. R. Atkinson, then mechanical superintendent, applied a Schmidt smokebox superheater to an 18 x 24, 4—6—0 freight engine, No. 548. During the succeeding two years this engine gave complete satisfaction and showed a decided and even remarkable fuel economy over both simple and compound engines of similar capacity in both freight and passenger service.



CONSTRUCTION OF THE SCHENECTADY SUPERHEATER.

About a year ago engine No. 1,000 of the 4—6—0 type, a compound and one of a class of 40 freight engines, was built weighing 172,000 lbs. At the same time engine No. 1,300, of another and heavier class, of 40 4—6—0 compound freight engines, was built, weighing 190,000 lbs. These were equipped with Schmidt fire tube superheaters. The first of these was built by Neilson, Reid & Company of Glasgow, the second by the American Locomotive Company at Schenectady. These two engines have also given good satisfaction and a statement showing their fuel consumption compared with engines of the same class not fitted with superheaters is shown in the accompanying table. This is not compiled from tests, but is made up from the operating fuel records of the road, which accounts for the variation of economy during the various periods. The economy shown by the superheater is so well defined that there is no question of its effective and substantial saving.

When the question of purchasing more locomotives arose last Spring it was felt that the results so far obtained were sufficiently definite to warrant the application of the superheater on a larger scale and that only by doing this could this device be given a sufficiently thorough and practical test to develop any defects which might occur were it in use on a considerable number of engines in regular service. If applied in a few isolated cases the engines would perhaps receive special attention from enginemen and roundhouse forces, even though such treatment was not intended by the management.



SECTIONS OF THE PISTON VALVE AND VALVE BUSHINGS.

The decision between the use of compound and simple engines was more difficult. It will be noted that taking the average economy of No. 548 over corresponding engines, at 30 per cent. and the economy of No. 1000 and No. 1300 over corresponding compound engines, at from 15 to 20 per cent., the difference in this relative economy was about that which would be expected over a compound freight and simple engine. In other words the superheater engines, whether compound or simple, show about the same percentage of economy over an ordinary simple engine. This is in accord with the conclusions of Herr Garbe of the Prussian State Railways, who has been an extensive user of superheated steam in locomotives and claims that the difference in economy obtained by the compound engines using superheated steam is so small (not exceeding as a rule 5 per cent.) that it does not compensate for the increased complication involved. In view of these considerations it was decided that the class of engines to be built, in the new order for 41 engines, should be simple superheaters.

The cost of repairs, as shown in the statement, is not of very great value, as it does not of necessity represent the relative cost of maintaining engines using superheated or saturated steam, since the majority of reports received were not dependent upon that detail. In addition these reports do not simply represent maintenance charges, but include more or less shop repairs. Mr. Vaughan, however, states that the experience thus far gained would appear to show that the superheater engines will probably cost less for repairs than the others. Engine No. 548, which has just passed through the shops after making 75,000 miles, was in excellent condition and the piston valves were put back without requiring renewal of the rings, which are of the Schmidt design. All the pipes in the front end were found in good condition and it would appear that the dryness of the steam has a positive advantage since the additional added expense on that account is so slight that it is more than compensated for by the absence of water in the cylinders. The superheater on this engine, however, gives a greater degree of superheat than the firetube type of engines Nos. 1000 and 1300, but in the new engines the latter type are adopted on account of their simplicity.

No trouble has been experienced with the tubes containing the superheated steam and on one occasion, when leaks occurred between these tubes and the header in the front end, it was found that although the engine still steamed sufficiently well to handle its train, the leakage was easily detected, showing that in service leaks may be easily detected by water test. While these engines have been working in good water districts it is not believed that the large tubes containing the superheater pipes will give any serious trouble, and that while they need slightly more attention than the regular firetubes the decreased demands on the boiler reduces the amount of attention needed by the latter sufficiently to compensate for the additional work required on the larger tubes. The result is actually a net gain in the amount of boiler work required.

The accompanying tables present the general characteristics of the new engines, the records made by the superheaters previously in service and a comparison of the dimensions of the engines of which the record is given.

SUPERHEATER FREIGHT LOCOMOTIVES, 2-8-0 TYPE.
CANADIAN PACIFIC RAILWAY.

Weight in working order	190,000 lbs.
Weight in drivers	164,000 lbs.
Weight engine and tender	315,700 lbs.
Wheel base, driving	15 ft. 10 ins.
Wheel base, rigid	15 ft. 10 ins.
Wheel base, total	24 ft. 4½ ins.
Wheel base, engine and tender	53 ft. 3½ ins.
Tractive Power	36,800 lbs.
Heating surface tubes	2,493.7 sq. ft.
Heating surface firebox	166.0 sq. ft.
Heating surface, total	2,659.7 sq. ft.
Grate Area	43.8 sq. ft.
Cylinders	21 by 28 ins.
Driving wheels, diameter	57 ins.
Driving wheels, centers	51 ins.
Driving journals, main	9½ by 12 ins.
Driving journals, others	9 by 12 ins.
Truck journals	6 by 11 ins.
Boiler, extended	wagon top
Boiler, pressure	200 lbs.
Boiler, diameter outside first ring	70⅝ ins.
Boiler, height of center above rail	110½ ins.
Fuel	bituminous coal
Firebox	96⅝ ins. long, 65¼ ins. wide
Water space	front 5 ins.; side 4½ ins.; back 3½ ins.
Tubes	length 14 ft. 2½ ins.
Tubes 2 ins. number	255
Tubes 3 ins. superheater	55
Smoke stack, diameter	16½ and 19 ins.
Smoke stack, above rail	15 ft. 3-16 ins.
Tender tank capacity	5,000 gals.
Tender coal capacity	12 tons

CANADIAN PACIFIC RAILWAY COMPARATIVE FUEL PERFORMANCE—ENGINES EQUIPPED WITH SUPERHEATER AND ENGINES NOT SO EQUIPPED.

Date	Engines With S. Heater	Engines Without S. Heater	Loco. Miles	Tons 1 Mile	Coal Tons	Ton Miles per ton of coal	Total Cost of Repairs	Total Miles of Engine	Cost per Mile for Repairs	REMARKS.	
				MONTREAL AND SMITHS FALLS.							
May/03 to	548		34,493	33,183,463	1,541¾	21,531	693.25	37,692	1.8	Freight	Service
Dec. 31/03		482	31,857	30,456,884	1,741¾	17,490	1,209.77	33,563	3.6	"	"
8 Months.											
Jany. to	548		16,812	14,403,672	931	15,473	652.92	18,649	3.5	"	"
May/04		616	15,722	13,247,527	1,167	11,351	432.90	17,411	2.5	"	"
5 Months.											
June to	548		15,768	2,450,861	467¾	5,239	288.63	15,914	1.8	Passenger	"
September		595	16,128	2,560,092	600	4,267	242.83	17,525	1.4	"	"
4 Months.		634	16,854	2,749,553	680¼	4,042	618.65	18,403	3.4	"	"
Jany. to	1,000		21,567	25,321,322	1,271½	19,915	1,001.00	22,852	4.4	Freight	"
July/04		997	19,662	23,277,718	1,499¼	15,521	1,578.37	22,552	7.	"	"
7 Months.											
August and	1,000		3,740	4,657,142	188½	24,705	122.89	4,607	2.7	"	"
September		996	5,666	7,025,559	409¾	17,146	129.20	5,765	2.2	"	"
2 Months.											
				CHALK RIVER AND NORTH BAY.							
Nov./03 to	1,300		22,987	17,074,757	1,127½	15,149	1,365.84	43,035	3.2	"	"
Sept./04		1,319	19,983	15,090,962	1,112½	13,560	1,679.42	43,561	3.9	"	"
11 Months.											
				NORTH BAY AND CARTIER.							
Nov./03 to	1,300		10,964	9,887,253	550½	17,960				"	"
Sept./04		1,319	10,521	9,249,414	616½	15,002				"	"
11 months.											

CHARACTERISTICS OF LOCOMOTIVES IN SUPERHEATER PERFORMANCE RECORD.

Engine. No.	Type.	Kind.	System.	*Capacity.	Cylinders.	Drivers.	Heating Surface Fire Tubes & Firebox.	Super-Heating Surface sq. ft.	Grate Area.	Boiler Pressure.	Weight on Drivers, lbs.	Total Weight, lbs.	Similar Engines.
548	4-6-0	Simple Superheater	Schmidt Smokebox	100%	18 by 24	62	1,116 sq. ft.	307	23.44	180	96,800	124,000	
616	4-6-0	Simple		100%	18 by 24	62	1,291 sq. ft.		23.44	180	95,400	119,250	
595	4-6-0	Compound	2-Cylinder Pittsburgh	100%	20 & 30 by 24	62	1,291 sq. ft.		23.54	180	96,800	123,400	
634	4-6-0	Simple		100%	18 by 24	62	1,428 sq. ft.		28.54	180	94,350	119,325	
482	4-6-0	Compound	4-Cylinder Vauclain	105%	13½ & 23 by 24	62	1,614 sq. ft.		28.54	200	94,100	129,225	
1000	4-6-0	Compound Superheater	2-Cylinder Schmidt Fire Tube	135%	22 & 35 by 26	63	1,888 sq. ft.	350	33.02	210	129,000	172,000	
997	4-6-0	Compound	2-Cylinder Pittsburgh	135%	22 & 35 by 26	62	2,420 sq. ft.		33.02	210	128,000	169,000	
1300	4-6-0	Compound Superheater	2-Cylinder Schenectady Fire Tube	150%	22 & 35 by 30	62	2,492 sq. ft.	390	44.08	200	141,000	192,000	
1319	4-6-0	Compound	2-Cylinder Schenectady	150%	22 & 35 by 30	62	3,065 sq. ft.		44.08	200	141,000	190,000	

* 100% = 20,000 lbs. draw-bar pull.

POWER REQUIRED BY MACHINE TOOLS.

The following formulæ represent average American practice, so far as the horsepower required to drive various machine tools under normal operation is concerned and are intended only as a guide in preliminary estimates based on normal conditions and normal machines. Formulæ based on the size of belts used generally call for too large a motor and are not as accurate as the following formulæ, which are taken from actual practice. The conditions under which machine tools operate are so varied that it is impossible to make any general statements which will enable all of the conditions to be taken into account. The formulæ have been based on the assumption that tools made of water hardened steel are used, and the average cutting speed has been taken in the neighborhood of 20 ft. per minute. Where high speed tool steels are used it is necessary to analyze the problem from the cut to the motor and no rule can now be made except on the basis of cutting speeds expressed in proportion to cutting speeds from the water hardened steels. Recent observations, however, indicate that the increase in power required with the high-speed tool steels is not so great as the increase in output secured.

Broadly speaking, machine tools may be divided into two classes: Those with direct rotary motion of either work or cutter, and those with reciprocating motion of either work or cutter. Under the first head come lathes, boring mills, milling machines, drill presses, etc., while the second class comprises planers, shapers, slotters, and machines of similar character. Under abnormal conditions, any of the machines covered by the formulæ are capable of absorbing horse-power in excess of those given; but such conditions must be considered abnormal, and motors specified with this point in view. In general, whatever the class of machine tool, the variable speed motor has decided advantages in the way of economical production. With the old method of speed variation by means of cone pulleys or nests of gears, coarse increments in speed only can be obtained. This invariably means that the machine tool cannot be worked up to its limit of productive capacity. With the new high speed steels, necessitating greater pulling power in belts and increased strength in gears, reasonably fine increments in speed are almost impossible, due to the increased length of the cone pulley, or the abnormally large size of the change gears required to obtain the necessary speed increments. For this reason the variable speed motor may in some cases actually decrease the cost of the machine tool by eliminating extremely bulky and expensive mechanical speed changing devices.

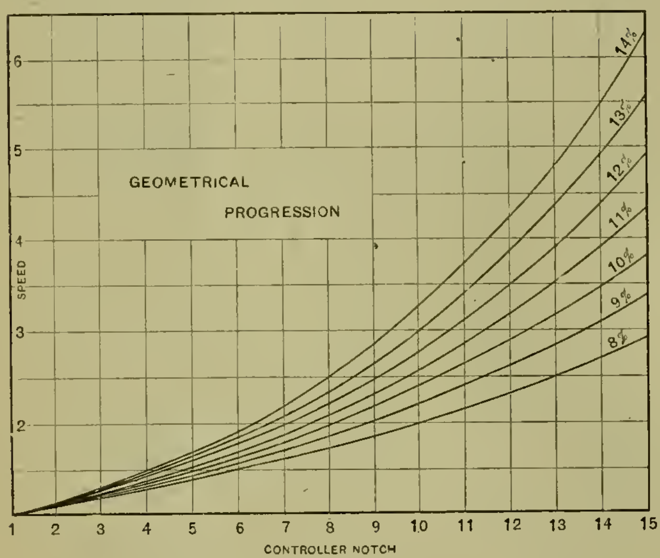


DIAGRAM SHOWING INCREASE OF SPEED BY GEOMETRICAL PROGRESSION.

The approved practice in the matter of cutting speeds is to make the ratio between the various speeds increase in geometrical progression, and as it is somewhat laborious to calculate in each case what the speeds will be on the different controller notches, the curve shown in the diagram has been prepared, with the hope that it may be of some service. This curve has been laid out on the basis of standard Westinghouse practice, in which the number of notches on the single voltage is 8, while on the double voltage 15 notches are used. The vertical represents the total increments in speed, the horizontal, the controller notches; while the curved lines each represent a certain percentage of the increase between the notches. For example: On the 15th notch of the controller, having 14 per cent. increments, the speed will be 6.25 times the initial speed.

In general, the handle of the controller used in connection with variable speed motors should be located convenient to the operator, as, for example, in the case of a lathe, good practice places the handle on the tool carriage. Connection between the controller handle and the controller proper should be made as rigid as possible, in order that the notches on the dial of the controller may correspond as nearly as possible to definite running positions on the controller. In general, the motors to be used for lathes, boring mills, drill presses, etc., should be shunt-wound, variable speed, d. c. motors, with good inherent speed regulation.

In general, if high speed tools are used, running at a higher cutting speed than that given, the increase in horse-power should be approximately proportional to the increase in speed.

Engine lathes using one cutting tool of water hardened steel at about 20 ft. per minute: H.P. = .15 S — 1 h.p. Heavy engine lathes, such as forge lathes: H.P. = .234 S — 2 h.p., where S = swing of lathe in inches.

For the operation of standard boring machines using one cutting tool of water hardened steel at approximately 20 ft. per minute, the following formula will be found to represent good practice for heavy work: H.P. = .25 S — 4 h.p., where S = swing of mill in inches.

For normal slab milling machines using water hardened steel cutters running at about 20 ft. per minute, the following formula will be found useful: H.P. = .3 W, where W = distance between housings in inches.

For normal drill presses using water hardened steel drills, running at a peripheral cutting speed of approximately 20 ft. per minute: H.P. = .06 S. For heavy radial drill presses: H.P. = .1 S, where S = capacity of drill press in inches.

Machines for reciprocating motion are from their nature less productive than those having a purely rotary motion of either cutter or work and for this reason it is especially important that they be run to the limit of their capacity. They require variable speed motors, similar to the one described in connection with rotary motion machines, except that the motor should be compound wound. The compound wound motor is useful in that at the instant of reversal, when the torque required of the motor increases very considerably above the normal, the compound winding assists materially in holding the inrush of current within reasonable limits, and this may be further improved by the use of a flywheel.

The following figures show average practice, so far as horse-power required for operation of some of the typical reciprocating machines is concerned.

Normal crank slotters, using water hardened steels at cutting speeds of from 15 to 20 ft, per minute: Stroke 10 ins., h.p. 5; stroke 18 in., h.p. 7; stroke 30 in., h.p. 10.

Shapers using water hardened tool steels at cutting speeds of from 15 to 20 ft. per minute: Stroke 16 ins., h.p. 3; stroke 18 ins., h.p. 3½; stroke 24 ins., h.p. 5; stroke 30 ins., h.p. 6½.

For normal planers using water hardened steels at cutting speeds of from 15 to 20 ft. per minute; H.P. = 3 W, where W = width between housings in feet. For heavy forged planers: H.P. = 4.92 W. These formulæ are for planers having a ratio of cutting to return speeds of approximately 1 to 3, and cover planers with two tools in operation. If more than two tools are used, or if the ratio between the forward and return speeds is more than 1 to 3, the horse-power given by above formula should be increased.

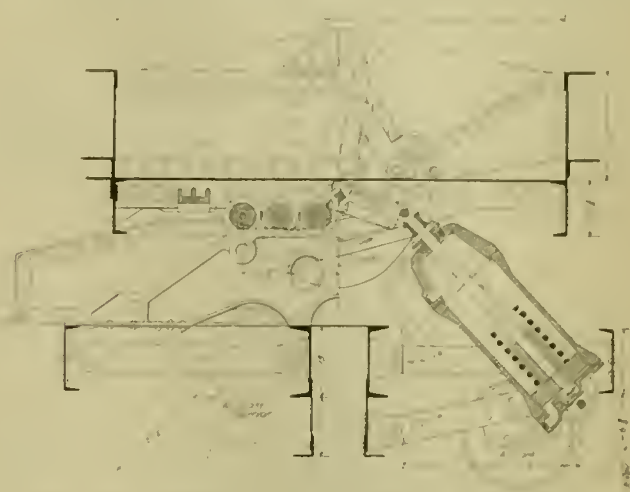
These formulae have been compiled from recent successful practice by the industrial and power department of the Westinghouse Electric & Manufacturing Company.

KING-LAWSON DUMPING CARS.

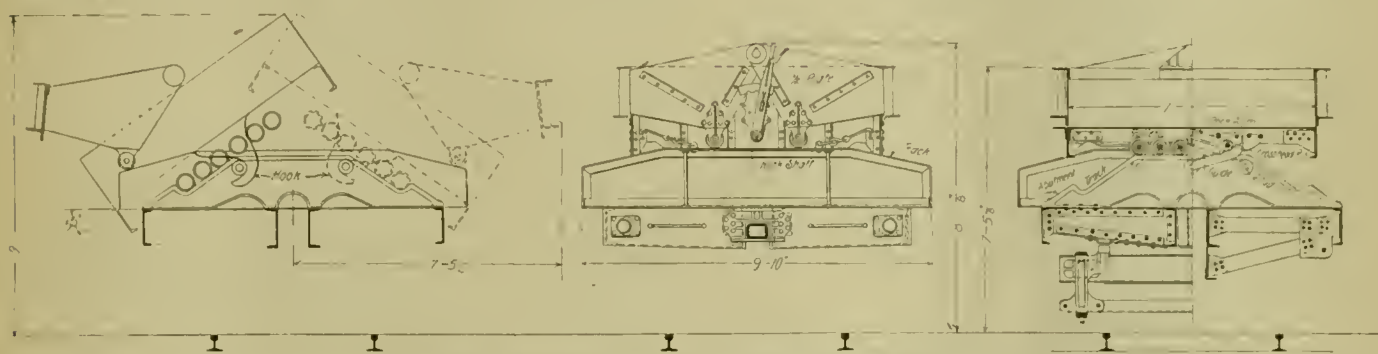
In this journal for April, 1904, page 137, the Lawson dumping car was illustrated. An improvement produced jointly by Mr. George I. King, of the Middletown Car Works, and Mr. Thomas Lawson is illustrated by these engravings. This car, which was built by the Middletown Car Works, Middletown, Pa., has a single box, dumping upon either side of the track. This car has been put into trial service on the Delaware, Lackawanna & Western Railroad. It dumps by dynamic action rather than by gravity. The box is moved 18 in. laterally from its normal position and then tipped until it comes forcibly against stops, which will shake out a refractory load, such as wet clay. The principal dimensions are given in the following table:

DIMENSIONS.

Contents of box level full	327 cu. ft.
Contents of box with 30 degree heap	515 cu. ft.
Nominal capacity	50,000 lbs.
Approximate weight	47,000 lbs.
Length over end sills	34 ft. 0 ins.
Length inside of box	28 ft. 0 ins.
Center to center of trucks	24 ft. 0 ins.
Truck wheel base	5 ft. 6 ins.
Width over side sills	8 ft. 6 ins.
Width over all	9 ft. 10 ins.
Inside width of box	7 ft 0 ins.
Inside height of box	1 ft. 8 ins.
Height from rail to top of side sill	3 ft. 6⅜ ins.
Height from rail to top of door	7 ft. 5¾ ins.
Height over all	8 ft. 1¾ in.
Height from rail to center of drawbar	2 ft. 10½ ins.



THE KING-LAWSON DUMP CAR—OPERATIVE DETAILS.



THE KING-LAWSON DUMP CAR—VARIOUS POSITIONS.

THE KING-LAWSON DUMP CAR.

The box is of steel mounted on three cast steel race rails and tipped by means of two pairs of pneumatic cylinders, connected with the train pipe. Two operating valves are connected to a reverse lever by means of which the respective pairs of cylinders are brought into use. Built up body bolsters are connected to 12-in., 25-lb. channel side sills, and 13-in., 33-lb. channel center sills. The end sills are ¼-in. plates bent to Z form and riveted to the longitudinal sill, and ¼-in. platform plates. A ¼-in. plate is used to reinforce the center sills. Connecting the side and center sills are 2 pairs of channel trusses and between the members of each pair 12-in. cast iron cylinders are hinged. These cylinders take air from 2 large storage tanks. Ten lbs. pressure will dump the car when empty and from 55 to 60 lbs. will be required when loaded.

The box is built on a steel frame with a floor of a single ⅜-in. plate. Each door is a ⅜-in. plate with flange angles. Attached to each end of each door is a heavy ½-in. plate hinged on a bracket carried by the box end at its center. The door in its normal position is carried by this bracket and the floor of the box. In dumping, the door rolls on two steel girders carried by the underframe of the car and is entirely automatic in its action. The box is supported upon 18 cast steel grooved rollers having antifriction bearings and rolling upon the cast steel race rails.

In dumping, a squared rock shaft lying under the center of the box is turned to the right or left and disengages locks permitting the box to move to the right or left. Air is then admitted to the proper pair of cylinders and the box is moved along the race rails to one side until stopped by large hooks on the bottom of the box, coming into contact with stop pins on the race rails. The box then tips under further action of the cylinders until stops on the box frame come into contact with the rail abutments. Springs in the cylinders protect these parts from shock and it is clear that the rollers are also protected from damage.

This car has been dumped on the low side of a track of which one rail was elevated 3½ ins. above the other. A load of 30 tons of pig iron mixed with car wheel scrap has been dumped in 30 seconds and 25 tons of water-soaked clay in 15 seconds, both loads being thrown entirely outside of the rails. From experiments, Mr. King believes this type of construction to be entirely satisfactory for loads up to 30 tons.

INSTRUCTIVE TESTS OF A BALDWIN BALANCED COMPOUND LOCOMOTIVE.

BURLINGTON & MISSOURI RIVER RAILROAD.

Engine No. 2,700, a Baldwin four-cylinder balanced compound, built for the Chicago, Burlington & Quincy, was illustrated in this journal in September, 1904, page 356. This engine has given remarkably good results in service, and through the courtesy of Mr. R. D. Smith, superintendent of motive power of the Burlington & Missouri River Railroad, results of tests comparing this with three simple engines on that road are presented. These results will cause even increased interest in this balanced compound.

The numbers of the four engines and their characteristics are stated in the comparative table of dimensions. The object of the tests was to determine the relative economy of the engines and their ability to fulfil the requirements on Train No. 1. The distance from McCook to Akron is 142.9 miles, and the average grade between these points is 15 ft. per mile, or 0.28 per cent. The maximum grades are 34 ft. per mile (0.64 per cent.). From Wray to Akron, 53.5 miles, the grade is 21.3 ft. per mile (0.4 per cent.), and from Wray to Eckley, 14.8 miles, there is an unbroken stretch of 34 ft. per mile (0.64 per cent.) grade.

Speed and drawbar pull were taken by the dynamometer car. An observer on the engine noted the steam pressure, injector applications, smokebox temperature and water drawn from the tank. The water measurements were taken from a float, the tank having been calibrated. The coal put on the tender was obtained from track scale weights, and that remaining at Akron was weighed on platform scales, the difference being the amount consumed on the tests. No indicator cards were taken, but the indicated tractive force was computed as follows:

Indicated tractive force equals (1) drawbar pull plus (2) engine, frictional and head resistance plus (3) engine grade resistance plus (4) resistance due to bringing the engine from a speed of zero miles per hour to the speed at which the engine was "shut off," times the number of starts. The first item is known from the dynamometer record, the second was obtained from the results of previous tests, and the third and fourth items are matters of mathematical computation. This gives the indicated horse-power to within a very small error, but of course shows nothing about steam distribution, which could be obtained only by indicator cards.

Train No. 1 usually consists of 7 cars, as follows: Mail, baggage, coach, chair car, diner, and two Pullman sleepers. This train makes three regular intermediate stops at Benkleman, Wray and Yuma. The schedule time is 3 hours 36 minutes, including the stops, or 39.7 miles per hour. Deducting 14 minutes for the stops, the average speed is 42.5 miles per hour.

Test of Engine No. 2,700.—This is an Atlantic type four-cylinder balanced compound, with 15 and 25 by 26-in. cylinders, 78-in. drivers and 3,206 square ft. of heating surface. On the tests of this engine the train was purposely delayed at Benkleman and Wray, in order to give an opportunity for making up time. On one test an extra stop was made at Wray on account of a freight train in the way. The time made up on this test with 8 cars was 16 minutes. On another test with 10 cars 28 minutes were made up. On another test with 12 cars running time was made with one extra stop.

Test of Engine No. 1,741.—This is a Prairie type simple engine, with 21 by 26-in. cylinders, 69-in. drivers and 3,080 square ft. of heating surface. On all the tests the train was late at McCook, and from ½ to 6½ minutes were made up.

Test of Engine No. 3,703.—This is an Atlantic type simple engine, with 20 by 26-in. cylinders, 78-in. drivers and 2,990 square ft. of heating surface. On one test 1½ minutes were made up, and on two tests (all with 8 cars) 2 and 8 minutes were lost, respectively.

Test of Engine No. 3,701.—This engine is like No. 3,703, except that the driving wheels are 84¼ ins. in diameter. This one had 1-16-in. positive lead in full forward gear instead of the ordinary valve setting off 1-16-in. negative lead. On all its runs an extra stop was made for water at Yuma. On one test with 8 cars 8½ minutes were made up. On another with 8 cars 7½ minutes, and on another with 9 cars 11½ minutes were made up.

In discussing the results the engine may be divided into two parts, the boiler and the cylinders. The boilers are compared by the water evaporated, from aud at 212 deg. per pound of coal for a given rate of evaporation. The cylinders are compared by the amount of steam used per indicated horse-power per hour at a given horse-power. The combination of the amount of steam furnished the cylinders by a pound of coal and the economy with which the cylinders use it determines the horse-power of the engine as limited by the boiler. On these tests the engine having the greatest horse-power run at a given speed develops the greatest tractive force. There are, however, two limits to the variations of tractive force and speed which combine to produce a constant horse-power; one is the tractive force at starting, which does not allow the engine to develop full horse-power at low speeds and the other is the maximum speed at which the steam may be worked through the cylinders.

RESULTS.

Considering the locomotives as a whole, without separating the boiler and cylinder performance, the comparative standing is as follows:

Engine No.	Rank.	Comparative Efficiency.	Coal per I. H.P. Hour.	Average I. H. P.
2700	1	100%	4.30	1,122
1741	2	93%	4.64	966
3703	3	87%	4.96	895
3701	4	85%	5.05	927

If the engines are compared by cylinder performance alone the following figures are obtained:

Engine No.	Rank.	Water consumed per I. H. P.	Water consumed per Draw-bar H. P.
2700	1	24.37 lbs.	36.78
1741	2	30.10 lbs.	46.11
3701	3	30.41 lbs.	49.54
3703	4	30.45 lbs.	48.30

It is apparent that for all engines except No. 2,700 the water rate is about 30 lbs. per indicated horse-power, the average being 30.45 lbs., while No. 2,700 used only 24.37 lbs. This saving of over 20 per cent. over the simple engines includes the figures from test No. 121, on which the compound was overloaded by a 12-car train, which it hauled on time. If this test is left out of consideration, the normal water rate for the balanced compound is 22.86 lbs. of water per indicated horse-power hour, or a saving of 25 per cent. over the consumption of the simple engines.

The figures with reference to the evaporative duty of the boilers are as follows:

Engine No.	Heating Surface.	Water per hour from and at 212 deg. Total.	Per sq. ft. Heating Surface.	Per pound of coal
1,741	2,770 sq ft.	37,530	13,55 lbs.	7.8 lbs.
3,703	2,650 sq ft.	33,784	12.75 lbs.	7.4
3,701	2,650 sq ft.	36,506	13.78 lbs.	7.22
2,700	2,881 sq. ft	31,418	11.96 lbs.	6.78

Other conditions concerning combustion are as follows:

Engine No.	Draft Vacuum.	Flue Gas Temperature.	Flues. Length.	Flues. Diameter.	Steam per 1 H.P. Hour.
1741	7.1 in.	765 deg.	18 ft. 4 in.	2¼	30.10
3703	6.7 in.	705 deg.	16 ft. 6 in.	2	30.45
3701	6.1 in.	700 deg.	16 ft. 6 in.	2	29.92
2700	4.8 in.	718 deg.	19 ft. 0 in.	2¼	24.37

As there was no coal record on test No. 122 with engine No. 3,701, the figures for this test are omitted in these averages.

It will be noticed that engine No. 2,700 shows the least economical evaporation, although the smokebox vacuum is the lowest and the flues are the longest. Of the other engines, No. 1,741, with long flues and high smokebox vacuum, gives the highest evaporation per pound of coal. In connection with the poor showing of the boiler of No. 2,700, it is worthy of mention that the crew was a new one for each day, and it was each fireman's first trip on the compound engine. No. 2,700 being a compound, and therefore having a lower water rate, uses from 20 to 25 per cent. less steam per indicated horse-power and still less coal than the simple engines.

With the same sized boiler, consequently, on his first trip with the locomotive a fireman is likely to fire too heavily. During a test there were sometimes two or three different men running the engine, which does not tend to improve the quality of the firing. It is quite possible that the draught on this engine could be increased with good results as to the economy of the evaporation.

DESCRIPTION OF LOCOMOTIVES TESTED, McCOOK TO AKRON, 1904.

Engine number	1741	3703	2700	3701
Class	R3	P2	P3 Comp.	P2
Wheel arrangement	2-6-2	4-4-2	4-4-2	4-4-2
Service	Freight or passenger	Passenger	Passenger	Passenger
Builder	Baldwin	Rogers	Baldwin	Rogers
Boiler type	Belpaire	Extended wagon top radial stay	Extended wagon top radial stay	Extended wagon top radial stay
" small diameter	65¼ ins.	65⅜ ins.	64 ins.	65⅜ ins.
" steam pressure, pounds	200	210	210	210
Fire box—Length	84 ins.	96⅛ ins.	96⅛ ins.	96⅛ ins.
" Width	72 ins.	66¼ ins.	66¼ ins.	66¼ ins.
" Height, front and rear	66¼ ins., 63¼ ins.	70⅝ ins., 68⅝ ins.	70⅝ ins., 68¾ ins.	70⅝ ins., 68⅝ ins.
Grate area, square feet	42	44.14	44.14	44.14
Tubes—Number	272	330	274	330
" Diameter outside	2¼ ins.	2 ins.	2¼ ins.	2 ins.
" Diameter inside	2.01 ins.	1.76 ins.	2.01 ins.	1.76 ins.
" Length	18 ft. 3 11-16 ins.	16 ft. 6 ins.	19 ft. 0 ins.	16 ft. 6 ins.
Heating Surface—Fire box, sq. ft.	173.6	155.5	155.5	155.5
" Tubes, inside surface	2,596.4	2,494.5	2,725.5	2,494.5
" Total	2,770.0	2,650.0	2,881	2,650.0
" Tubes, outside surface	2,906.6	2,834.5	3,050.5	2,834.5
Total	3,079.6	2,990.0	3,206	2,990.0
Cylinders—diameter and stroke	21 in. x 26 in.	20 ins. x 26 ins.	15 ins & 25 ins. x 26 ins.	20 ins. x 26. ins.
Valves	12-in. Piston	12-in. Piston	15-in. Piston	12-in. Piston
Wheels—Driving, diameter	69 ins.	78 ins.	78 ins.	84¼ ins.
" Truck, diameter	37¼ ins.	33 ins.	33 ins.	37¼ ins.
" Trailing, diameter	42½ ins.	48 ins.	48 ins.	54¼ ins.
Wheel base—Driving	13 ft. 0 ins.	7 ft. 3 ins.	7 ft 3 ins.	7 ft. 3 ins.
" Engine	28 ft. 3 ins.	27 ft. 7 ins.	30 ft. 2 ins.	27 ft. 7 ins.
" Engine and tender	55 ft. 8½ ins.	55 ft. 0¼ ins.	57 ft. 7¼ ins.	55 ft. 0¼ ins.
Weight—On drivers	131,000	91,250	92,000	91,250
" Of engine	180,500	187,000	196,600	187,000
" Of engine & tender, ½-load	263,900	270,400	280,000	270,400
Exhaust nozzle—tip diameter	5 ins.	5 ins.	5⅜ ins.	5 ins.
Tender—Water capacity, gallons	6,000	6,000	6,000	6,000
" Coal capacity, tons	12	12	12	12

The Best Locomotive.

To meet the requirements of the service engine No. 2,700 stands first on account of its low water rate. The low water rate gives it effectively a boiler of over 25 per cent. larger capacity than if it were a simple engine, or if this engine had simple cylinders a tank of 8,000 gals. would be the equivalent of the 6,6..0 gal. tank and compound cylinders. The low water rate and effectively larger boiler give the engine a higher horse-power which is needed at high speed, and this engine can run at a sustained high speed, not being limited by cylinder and valve motion design. The high horse-power and the ability to attain high speed combine to give this engine reserve capacity, which is very much needed on the McCook-Akron section in case additional cars are put on the train or when high winds or late trains are to be dealt with.

These tests were conducted by Mr. J. G. Crawford under the direction of Mr. Max H. Wickhorst, engineer of tests of the Chicago, Burlington & Quincy Railway.

SPIRALLY CORRUGATED BOILER TUBES.

Because of the interest expressed at the Master Mechanics' Association Convention last June in spirally corrugated boiler tubes for locomotives, inquiry has been made by the editor concerning their operation in service from several railway officials who are using them. Last month a letter from one of these gentlemen was presented, and with the permission of Mr. G. W. West, superintendent of motive power of the New York, Ontario & Western Railway, the following opinion, representing experience on that road, is given:

"We have been running one set of the corrugated boiler tubes for four or five years, and can only speak of them with praise. We have recently put in the second set in one of our wide firebox boilers, and have every reason to believe that they will lessen our trouble with leaky flues. We had some doubt on the start of our being able to keep the flues clean, thinking that the corrugation would clog the flues, but have had no more trouble in the clogging of flues with the corrugated tubes than with the plain ones. We know the flues require less attention than plain tubes, and I believe these tubes will keep a lot of boiler makers out of the roundhouse."

"The only thing I can add to the statement made to you some time ago in regard to the corrugated tubes is that the reports from the wide firebox boiler in one of our consolidation engines are to the effect that the engine steams more freely, uses less water and coal than others of the same class, and that there has been no trouble whatever with leaky tubes as yet."

Self Propelled Vehicles, a Practical Treatise on the Theory, Construction, Operation and Management of Automobiles. By James E. Homans. 652 paages, illustrated. Theo. Audel & Company, 63 Fifth avenue, New York, 1904. Price $2.00.

This is the second edition of this interesting book. It is valuable to the student of machinery who desires information on the methods of automobile builders, to the user of the machines, to those who are concerned in the development of internal combustion engines and to the reader who is merely interested in an important mechanical development. The author is thorough. He describes many typical constructions, goes into the theory of gasoline engines and into transmission gearing and other essentials of these machines. He presents an excellent chapter on steam automobile boilers and treats every subject for which a book would be consulted. The work is well indexed.

ELECTRIC LOCOMOTIVE TEST.

New York Central & Hudson River Railroad.

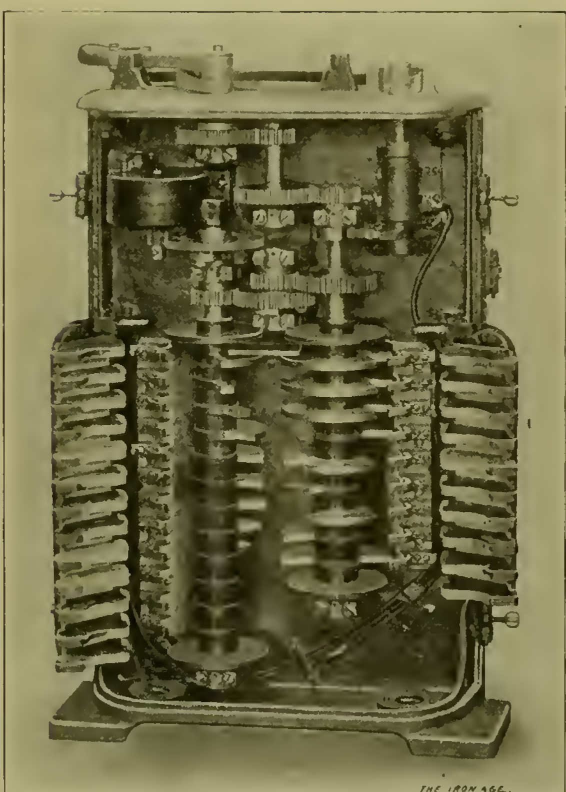
On November 12th the powerful highspeed electric locomotive designed and built by the General Electric Company and the American Locomotive Works for the New York Central & Hudson River Railroad was exhibited and tested in the presence of the Electric Traction Commission of the railroad and their guests.

The results of the trial were extremely satisfactory. This is the most important development which has taken place in this direction and this article will be followed by one in our next issue describing the constructiou of the locomotive in detail.

GENERAL DIMENSION AND DATA.

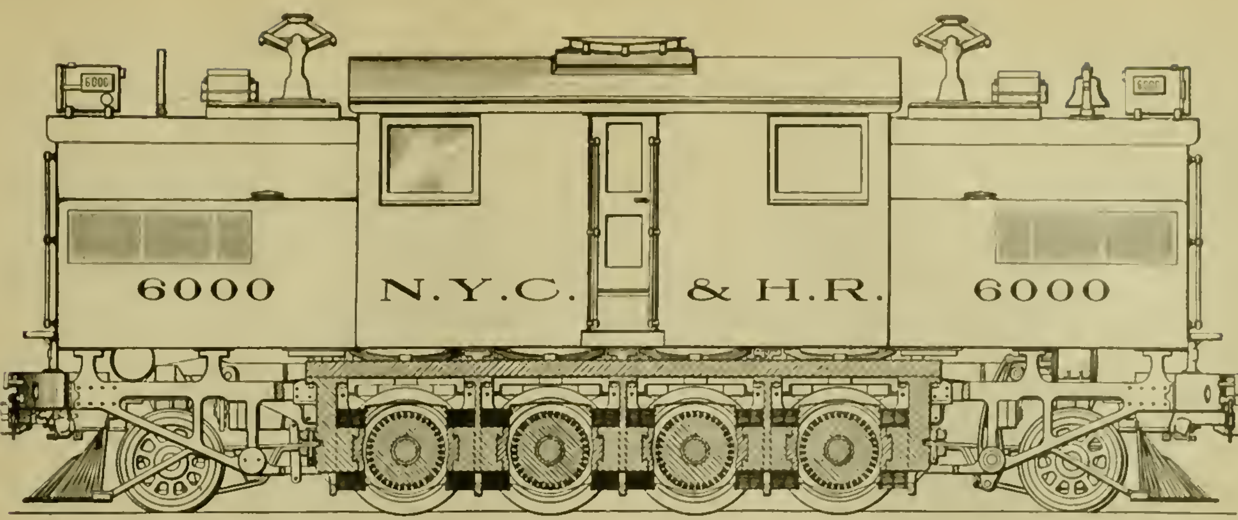
Number of driving wheels	8
Number of pony trucks	2
Weight on drivers	69 tons
Total weight	95 tons
Rigid wheel base	13 ft.
Total wheel base	27 ft.
Length over buffer platforms	37 ft.
Extreme width	10 ft.
Height to top of cab	14 ft. 4 ins.
Diameter of drivers	44 ins.
Diameter of pony truck wheels	36 ins.
Diameter of driving journals	8½ ins.
Normal rated horsepower	2,200
Maximum horsepower	3,000
Normal drawbar pull	20,400 lbs.
Maximum starting drawbar pull	32,000 lbs.
Speed with 500-ton train	60 m.p.h.
Voltage of current supply	600
Normal full load current	3,050 amperes
Maximum full load current	4,300 amperes
Number of motors	4
Type of motor	GE-84-A
Rating of each motor	550 h.p.

NEW YORK CENTRAL ELECTRIC LOCOMOTIVE WITH TRAIN.



CONTROLLER WITH COVER REMOVED, SHOWING INTERIOR.

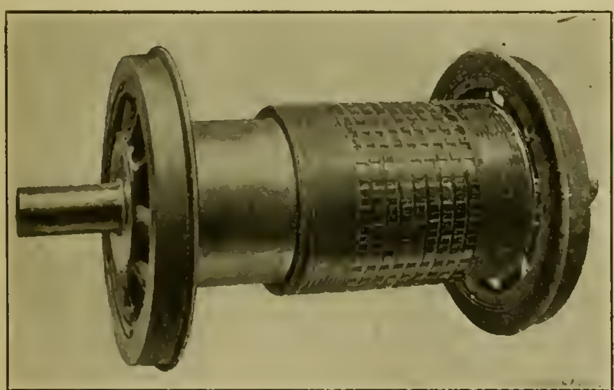
REAR VIEW OF CONTROLLER, SHOWING FUSES AND CUT-OUTS.



NEW YORK CENTRAL ELECTRIC LOCOMOTIVE—LONGITUDINAL SECTION THROUGH FRAME.

The New York Central & Hudson River Railroad Company is now electrically equipping its New York terminal for a distance of 34 miles on the main line from the Grand Central station to Croton, and for 24 miles on the Harlem Division as far as White Plains. It is the intention to handle all the traffic within this district electrically and this locomotive is one of from 30 to 50 which will be used in hauling the through passenger trains, the heaviest of which weigh 875 tons and must run at a maximum speed of 60 to 65 miles per hour.

By the use of the Sprague-General Electric multiple unit system of control, two or more locomotives can be coupled together and operated from the leading cab as a single unit. The motive power may therefore be easily adapted to the weight of the train with no complication in operation and with



ONE OF THE ARMATURE-AXLE UNITS.

uniform make-up of train crew. A single electric locomotive will be able to maintain the schedule with a 450-ton train, two locomotives being coupled together for heavier trains.

In the tests the locomotive developed remarkably easy riding qualities at high speeds and during acceleration. The designers have secured the best mechanical features of the high speed steam locomotive combined with enormous power and simplicity of control made possible by the use of the electric drive.

It is the intention of the railroad company and the General Electric Company to make complete preliminary tests and trials on these locomotives under all conditions likely to obtain in service operation. For this purpose the railroad company has set aside a 6-mile stretch of track on its main line between Schenectady and Hoffmans and equipped it with standard third rail construction. The track is practically straight and ballasted so as to permit a maximum speed of 70 to 80 miles per hour being attained.

Power for operating the locomotive is furnished by the General Electric Company, and for this purpose there has been installed in the new power house at the Schenectady plant a 2,000 k.w., three phase, 25 cycle, Curtis turbo-generator delivering 11,000 volts to the line. A special high tension transmission line has been constructed from the power station for a distance of 5 miles to the substation at Wyatts. This substation contains a 1,500-k.w., 650 volt, 25 cycle General Electric rotary converter with necessary static transformers for reducing the line potential from 11,000 to 460 volts, and a switchboard consisting of a 600-volt d.c. rotary converter panel, an a.c. starting panel and a high tension panel with electrically operated type H oil switch. The rotary converter is self-starting from the a.c. end, thus requiring no synchronizing or other complication when throwing the machine into service. The stepdown transformers are provided with taps giving 1-3, 2-3 and full voltage for starting the rotary converter, these voltages being applied successively by means of double throw lever switches. The machine starts freely and easily without sparking and without drawing more than full load current from the line.

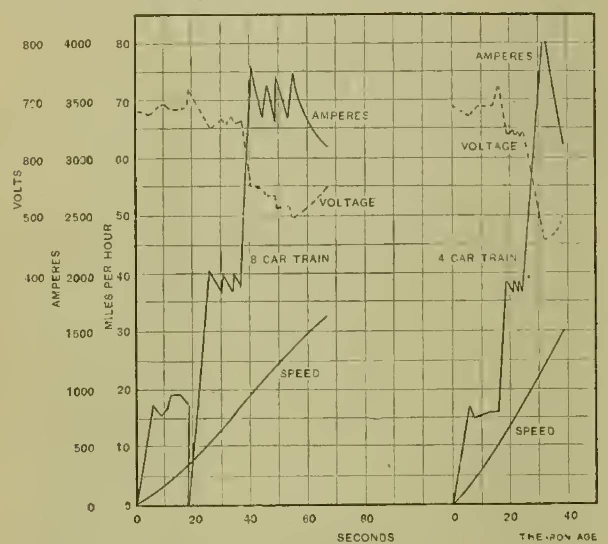
The apparatus in the substation, the location and arrangement of same, the width and dimensions are in general as proposed for the substations to be built within the electric zone at the New York City terminal, so that practical experience with the plant may be obtained while the locomotive tests are being made and in advance of the construction of these stations.

This power station, transmission line, substation equipment and 6 miles of track is undoubtedly the most complete testing plant ever provided for a trial of electric railroad motive power, and with the facilities afforded in addition to testing the new locomotives much interesting and valuable electric railroad information will unquestionably be obtained.

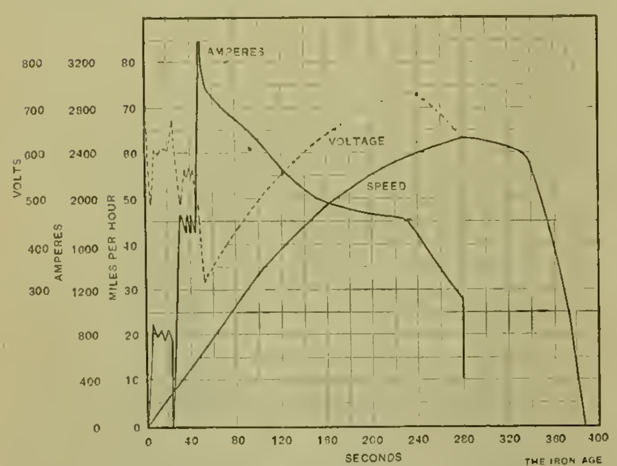
Owing to the fact that only a portion of the track to be used for testing is available as yet, no complete locomotive tests have been made. A full set of recording instruments has been installed in the cab of the locomotive, and records have been obtained of some of the preliminary runs made to test the bearings and running qualities of the locomotive. Although these records will be superseded by careful tests made on the full length of track, bonded and with sufficient feeders supplied to minimize the drop, they indicate in a general way what may be expected of the locomotive running in regular service. Two of the diagrams show the speed, current input and voltage at the locomotive all on a time basis, with an 8-car train weighing 336 tons, and a 4-car train weighing 170 tons, both exclusive of locomotive. The total weight of train, including locomotive and passengers, was 431 tons for the 8-car and 265 tons for the 4-car train.

On these two running tests as high a maximum speed as possible was reached with the length of track available. The two sets of starting tests show the more rapid rate of acceleration possible with the higher maintained voltage available near the substation. The maximum speeds reached were 63 m.p.h. with the 8-car train, and 72 m.p.h. with the 4-car train. It will be noted that the trains were still accelerating at these speeds, but the length of track so far equipped did not permit of attaining higher speeds. These locomotives are not designed for abnormally high speeds at intervals, but rather to obtain a high average schedule, due to their ability to accelerate more rapidly than is possible with the present steam locomotives.

In the starting tests a speed of 30 m.p.h. was reached in 60 seconds with an 8-car train, weighing, including the locomotive, 431 tons, corresponding to an acceleration of one-half mile per hour per second. During certain periods of the acceleration the increase in speed amounted to .6 miles per hour per second, calling for a tractive effort of approximately 27,000 lbs. This value was somewhat exceeded with the 4-car train, where a momentary input of 4,200 amperes developed a tractive effort of 31,000 lbs. with a coefficient of traction of 22.5 per cent. of the weight on drivers. The average rate of acceleration with the 4-car train, weighing, including the locomotive, 265 tons, was 30 miles in 37½ seconds, or .8 miles per hour per second, calling for an average tractive effort of 22,000 lbs.



STARTING TEST.

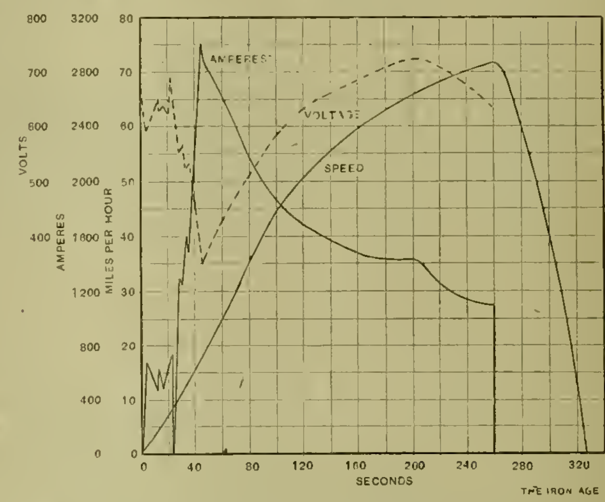


PRELIMINARY SPEED RUN NO. 1.—EIGHT-CAR TRAIN, 336 TONS; LOCOMOTIVE, 95 TONS; TOTAL, 431 TONS.

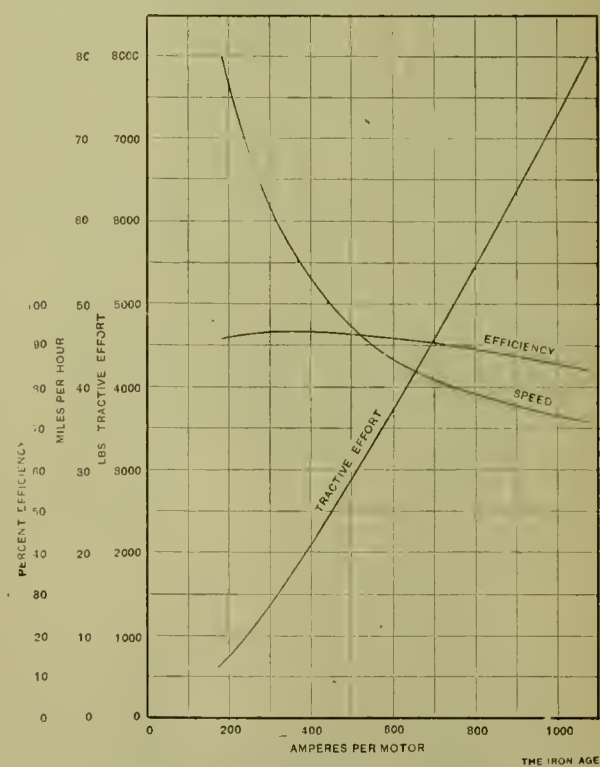
The maximum input recorded, 4,200 amperes at 460 volts, or 1,935 k.w., gives an output of the motors of 2,200 h. p. available at the wheel. With 4,200 amperes and a maintained potential of 600 volts there would have been an input to the locomotive of 2,520 k.w., corresponding to 2,870 h.p. output of the motors. This output is secured without in any way exceeding the safe commutation limit of the motors and with a coefficient of traction of only 22.5 per cent. of the weight upon the drivers, thus placing this electric locomotive in advance of any steam locomotive yet built. No service capacity temperature runs have been made as yet, and the preliminary tests have not shown any appreciable warming up of the motors.

Throughout both the starting and running tests the electric locomotive shows its remarkable steadiness in running, a distinct contrast in this respect to the steam locomotive, especially should the latter be forced to perform the work here shown to be accomplished by the electric locomotive.

The motor armatures are mounted fast to the driving axles and the elimination of gear and bearing losses permits of a very high efficiency of the locomotive. Reference to the motor



PRELIMINARY SPEED RUN NO. 2.—FOUR-CAR TRAIN, 170 TONS; LOCOMOTIVE, 95 TONS; TOTAL, 265 TONS.



CHARACTERISTIC CURVES—DIAMETER OF WHEELS, 44 INCHES; VOLTAGE, 600.

characteristics shows a maximum efficiency of approximately 93 per cent., this value being fully 4 per cent. better than possible with motors of the geared type. This gain is especially noticeable at the high speeds, the efficiency curve remaining above 90 per cent. even at the free running speed of the locomotive alone, in contrast to the 85 per cent. or less which would be a good showing for a locomotive provided with geared motors. The simple construction and high efficiency made possible with this design of gearless motor, together with the minimum cost of repairs attending such a construction, makes the direct current gearless motor type of locomotive a distinct forward step in electric locomotive construction.

WHAT MOTIVE POWER OFFICERS ARE THINKING ABOUT.

Editorial Correspondence.

It is a pleasure to announce the Discovery of the Motive Power Department by a general manager of an important railroad. (The gentleman asked that his name be concealed, as almost everybody does when they have anything important to say). He has discovered that the mechanical department never had half a chance. He finds that in one of his shops the general foreman receives $150 per month for directing the labor of men whose pay roll amounts to $60,000. This man draws much less than any engineer in freight service, and yet the fine new shops for the operation of which he is responsible cost a half million. The manager has just discovered that a big roundhouse needs a man who is equal to any emergency, ready to cope with untellable difficulties and do unheard-of repairs with facilities no better than were provided under the conditions of the days of woodburners and engines weighing 60,000 lbs. One of his roundhouse foremen had fifty engines which he was trying to keep out of the shops and nearly an equal number of new ones fresh from the builders, all of which were expected to be in clockwork order during the past winter, when everybody fell down in trying to operate our railroads. It was last winter that the discovery was made, and the motive power department may live to see great benefits from that season of trial and grief. This general manager said that he did not understand how motive power superintendents got along at all, and he promises, for one, to "look into the matter and see what can be done."

What needs to be done is that which has long been done abroad—put the motive power department upon an independent basis, give the head of the department independent authority, allow him to build up his organization on a basis of efficiency, and then hold him responsible for results. He should have a salary instead of a remittance on account, and the position should be such that the best men cannot afford to step out because of superior attractions in other lines of activity. Not until this is done will American railroads have the benefit of the mechanical skill which they so greatly need.

It is encouraging to have a railroad president say (though editors have often said it) that the motive power problems of a great railroad system cannot be properly dealt with by any officer lower in grade and authority than a vice-president, reporting only to the president. "What we need," he said, "is a mechanical vice-president who has grown up in the motive power department." To hear such a remark is the crowning triumph of a good trip about the country. Where there is so much smoke there must be some fire.

The roundhouse has been a storm center, especially since the unusual congestion of traffic combined with the severe weather last winter. Many motive power men now find it easier to secure appropriations for improvements in handling locomotives at terminals, and the writer has seen several comprehensive and interesting plans for new roundhouses which are soon to be built. The mention of engine failures and roundhouse facilities brought instant response on a number of roads.

In one case, and it is to be hoped that there is only one such in the country, a strange lack of business capacity on the part of the operating department was revealed. After exacting a promise not to use his name, a superintendent of motive power stated that the division superintendents on his road made a practice of ordering engines when not needed, merely to keep one on hand for emergencies and "to keep it up to the master mechanics to have their engines ready—in other words, to keep the motive power department continuously in a hole." This gentleman showed me a telegram complaining because an engine was not ready which had not at the time arrived at the terminal. I have heard of such things, but never saw the evidence until now. A little intelligent co-operation would mean something to the stockholders of that road.

It is evident that the motive power department needs to be studied attentively by managing officers, who, as a rule, do not come into close enough contact with the motive power problems to understand them.

Apprenticeship is in as bad a condition as ever among the railroads visited. In two cases considerable interest was expressed in the subject, but it is incomprehensible that nothing is done. The railroads are paying dearly for neglecting apprentices. They will awake, but perhaps too late, to the facts. Subordinate officials may claim to be too busy to think about apprentices, but before long some one must have sufficient leisure to establish apprenticeship properly or all kinds of bad things will result, such as would naturally be expected from neglect of the system of recruiting the workmen of the future. Every year of delay will increase the difficulties of the next generation of managements as well as this generation.

An adequate apprenticeship system requires as a foundation a stable and businesslike official organization, with a well established policy which will take the future into consideration. The writer was asked whether anyone is doing anything to meet the apprentice problem, and he was obliged to say that he did not know of one railroad on which the problem is even fully understood.

It would be impossible to state the vital needs of the apprentices too strongly. The apprentice is the embryo shop man, and probably also the embryo officer, of the future. The educational aspects of his case constitute the vital question of the labor and organization problems of the future. Why should it be so neglected?

In connection with the World's Fair at St. Louis the Baldwin Locomotive Works are doing a nice thing for their apprentices. They are sent to the exhibit at the fair to stay three weeks, and two are changed every week. There are usually six there at a time. For two weeks the boys work about the exhibit and the other week they are left to themselves to visit the fair. All their expenses are paid, and on returning to Philadelphia each is required to write a report of something he saw. This plan is good for the boys and good for the firm. It is typical of the factors which bring the loyalty which is everywhere apparent among past or present employees of the Baldwin Works. The educational value to the boys is immense and the reports prepared by them are said to be very interesting.

At the St. Louis Exposition the writer ran across several groups of motive power men who were "doing" the exhibits together. In one case a superintendent of motive power had seven of his master mechanics with him and another had three. These people had arranged beforehand to meet the various exhibitors on certain days, and they got a lot more out of the exhibits than if they went independently and alone. The writer was invited to join one of these groups and found it remarkably helpful studying the various improvements. There seems to be a growing tendency toward "team work" on the railroads. A number of heads of departments are bringing up their subordinates to completely handle details, in order that the big business questions of the motive power problem may have appropriate attention. This tendency is marked and it is exceedingly important.

Five years ago, when this journal began a quiet campaign in favor of 4-cylinder balanced compounds, the railroad men were cold and would scarcely admit the subject into their conversations. Now all are watching them on the Pennsylvania and Santa Fe, the Burlington and the New York Central with intense interest and two roads wish to borrow one of these engines to investigate its merits. When the New York Central and the Pennsylvania engines are released from the World's Fair exhibits much more will be heard about them. The merits of this system of construction seem now to be so well established as to confirm the prediction of this journal that the 4-cylinder balanced compound principle will constitute the line of the immediate development of American practice.

Everybody is ready to talk about improving shop practice and everybody has improved records from certain machines, while some have remarkable results to show. One gentleman said: "We are up against shop improvement in earnest. Wages are advancing. For instance, our boiler makers' rates have gone up an average of 17 per cent. in the past two years. Increased production of machinery and improved shop methods are necessary to enable us to hold our own against increased cost of labor. We must improve machinery and methods of doing work and handling material, but we do not find the support we ought to have in the form of appropriations for new machinery."

VAUCLAIN FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE.

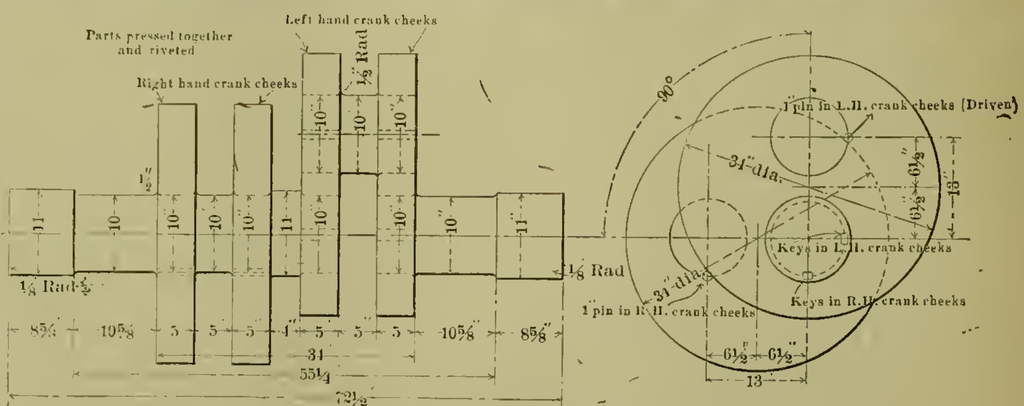
4—6—0 TYPE.

NEW YORK, NEW HAVEN & HARTFORD RAILWAY.

The Baldwin Locomotive Works have built two of the 4-cylinder balanced compounds illustrated in the accompanying engraving in a lot of 20 passenger locomotives recently delivered to the New York, New Haven & Hartford Railroad. These locomotives are not heavy, in general appearance they resemble ordinary 4—6—0 construction, with the connecting rods coupled to the leading pair of drivers. Except as to the firebox and tender, these engines bear a strong resemblance to the first balanced compound from these works, which was built for the Plant system and illustrated in this journal in March, 1902, page 72. The present engines have narrow fireboxes.

VAUCLAIN FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE—NEW YORK, NEW HAVEN & HARTFORD RAILROAD.

The introduction of the 4-cylinder balanced compound on this road is interesting because the present bridges limit the allowable weight on driving wheels and prevent the operation of such heavy locomotives as are really required to meet present conditions. It is significant of the value of this balanced type of construction that the eighteen simple engines of this order are limited to a weight of about 110,000 lbs. on driving wheels, whereas the balanced engines are allowed 123.000 lbs. In general features the two designs are very much alike, except as to the factors introduced into the two compounds by balancing.



BUILT-UP CRANK AXLE.

The experience with these engines on this road will be watched with marked interest because of the fact that there seems to be something about the 4-cylinder balanced principle which leads to a remarkable duty in service, which cannot be entirely accounted for on theoretical grounds. The Burlington engine No. 2700, the report of tests of which is presented elsewhere in this issue, by its work justifies this statement.

In connection with these New Haven engines the built-up crank axle is interesting. These axles are made of the built-up type in order to insure the proper "working" of the material used in the cheeks and crank pins, which is believed cannot be properly secured in an axle of the forged type. These built-up axles are put together with a pressure of about 110 tons, and it is believed that in addition to the proper working of the metal, which can be secured in this construction, an additional safeguard is provided against fracture by providing an elasticity at the joints, which it may be expected to prevent failure by fracture. If a crank axle is to fail it is much better that it should become loose than to break. This step is in accord with recent locomotive practice abroad, where crank axles of large size are usually made of the built-up construction.

The dimensions of the compound locomotive are presented in the accompanying table.

BALANCED COMPOUND PASSENGER LOCOMOTIVES.

4-6-2 TYPE N. Y., N. H. & H. R. R.

Gauge	4 ft. 8½ ins.
Cylinder	15 ins. and 25 ins. by 26 ins.
Valve	balanced piston

BOILER.

Type	wagon top
Diameter	60 ins.
Thickness of sheets	9-16 ins., 11-16 ins., ⅝ ins.
Working pressure	200 lbs.
Fuel	soft coal
Staying	radial

FIRE BOX.

Length	120⅝ ins.
Width	41½ ins.
Depth front	73 ins.
Depth back	62 ins.
Thickness of sheets, sides, ⅜ in., back, ⅜ in., crown, ⅜ in., tube, ½ in.	

WATER SPACE.

Front	4 ins.
Sides	3 ins.
Back	3 ins.

TUBES.

Material	iron
Wire gauge	No. 12
Number	318
Diameter	2 ins
Length	15 ft. 1 ins.

HEATING SURFACE.

Fire box	168.5 sq. ft.
Tubes	2497.5 sq. ft.
Total	2666 sq. ft.
Grate area	34 69 sq. ft.

DRIVING WHEELS.

Diameter of outside	72 ins.
Diameter of inside	66 ins.
Journals, main	10 ins. by 10½ ins.
Journals, others	8½ ins. by 12 ins.

ENGINE TRUCK WHEELS.

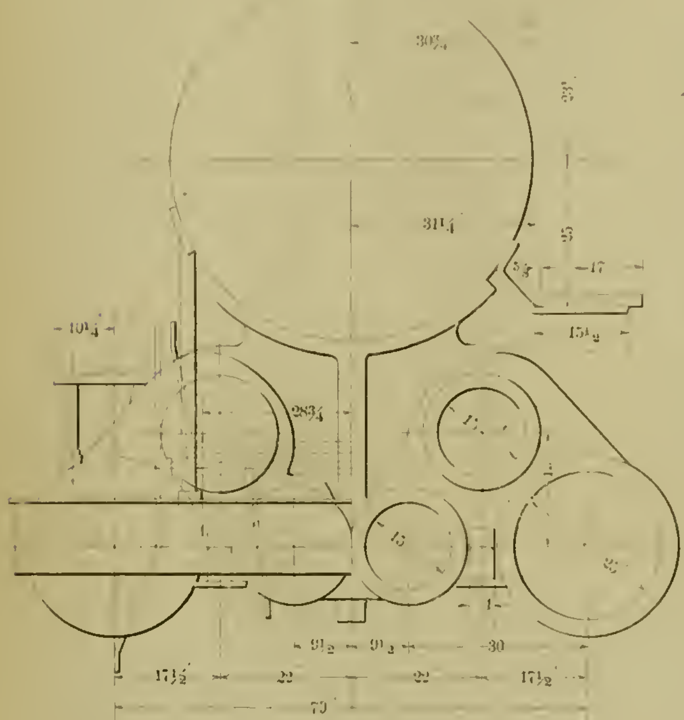
Front, diameter	33 ins.
Journals	5¼ ins. by 10 ins.

WHEEL BASE.

Driving	13 ft. 6 ins.
Rigid	13 ft. 6 ins.
Total engine	27 ft. 5 ins.
Total engine and tender	56 ft. 8 ins.

WEIGHT.

On driving wheels	123,100 lbs.
On truck, front	37,500 lbs.
Total engine	160,600 lbs.
Total engine and tender	about 270,000 lbs.



HALF-END VIEW AND SECTIONS THROUGH CYLINDERS.

TENDER.

Wheels No.	8
Wheels diameter	33 ins.
Journals	5 ins. by 9 ins.
Tank capacity	5,500 gals.

FIRE RISKS OF RAILROAD SHOPS.

Opinions of an Insurance Expert.

Whether railroad companies insure their shops themselves or with the insurance companies, the question of fire risks is always important. In many cases the only precaution, aside from providing hose reels in the buildings and hydrants in the yards, is the separation of the buildings by distances supposed to be sufficient to guard against a general conflagration in case one of the buildings takes fire. Automatic sprinkler systems are not used as generally in these shops as in other industrial establishments. Having this fact in mind, and also the popular impression that steel roof trusses will resist fire better than those of wood, the editor of this journal consulted Mr. John R. Freeman, widely known as an experienced expert on these questions. Mr. Freeman's statements are so explicit and so valuable as to commend themselves to our readers. He says:

I am a most hearty believer in slow-burning construction with timbers rather than steel trusses, and also a believer in the saw-tooth roof.

The result of our experience is a most earnest recommendation of complete sprinkler protection for substantially every building of a great railroad shop. Sprinkler protection is fourfold more effective in lessening the fire hazard than is a mere subdivision and isolation of the buildings without sprinkler protection.

In railroad shops, the woodworking and the painting must always remain extra-hazardous, and these departments should have isolated buildings. The interior of a box car, and especially the interior of a coach during the varnishing and finishing process, are extra hazardous and present so large an area shielded from the direct action of water from the sprinklers that is is conceivable that a fire within may obtain sufficient volume so that when it bursts out it will open a good many sprinklers, and make extraordinary demands on the water supply. I believe that the cases will be found extremely rare where sprinklers will not confine a fire of this kind to the car in which it originates, but causing very likely considerable smoke and water damage to the surrounding property.

The machine shop, smith shop, and the foundry must naturally be cut off from one another to insure freedom from dust and dirt, and so these buildings should be isolated or stand end to end and be cut off from one another by first-class fire walls.

For the main machine shop, there will seldom be occasion for one so large that it cannot remain a single area unobstructed by any partition. We, of course, realize that the more a large shop is subdivided by fire walls, the better insurance risk it becomes, but on the other hand, we recognize that absence of partitions favors low cost of production and we try not to stand in the way of the best economy.

We now insure one-story machine shops from 600 to 800 ft. in length, and from 100 to 200 ft. or more in width, without hesitation, and at a rate not materially higher than for smaller shops, providing the construction is first-class, and the sprinkler and hydrant system complete, and the net cost of this insurance in our companies for the past five years has averaged considerably less than 1-10 of 1 per cent. per annum, which you can easily figure out presupposes that the building and its contents will not be completely burned up as often as once in a thousand years.

We have come to make no distinction between buildings having their roofs supported by steel trusses and those supported by timber, although our experience demonstrates that the slow burning plank and timber construction will resist fire far better than any steel truss construction. We have found that with complete sprinkler protection, there is very little danger of the fire reaching such proportions that the trusses get heated to the warping or yielding point, but without sprinklers a brisk fire of 10 minutes' duration can completely warp a steel truss where a 12 x 16-in. Georgia pine beam 25 ft. in length could stand for an hour before it would yield.

Personally, I am a very strong advocate of the saw-tooth roof, and believe it well adapted to car shop work. Some care and skill are needed in working out the design to avoid condensation drip, and to avoid trouble from snow in northern latitudes, but it presents no unsolved problem, and will afford far better light than any roof of the monitor type, and is much easier to heat and much safer against fire than any steep lantern roof.

We may also look forward to the time, not far ahead, when recording instruments on the tools will give the superintendent a check on production and on the individual operator, that will enable him to keep track of the "personal equation" in the shape of lazy workmen in a most accurate and impartial manner, with corresponding benefits to the output of his tools, the dividends of the stockholders and the pay envelope of the diligent mechanic.—*F. B. Duncan, Franklin Institute.*

The largest all wood pulley ever built is on exhibition at the St. Louis Exposition. It is 20 ft. in diameter, has a 50-in. face and a 20-in. bore and is composed of over 11,000 pieces. It will transmit 1,500 h.p. and was made by the Reeves Pulley Company.

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Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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Not one superintendent of motive power in this country has all of the facilities and equipment which he needs in order to keep up his locomotives and cars to their highest standard of efficiency. The railroads are waking up to the importance of improved machinery and improved methods, and we hope general managers will soon give unrestricted assistance in providing shop equipment which will permit of economical maintenance of rolling stock. This journal is alive to the need, and is endeavoring to assist motive power men by informing them of every important step in progress. It is only fair to ask for co-operation in an effort to help motive power men in their work. We ask a simple and easy thing, merely that the readers will mention this journal in asking for information concerning improvements in machine tools or other developments described in our pages.

The results of the preliminary tests of the New York Central & Hudson River Railroad electric locomotive, described on another page of this issue, are very gratifying. The General Electric Company and the American Locomotive Company, who designed and built it, have introduced some very radical changes in design from that of previous locomotives of this type which have greatly increased its efficiency. The quick acceleration, the easy riding at all speeds, the large, roomy cab, the absence of smoke and steam, and the fact that the engineer has a large, wide cab window, which enables him to see the full width of the track to within a few feet of the front of the locomotive, are qualities that forcibly impress one accustomed to riding a steam locomotive. With a greater length of track for the test and better bonding of the rails, it is reasonable to expect even a better showing than has thus far been made. The high efficiency of the locomotive over a wide range of speed is remarkable.

A manufacturer who had fitted up his shop with motor drives thought his power bills too large. He thought it due to wastefulness and took his men to task. The next power bill was some 40 per cent. less and he was pleased—until he discovered that the output of the shop was reduced correspondingly. He then wisely told the men that he wished large power bills, his reason being that the power was almost a direct measure of the output. He next bought recording watt meters and kept close watch of the power used in the different groups of machines, all of which led to a marked increase of output. Wattmeters might be used with great advantage in checking the work of departments and they should be more often used for this purpose.

Those who first applied individual motors to machine tools had very little information as to the amount of power required by the various tools and based their calculations on the size of belt used. But this method was not very satisfactory. Another method which was based on early experiments in motor driven tools and which gave fairly good results for machines on which either the work or the cutter rotated was to multiply the number of cubic inches of material removed per minute by a constant depending upon the material being machined. The formulæ given in an article in this issue are derived from actual practice and each type of machine is treated by itself. They are intended for preliminary estimates only.

The use of dull or poorly ground tools means that both time and power are being wasted and that a poor grade of work is being turned out. The purpose of the article on "Tool and Cutter Grinders," on another page of this issue, is to indicate certain types of grinding machines which it is essential to have in every well equipped railroad machine shop. This includes tool grinding and shaping machines for tools such as are used on lathes, planers, slotters and boring mills; universal tool and cutter grinders for milling machines, cutters of all kinds and such tools as reamers, counter-borers, etc.; and drill grinders adapted for sharpening both flat or twist drills. Self-contained motor driven emery wheels should be scattered through the shop, especially on the erecting side. These may be used to very great advantage for smoothing off castings or other kinds of work, in place of using a file, but should not be used to any great extent for sharpening tools, as this work should be concentrated in the tool room, where it can be handled by unskilled labor.

A record of a reduction of 56 per cent. in boiler-makers force, and a decrease of 80 per cent. in engine failures, accompanied by an increase of 6 per cent. in tonnage handled and a reduction of 4 per cent. in the number of locomotives required to do the work, is one which should bring the subject of water purification forcibly to the attention of managers and presidents. These results, as obtained on the Chicago & North Western, we describe on another page of this issue and no more forceful argument for liberal investments in water purifying plants can be required. Engine failures are becoming the subject of rigid investigation everywhere, and if no other advantage than their reduction is obtained the cost of the plants is fully justified. It is safe to say that the experience of this road may be repeated, and even in many cases surpassed, by other roads where the water is worse and the locomotives are of heavier types. This journal maintains that there is no plainer duty lying before railroad managements than the installation of apparatus for improving locomotive boiler feed water. In bad water districts nearly every boiler shop is overtaxed and men of the right sort to contend with the work are growing scarcer. Their wages are advancing, which constitutes another strong argument for a broad-minded business policy in this important matter.

It is a good plan to educate your successor so that when you are wanted for a higher position some one is ready to carry on your work. Taking this precaution indicates a broad-minded way of dealing with subordinates, and a man who prepares for promotion in this way usually receives it because his subordinates are helping him make his record. A young railroad officer, whose advancement is announced in this issue, is promoted largely because his whole outfit of subordinates were competent to carry on his work while he was called away temporarily for important special service. This is not merely good policy; it is an excellent business principle.

THE BEST LOCOMOTIVE.

Under this heading on another page of this issue a four-cylinder balanced compound locomotive is shown to provide the equivalent of 25 per cent. more boiler capacity than if it had simple cylinders with the same boiler. If a better record of the advantages of a compound over a simple locomotive has appeared in print the writer does not know it. A steam consumption of 22.86 lbs. per indicated horse-power per hour for a large modern locomotive is a remarkable result, and the Burlington tests are therefore specially noteworthy. The fact that the results come from the Aurora laboratory organization is a sufficient guarantee of their accuracy and trustworthiness.

These tests show nothing concerning the smoothness of working of the balanced compound or of its effect on the track. On another road the officials say that the saving in track repairs due to the use of the balanced compounds lead them to wish for no other than balanced engines.

To those who have expected much of the balanced compounds these tests and the opinions of the officials referred to are exceedingly gratifying.

A PREFACE IN SUPERHEATING.

It is significant that the Canadian Pacific, being the road on which the superheater was first applied to a locomotive in American practice, should be the first to take up the practice on a large scale. The reasons for this are stated in connection with a description, in this number, of new locomotives just completed for the Canadian Pacific, the statements being quoted as exactly as possible from the words of Mr. Vaughan. Thus far there seems to be no reason to believe that superheating will be anything but satisfactory; at all events, nothing of an unsatisfactory nature has thus far developed on that road. The table of figures, taken from performance sheets, is not entirely satisfactory as measure of the value of superheating, but it certainly justifies the step taken by the Canadian Pacific. The enginemen like these engines, and the firemen at once noticed a reduction in the amount of coal required. This indicates the possibilities for increasing the capacity of present locomotives, and because superheaters are easily applied to old as well as new locomotives, this principle seems to be one of very great importance. It will mean much to the railroads of this country if many engines which are deficient in boiler capacity may, by the addition of the superheater, be improved in effectiveness from 25 to 30 per cent. If the promises of the present are fulfilled, this will place in the hands of motive power officials that which they have long wanted, a means for improving existing locomotives as well as new ones, rendering them capable of dealing with conditions which have far outstripped their capacity. The decision of the Canadian Pacific may therefore be considered a most important one, and it is likely to mark a new epoch in American locomotive practice which no railroad official can afford to ignore. The beauty of the superheater is that, while revolutionizing in results, it is very simple mechanically; its use involves no radical changes in practice except, perhaps, in lubrication, and in this all will agree a revolutionary improvement is required for ordinary engines.

BOILER REPAIRS WITH TREATED WATER.

Records From Chicago & North Western Railway.

The results in a reduction of boiler repairs and failures due to flue leakage which are being obtained through the introduction of water treating plants are now becoming available after two or more years of service. The Chicago & North Western has installed a sufficient number of plants to supply good water to the locomotives running into Clinton and Boone, Iowa, and Mr. Robert Quayle, superintendent of motive power, has courteously granted permission for the publication of a report by Mr. F. G. Benjamin, master mechanic at Clinton, which contains valuable information of the sort that is greatly needed. This record does not represent all the advantages to be had from the treating plants, because about 15 per cent. of the locomotives had not been through the shops for general repairs during the period covered by the report, and these boilers have never been freed entirely from scale to give the treated water a perfectly fair chance. From the report the following is taken:

With reference to the reduction that has been made in the cost of operating locomotives in Iowa, due to the installation of water purifying plants, it is a little difficult to say exactly what reductions have been made because of other influences besides the purified water that may affect the decreased costs. The following figures, however, are submitted in testimony of the benefits derived from this purified water. The boilermaker force, for instance, has been decreased as follows: In 1902 there were at Clinton and Boone an average of 36 boilermakers, costing $10.40 an hour, and 42 boilermaker helpers, costing $7.09 per hour, while in 1903 and thus far in 1904 an average of 23 boilermakers at an average cost of $7.71 per hour and 35 boilermaker helpers at an average cost of $6.70 an hour have been sufficient. This means that the boilermaker force has decreased 56 per cent. and the cost for boilermakers has decreased 21.4 per cent. The larger percentage of the men being boilermakers and the increased compensation received by boilermakers makes the difference in the percentage of force employed and the cost of the labor.

This is not the only result, however, that has been produced, as the decreased number of boilermakers with the beneficial results from the treated water together have permitted the engines to be kept in such condition that the number of engine failures has dropped off to a remarkable degree. Below is a comparison of the failures due to leaky conditions in 1902 and 1903:

	1902.	1903.
Leaky flues	463	330
Leaky fireboxes	31	26
Leaky arch tubes	6	2
Total	500	358

From this it will be seen that the failures on account of leaky flues in 1903 over 1902 was reduced 30 per cent.

The greatest benefits, however, from treated water did not seem to be reached until along in August, 1903, and a comparison of the results from August, 1902, to and including June, 1903, and August, 1903, to and including June, 1904, shows the following very gratifying results:

	Aug., 1902, to and including June, 1903.	Aug., 1903, to and including June, 1904
Leaky flues	544	99
Leaky fireboxes	33	20
Leaky arch tubes	6	1
Total	583	120

This gives us a reduction of 80 per cent. in failures due to leaky conditions in these months. These improved results in engine failures in 1903 over 1902 have been made with conditions that show a heavier ton mileage in 1903 than in 1902, showing that the engines were worked up to their full capacity and even under these conditions, made such an improvement.

The total ton mileage for 1902 was 2,934,130,377 ton miles and this tonnage was handled at a cost of 28.7 lbs. of coal per

100 ton miles. In 1903 the total was 3,154,484,507 ton miles at a cost of 27.5 lbs. of coal. From this it will be seen that an increase of 6.6 per cent. in ton mileage was handled during the year 1903 over the previous year, and that this work has been done with an average assignment of 159 engines in 1902, as compared with an average assignment of 154 engines in 1903, a saving of 4 per cent. in the number of engines. In each of the years, 83 per cent. of the engines assigned were in constant service.

From the above figures it will be seen that the boilermaker force was reduced 56 per cent.; the cost of boilermakers 21.4 per cent.; engine failures decreased 80 per cent.; an increased tonnage of 6.6 per cent. was handled, and the number of engines in service decreased 4 per cent.

It is rather difficult to say to what extent the cost for material and labor has been affected by this item, but it is safe to say that a very material decrease has been affected in this direction, as engines are being taken into the shops right along which required flues reset and new side sheets, where now repairs to machinery and resetting a portion of the flues is sufficient, thereby placing the engines in serviceable condition for from six to eight additional months before it is necessary to do the work that formerly would have to be done on the engines when first taken in under previous conditions.

There are a number of things that can be mentioned in connection with this as being beneficial, but which cannot be computed in dollars and cents, among which may be enumerated the benefits derived as follows: First, from the short time required for engines to go over the road, due to less engine failures and delays on account of leaking; second, a better tone and feeling among our men, which necessarily means better service; third, longer time at terminals, which means more time to work on engines, consequently the engines are in better condition; fourth, less coal is consumed, other conditions being equal, because they are less hours on the road, and the destruction of the encrusting matter on the flues and firebox sheets means a higher evaporating power of the fuel consumed; fifth, there is less expense in the cost of delay and overtime because of the shorter time the engines will have necessarily been on the road; sixth, relief engines are not sent out to protect important passenger and mail trains, or to protect trains on stock nights, as was formerly necessary.

All of these things cannot be stated in cost in dollars and cents, but they all count for economy and better results.

PLANT OF THE LOCOMOTIVE & MACHINE COMPANY OF MONTREAL.

The American Locomotive Company has recently acquired the plant of the Locomotive & Machine Company of Montreal, Canada. This Montreal plant is operated under its original corporate name (The Locomotive & Machine Company of Montreal, Limited); there is a local manager and staff at the works, and a city office at Montreal, while the general offices are located at New York.

The plant is located some 6 miles to the eastward of the heart of the city of Montreal, being actually in the Parish of Longue Pointe, Quebec. The plot, covering 63 acres, extends from the St. Lawrence River on the south, to the right of way of the Great Northern Railway and the Montreal Terminal Railway at the north. The plant is provided with a complete system of tracks, connecting the various buildings with the two railways mentioned, and through them to all the lines which radiate from Montreal. The Government is constructing a dock and basin on the river front, from which water shipments may be made, and at which supply materials may be received.

LOCOMOTIVE & MACHINE COMPANY OF MONTREAL.
VIEW OF MACHINE SHOP AND OFFICE BUILDING.

The plant is seen to comprise a main building (including 5 principal departments), a power plant, a carpenter and pattern shop, a pattern storehouse, a structural shop and a scrap house. It is the most compact locomotive building plant in America, the arrangement of the several departments of the main building securing the free interchange of material and minimum distances to be traversed.

The main building includes a machine shop 132 ft. x 420 ft., also a forge and smith shop and erecting shop, a boiler shop and a foundry, each 66 ft. x 380 ft. The machine shop is divided into two bays by a central line of columns. Electric traveling cranes are provided as follows: Machine shop, 4, 10-ton; erecting shop, 2, 60-ton; boiler shop, 1, 20-ton; foundry, 2, 15-ton. In adition to these there are in the riveting tower of the boiler shop 2, 20-ton and 1, 10-ton hydraulic traveling cranes. All departments are provided with ordinary swing cranes; the provision of cranes of this class being extremely liberal.

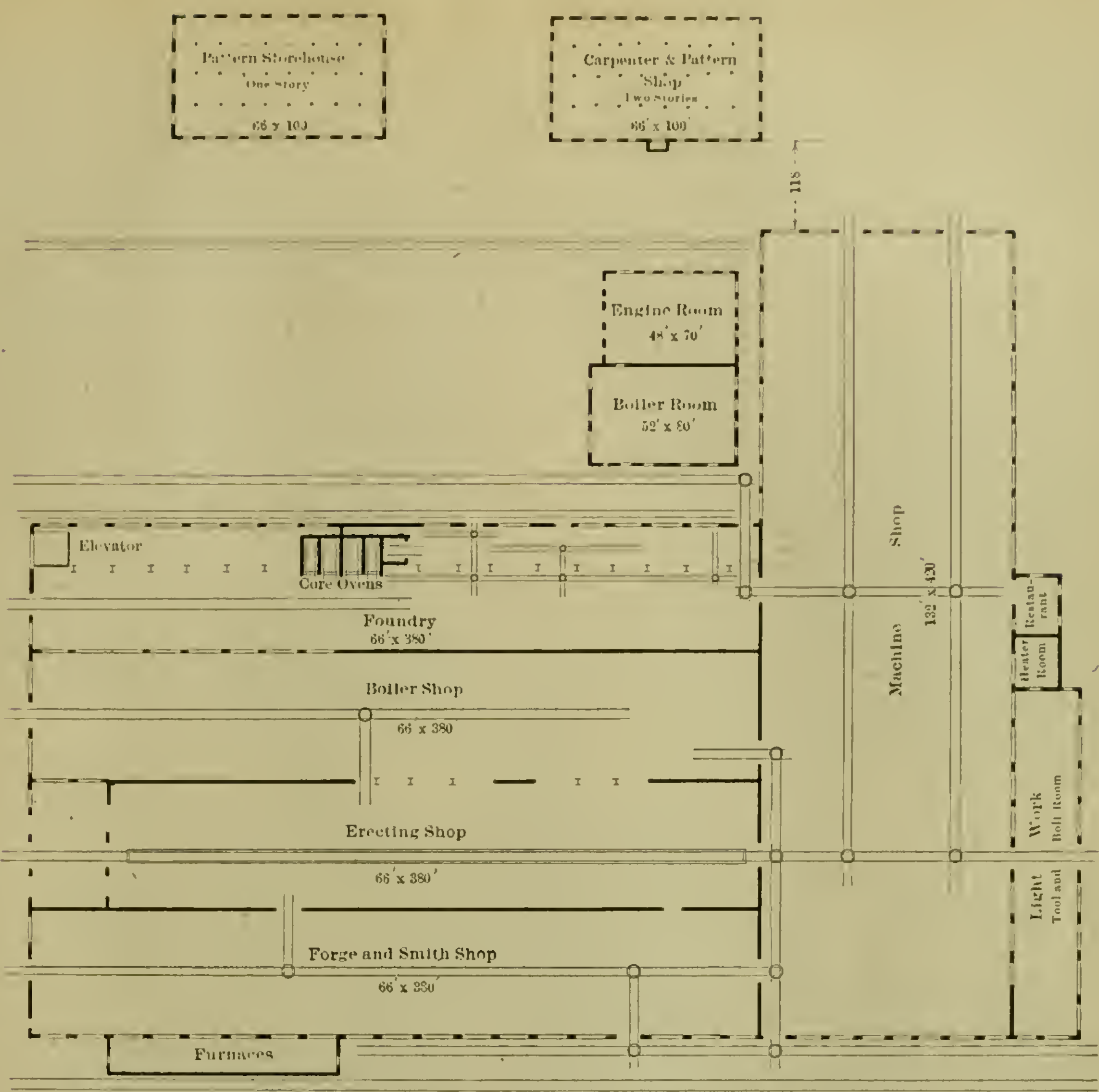
The pattern and carpenter shop is 66 ft. x 100 ft. and is of two stories. The pattern storehouse, adjacent to this building, is of the same size, but of one story. A storehouse and office building is located at the southwest corner of the main building.

There is also a large structural shop, 200 ft. x 300 ft., with but two posts within the entire floor area. Conditions existing in Canada justified the expectation that a structural shop, operated in connection with this locomotive building plant would be a profitable enterprise. It is especially designed and perfectly adapted to general structural work, either the building of bridges or trusses, steel work, etc., for steel buildings, and a great deal of work of this character has already been done and is now under way.

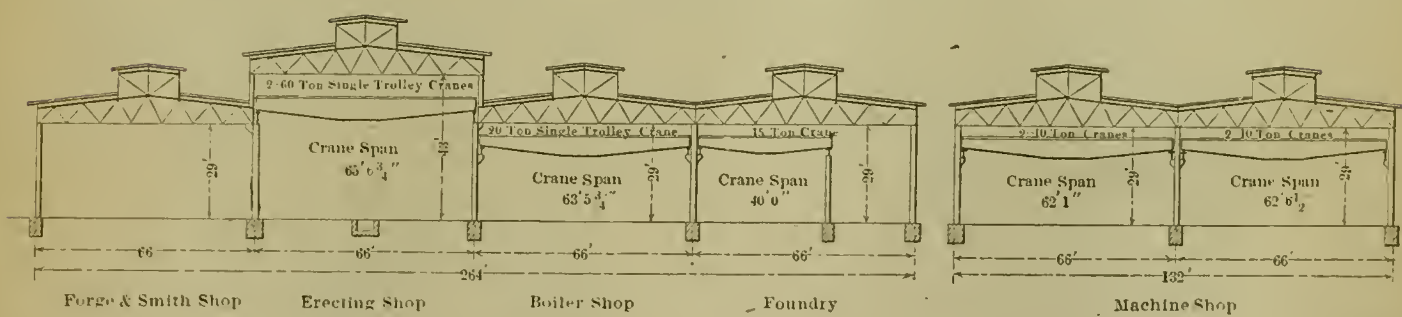
The buildings are thoroughly modern; the outer walls being of stone up to the window sill line and above that of brick. The roof trusses are of steel throughout. Many of the interior partitions are formed by studding, supporting expanded metal sheets and surfaced with plaster on both sides. Such partitions serve every purpose in the way of dividing the different departments, and are also cheap to construct and occupy a minimum of floor space.

The tool equipment of the plant was very carefully selected and is modern throughout. It is being amplified and enlarged, and a very liberal policy is in force, under which new tools or appliances which facilitate work or accelerate output are always installed as soon as their merits have become known.

The exterior appearance of the buildings of this plant shows them to be substantial and generally pleasing, but without any unnecessary ornamentation. A photographic view of the main building from the southwest shows the character of the buildings.



GROUND PLAN SHOWING COMPACT ARRANGEMENT OF BUILDINGS.



LOCOMOTIVE & MACHINE COMPANY OF MONTREAL CROSS SECTIONS OF SHOPS.

As regards output, it may be said that under present conditions, the works may be expected to turn out about 150 locomotives per year; with the additional tool equipment which has been ordered, and with the improved methods and organization which are being perfected, this output can be advanced to about 175 locomotives per year, when the force is on day work only, or to about 200 locomotives per year when working overtime. The boiler shop has a capacity in excess of the other departments, and can probably turn out about 300 boilers per year, but this excess capacity can be used to good advantage, as many railways order new boilers to replace the boilers of old locomotives which they modernize.

The company is building a large hotel and a number of cottages to accommodate many of the skilled workmen. These will be located on the company's land near the St. Lawrence River.

In our opinion, there never will be any pronounced improvements in steel car painting and maintenance until ways and means are devised to remove the flash scale always adhering to all new, common rolled steel plate; that, regardless of all adverse claims, all flash scale, hard or soft, should be removed, from the fact that when a coated over flash scale comes in contact with moisture through abrasion, it rots away from between paint coating and true under metal and falls off in large flakes, regardless of applied paint, in quantity or quality. On the question of possible improvements, we would recommend that the sand blast method be used to remove all scale from steel car structural plate; that it also be used by the manufacturing concern in original painting; that it also be used in railway repair yards as a matter of labor saving and economy.—*W. O. Quest, Master Car and Locomotive Painters' Association.*

TOOL AND CUTTER GRINDERS.

Improved tool and cutter grinders are rapidly coming into general use in railroad machine shops. With the advent of the high-speed tool steels attention has been forcibly directed to the importance of having the tools accurately ground to suit the class of work upon which they are to be used and of having them kept sharp and in good condition. The old system of having the high-priced machine hand let his machine stand idle while he sharpened his tools by hand and shaped them according to his own judgment, is fast being superseded by a new system of placing in the tool room tool grinding and shaping machines so designed that they can be operated by unskilled labor and will quickly and accurately grind the tools to the proper shape. As the various types of milling machines have been developed and come into more general use, a demand has been created for improved universal grinders to sharpen the various cutters used by them. With the introduction of the individual motor drive for machine tools there has been a demand for self-contained motor-driven emery grinders. The purpose of this article is to present some of the best types of these grinding machines, and by a few illustrations in each case to convey an idea of the wide range of work for which they are adapted.

Fig. 1 illustrates a William Sellers & Company No. 1 universal tool-grinding and shaping machine adapted for tools with shanks not over 2½ x 2 ins. The wheel has two conical grinding surfaces forming a V, with 90 degrees included angle, for convenience in grinding the different faces of tools, for increasing the available grinding surface, and to enable small and delicate splining tools to be ground. The tool-chuck can be rotated about a horizontal axis parallel with the shank of the tool, and can be readily set to any angle by means of a graduated circle and vernier reading to 1-10 degree. It is carried in a frame which can be rotated about a vertical axis passing near the point of the tool, and can be set to 1-10 degree. The frame is carried by two slide-rests at right angles to each other and moving parallel to the tangent planes of the two grinding surfaces. The slide-rests, frame and chuck are all carried by a vertical slide having a long square bearing accurately fitted, and the weight of the moving parts is counterbalanced by a spiral spring, so that, although massive and rigid, it can be reciprocated vertically with surprising ease. The chuck for grinding curved surfaces is inserted in the regular tool-chuck, and a frame carrying a gauge and a roller against which the former-plates work, is put in place in about half a minute. Means are provided by which a tool filed or ground to any desired curved shape can be used as a guide or templet from which a former-plate can be ground in the machine and afterwards used to exactly reproduce the tool or a curve parallel to it. A chuck is provided for grinding the side or base of a tool shank. Also a chuck by which a tool bent at a right angle can be ground the same as a straight tool without changing its position in the chuck.

The tool holder is capable of presenting the tool to the wheel in such a manner that any face can be so ground as to have a definite, predetermined relation to the other faces and to the shank, and the adjustment necessary to do this is simple and easily understood. The only shapes of cutting edges which cannot be ground on this machine are concave curves and re-entrant angles less than 90 degrees.

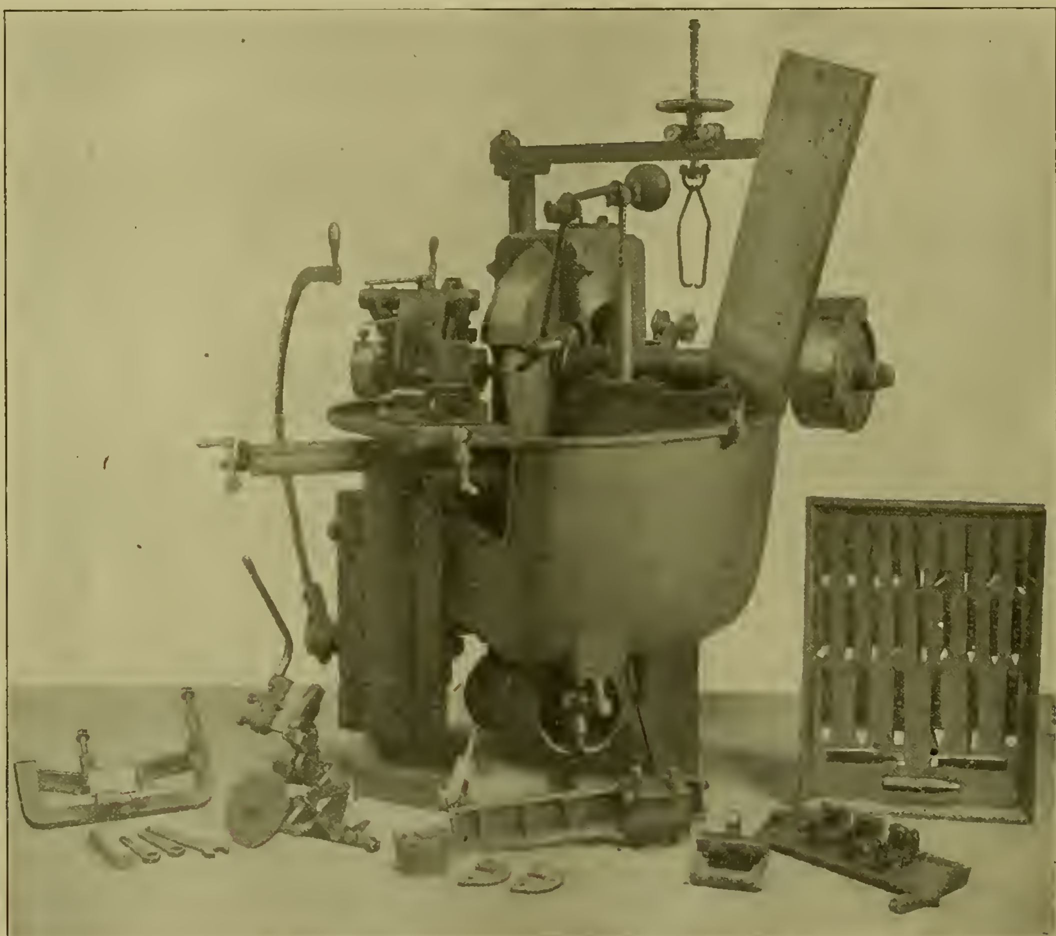


FIG. 1.—UNIVERSAL TOOL-GRINDING AND SHAPING MACHINE. WILLIAM SELLERS & COMPANY.

Fig. 2 illustrates the method of grinding a circular tool, Fig. 3 the application of a supplemental chuck as used for the outside face of an inside thread tool, Fig. 4 the grinding of the left side face of a large V tool and Fig. 5 an attachment for grinding boring cutters with correct and uniform clearance. These few applications will give some idea as to the wide range of work for which this machine is adapted. It is equipped with a crane for changing the wheel on its spindle and with a rotary pump for forcing water through a system of jointed pipes, ending in an adjustable nozzle. The working parts of the machine are protected from the water and the grit carried in it.

The importance of correctly grinding the lips of a drill cannot be too strongly emphasized. Fig. 6 shows a patent improved drill grinding machine which is the result of a long and painstaking research made by William Sellers & Company. It is simple, can be operated by unskilled labor and will grind flat or twist drills from 5-16 in. to 3 ins. in diameter. The

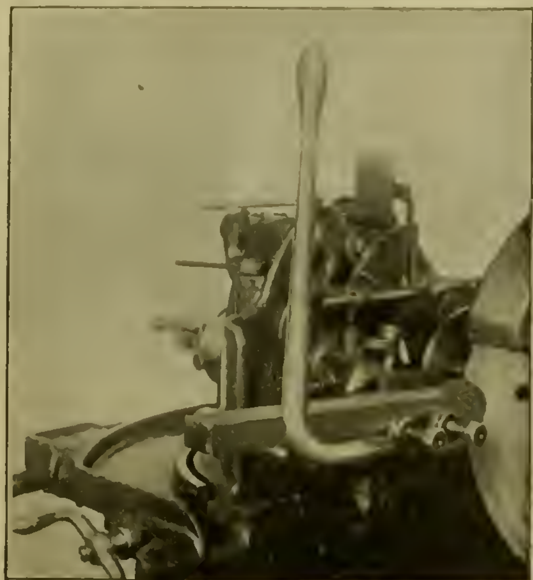


FIG. 2.—GRINDING A CIRCULAR TOOL.

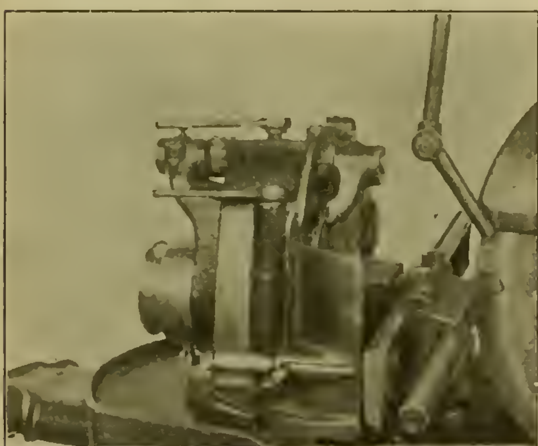


FIG. 3.—SUPPLEMENTAL CHUCK AS USED FOR THE OUTSIDE FACE OF AN INSIDE THREAD TOOL.

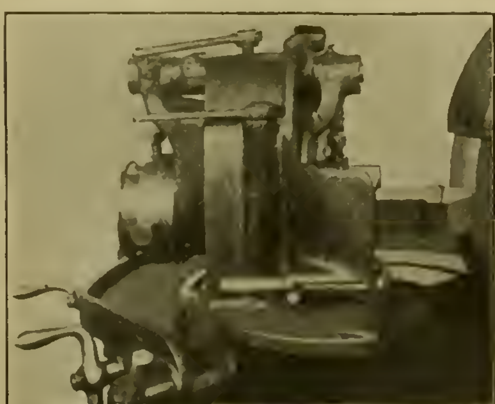


FIG. 4.—GRINDING THE LEFT SIDE FACE OF A LARGE V TOOL.

grinding of the lips is done on the face and not on the curved edge of the grinding wheel, which is in the form of a ring of emery firmly attached to a cast-iron back ring. The grinding wheel is protected by a cover, except where the drill comes in contact with it, and a centrifugal pump delivers the water in a gentle, abundant flow to the stone and drill without splash or waste. The ball handle F, operated by the left hand of the workman, rotates the drill back and forth in front of the grinding wheel in such a way as to insure the proper clearance. A device for pointing the drill is attached to the machine.

A universal tool and cutter grinder made by the Norton Emery Wheel Company, Worcester, Mass., and which takes 36 ins. between centers and has an 8-in. swing, is shown in Fig. 7. This machine is provided with attachments which can be easily and quickly adjusted for the various operations required in sharpening milling cutters, taps, countersinks, mills, etc. It is equally efficient for any cylindrical or conical

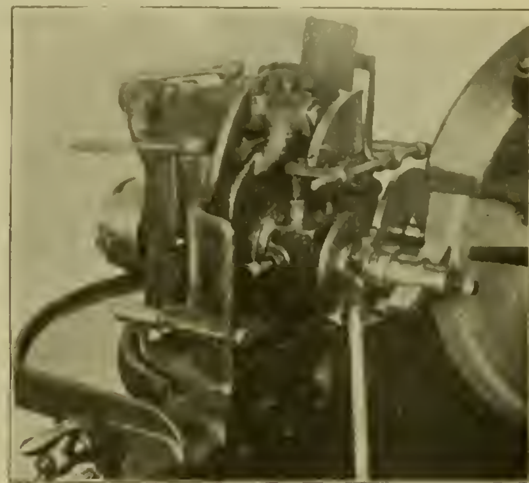


FIG. 5.—ATTACHMENT FOR GRINDING BORING CUTTERS WITH CORRECT AND UNIFORM CLEARANCE.

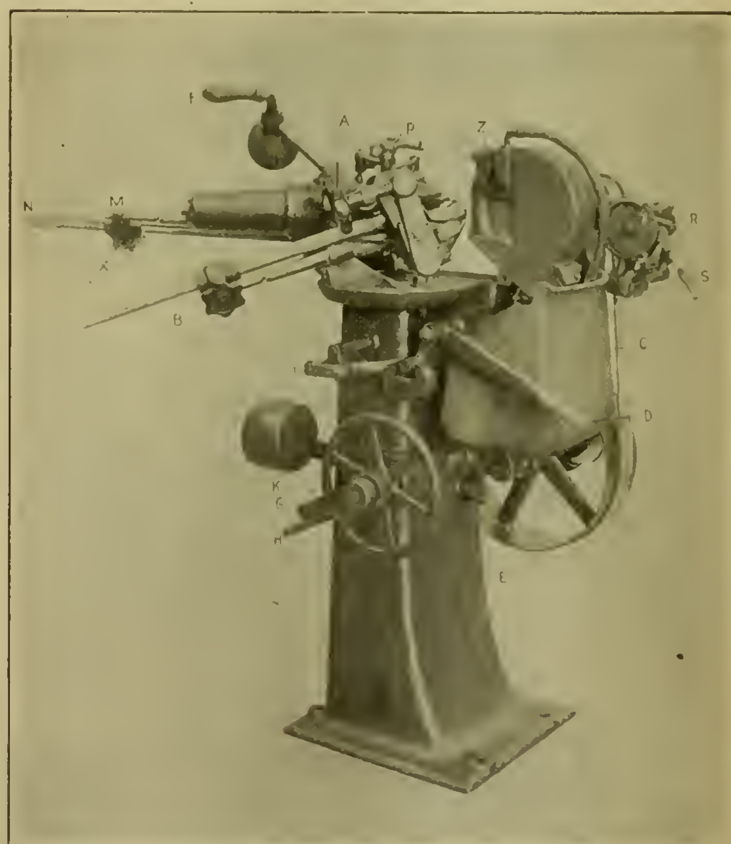


FIG. 6.—PATENT IMPROVED DRILL-GRINDING MACHINE—WILLIAM SELLERS & COMPANY.

work either on centers or on a chuck and for accurate sizing of internal work. It is provided with an automatic cross-feed arrangement for surface grinding.

Fig. 8 shows the method of sizing the taper shank of a cutter, Fig. 9 the method of sharpening a rose reamer, Fig. 10 the method of sharpening a small end mill and Fig. 11 shows the spindle and a piece of work adjusted ready for in-

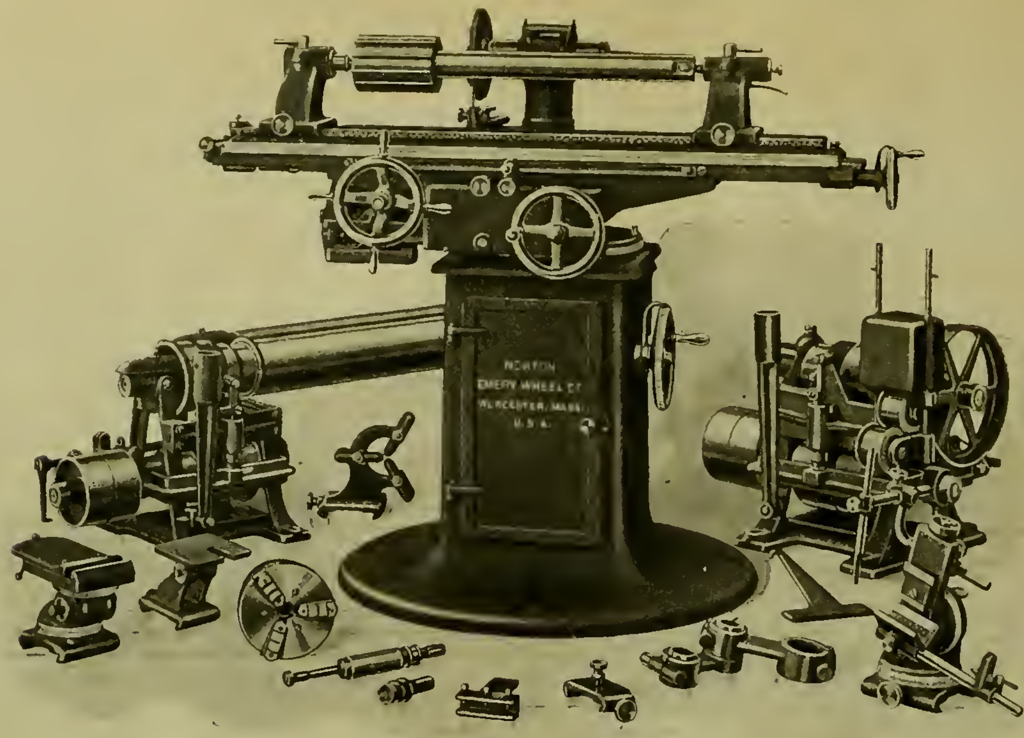


FIG. 7.—NO. 2 UNIVERSAL TOOL AND CUTTER GRINDER.
NORTON EMERY WHEEL COMPANY.

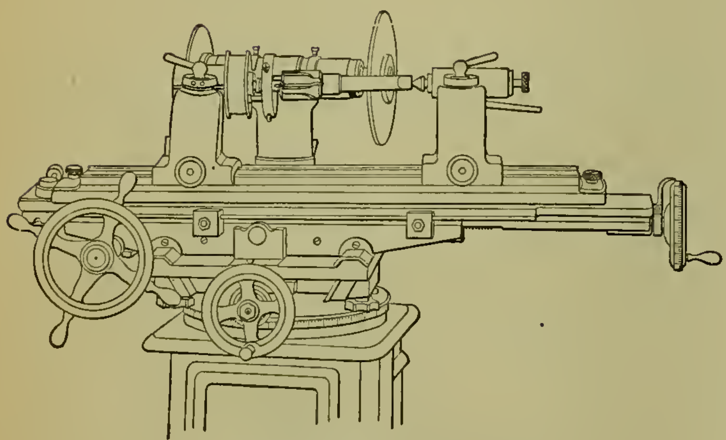


FIG. 8.—SIZING TAPER SHANK OF CUTTER.

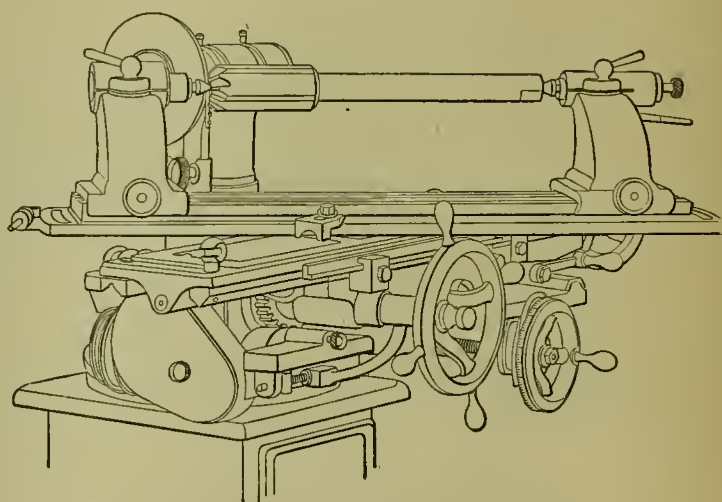


FIG. 9.—SHARPENING A ROSE REAMER.

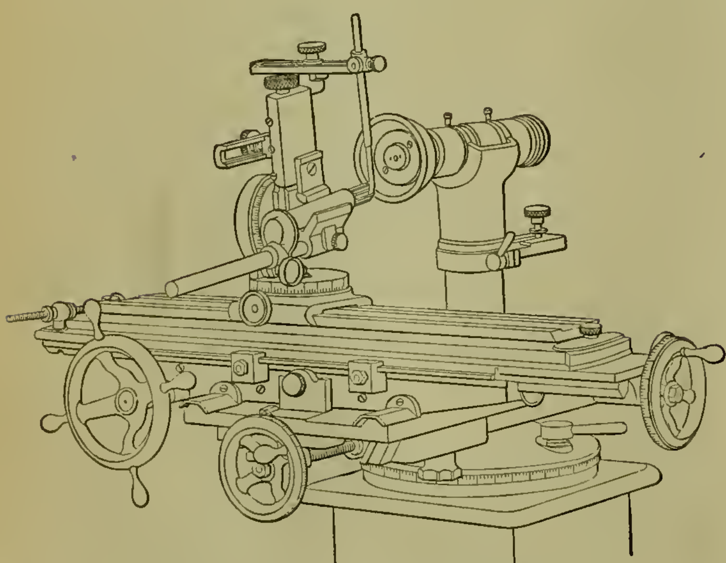


FIG. 10.—SHARPENING A SMALL END MILL.

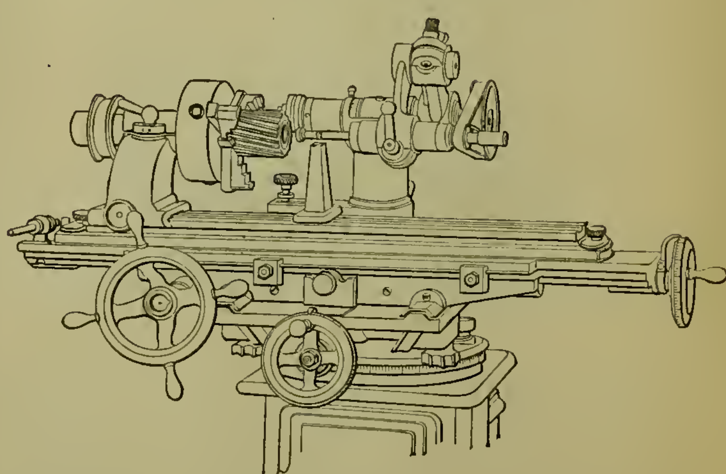


FIG. 11.—SPINDLE AND WORK ADJUSTED READY FOR INTERNAL GRINDING.

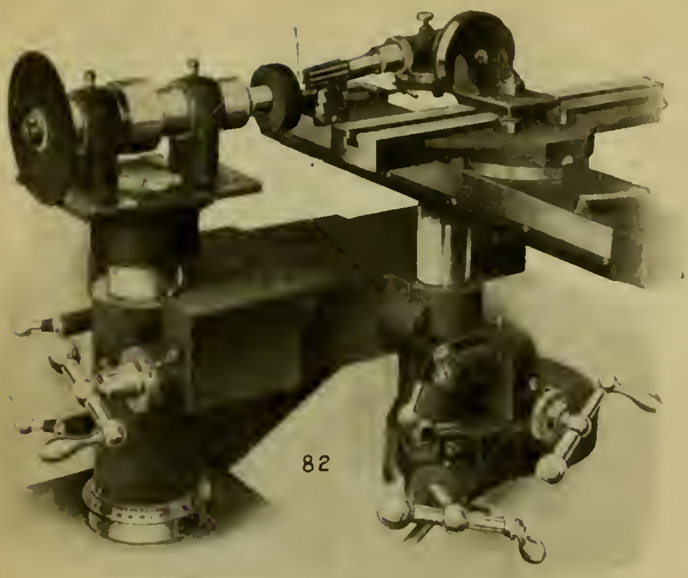


FIG. 13.—SHARPENING END TEETH OF AN END MILLING CUTTER.

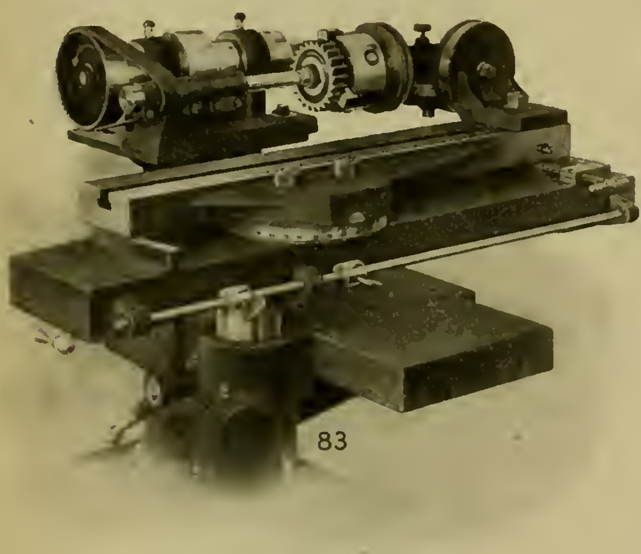


FIG. 14.—INTERNAL GRINDING.

ternal grinding. These are but a few of the many varieties of work which can be done on this machine.

Fig. 12 shows a Cincinnati universal cutter and tool grinder made by the Cincinnati Milling Machine Company. It is also adapted for cylindrical, internal, face, surface and angular grinding. Fig. 13 illustrates the method of sharpening the end teeth of an end milling cutter, Fig. 14 shows an application of internal grinding, Fig. 15 the method of sharpening a spiral mill and Fig. 16 the method of sharpening a hand reamer.

A simple, self-contained motor-driven grinder, made by the Northern Electrical Manufacturing Company, Madison, Wis. is shown in Fig. 17. The starting and controlling mechanism is located in the pedestal. A variation in speed of 25 per cent is provided by the field rheostat. The motor is protected from dust, dirt and mechanical injury. In Fig. 18 the covers are shown transparent to illustrate the arrangement of the parts of the motor. Fig. 19 shows the wall type of Northern Electric Emery grinder arranged for grinding sprues in a foundry. The wheel at the right may be operated without a guard or rest, so that large pieces can be conveniently worked.

Fig. 20 illustrates the Milwaukee universal cutter and tool grinder manufactured by Kearney & Trecker of Milwaukee, Wis., and sold by Hill, Clarke & Company. A few of the many different kinds of work which can be handled on this machine are shown on Figs. 21 to 25 inclusive. These show the methods of sharpening a small end mill, an inserted tooth face mill, and a tap, and also illustrate the machine arranged for both internal and cylindrical grinding.

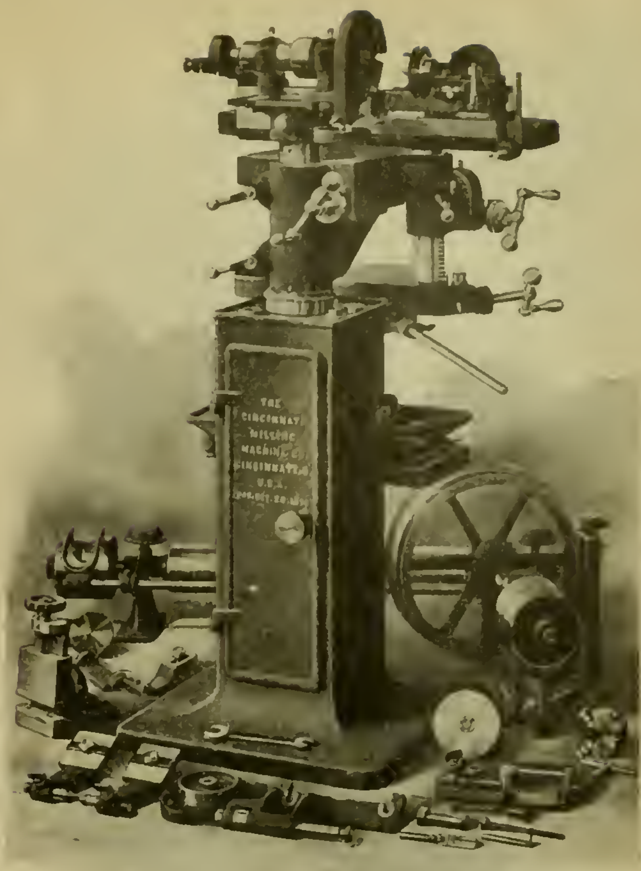


FIG 12.—UNIVERSAL TOOL AND CUTTER GRINDER—CINCINNATI MILLING MACHINE COMPANY.

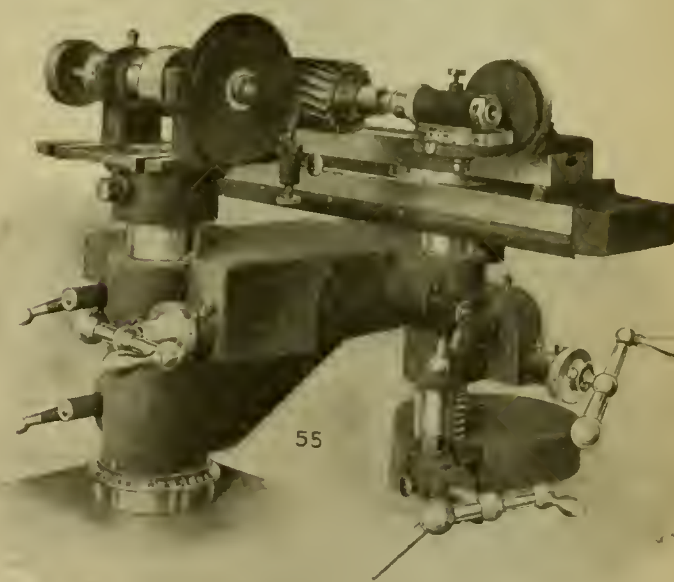


FIG. 15.—SHARPENING A SPIRAL MILL.

DO IT NOW.

"Do it now. Do not wait a lifetime before putting what seems to be a good thing into effect. Fix it up the best you can, and get the benefit of the improvement while you live and can watch the results, and perhaps you can improve upon them later." This is the rule of practice of a railroad official who has advanced rapidly, and is still advancing. By doing this he keeps his desk clear of detail and has time for the consideration of important problems.

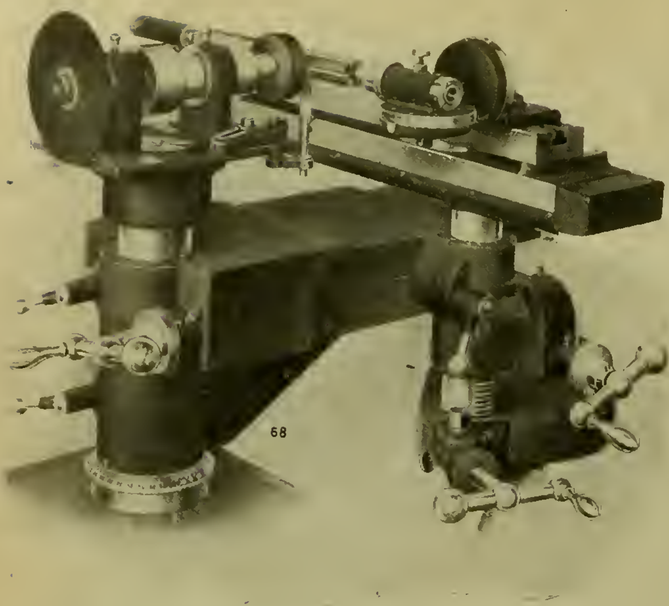


FIG. 16.—SHARPENING A HAND REAMER.

FIG. 17.—MOTOR-DRIVEN EMERY GRINDER—NORTHERN ELECTRIC MANUFACTURING COMPANY.

FIG. 18.—NORTHERN ELECTRIC EMERY GRINDER WITH TRANSPARENT COVER TO SHOW MOTOR.

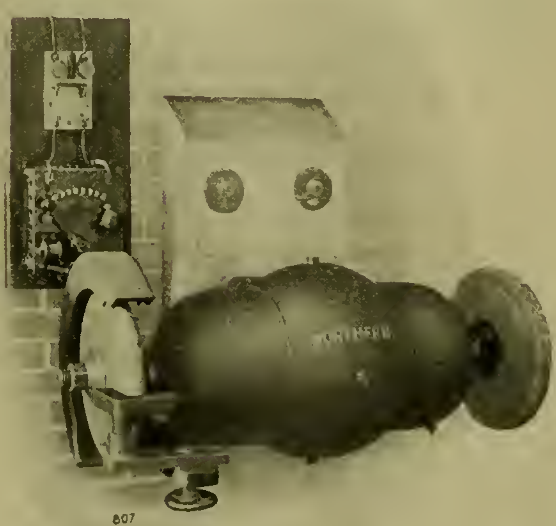


FIG. 19.—NORTHERN ELECTRIC EMERY GRINDER, WALL TYPE.

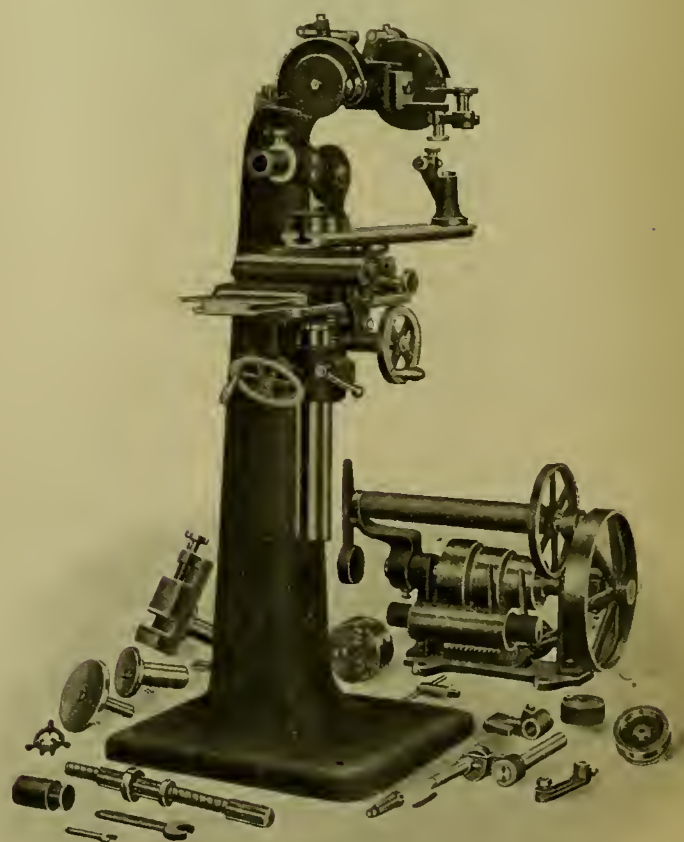


FIG. 20.—MILWAUKEE UNIVERSAL CUTTER AND TOOL GRINDER.

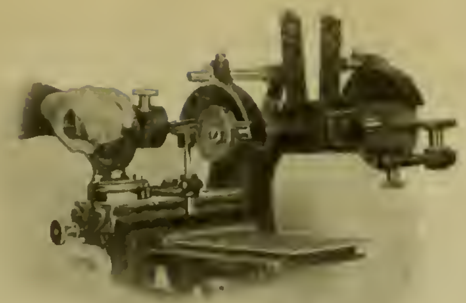


Fig. 21.—Sharpening Small End Mill.

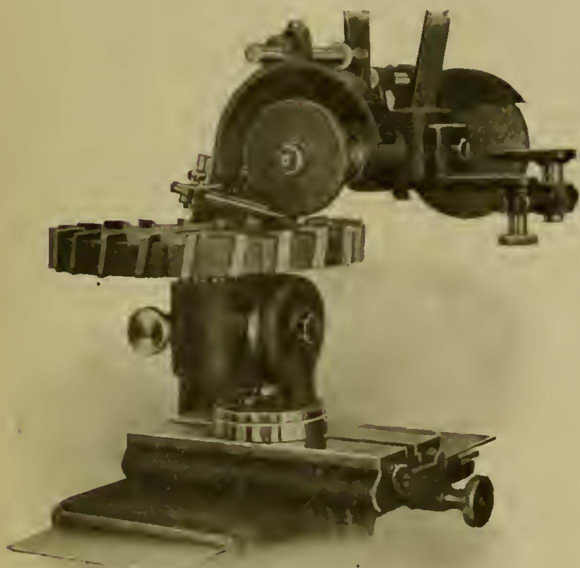


Fig. 22.—Sharpening Inserted Tooth Face Mill.

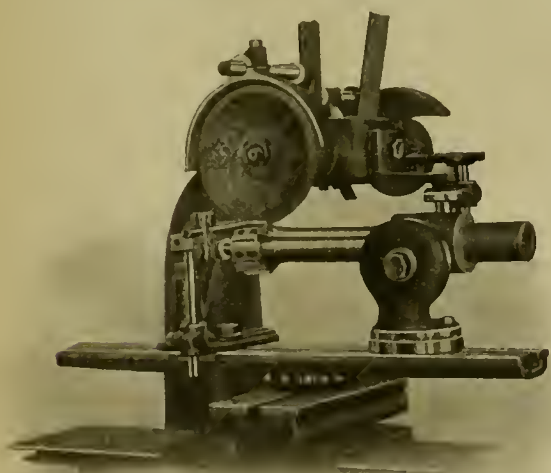


Fig. 23.—Sharpening Tap.

The thermo-dynamic efficiency of all gas engines is now so much greater than any heat efficiency attained in steam engines that we can well afford to reduce economy, if need be, in order to make more certain of good practical results—that is, to make more certain of low cost for upkeep and repairs. In my view it would pay in large gas engines even to reduce fuel economy if by so doing entire immunity from breakdown was secured. So far the best means of limiting temperature in a simple way appears to be found in the addition of cooled exhaust gases to the charge before compression; and this method, although reducing flame temperature, has actually increased the efficiency instead of diminishing it.—*Mr. Dugald Clerk, British Association for Advancement of Science.*

THE NATIONAL MACHINE TOOL BUILDERS ASSOCIATION.

This association met in New York City November 15th and 16th. After discussing a number of important commercial questions the subject of motor application to machine tools occupied the most important position in the proceedings.

In view of the fact that about 25 per cent. of the product in lathes is arranged for electric operation, and considering that at present motor-driven lathes are not standardized, it is important that standardization of practice should be effected, which will permit of building direct-driven machines on the duplicate part system, which has been practised in building belt-driven lathes. This applies not only to lathes, but al-

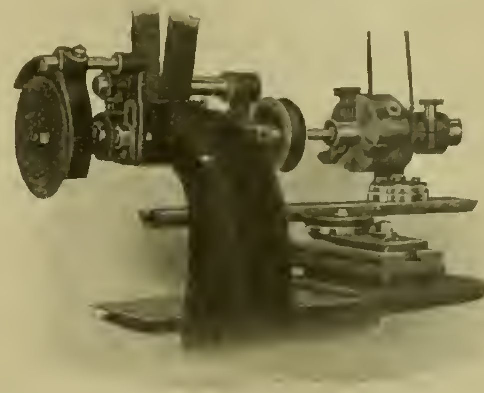


Fig. 24.—Internal Grinding.

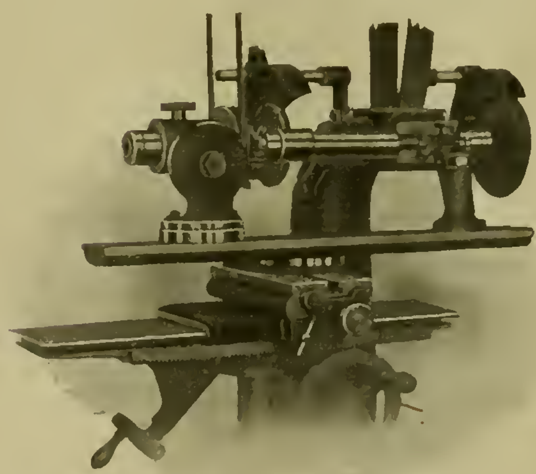


Fig. 25.—Cylindrical Grinding.

sorts of machine tools. At present machines with direct motor applications cannot be built upon a manufacturing basis.

Mr. Fred A. Geier, secretary and treasurer of the Cincinnati Milling Machine Company, read an important paper, in which it was shown that the direct connected motor-driven machine tool has come to stay. He considered it necessary to decide upon a standard speed range of variable speed motors which would cover the entire field of machine tool driving, after which there will be no difficulty in bringing out a line of motors as a standard for machine tools. Because milling machines require a very wide range of speeds, he considered that a motor which was suited to milling would have sufficient range for any other machine. His company had found a 2½ to 1 variation satisfactory, with the standardized electric drive arrangement, for the milling machines built by them. He deplored the variety in shapes and sizes of motors which required special parts to suit the particular motor specified on every order. Mr. Geier suggested standardizing the size and shape of the base, the distance from the center of the driving pulley to the center of the base; the distance from the bottom of the base to the center of the armature shaft and the diameter of the shaft. Two and a half, or at the most 3 to 1 variation, would be ample, and the maximum speed should be kept below 700 revolutions a minute.

Mr. W. H. Powell, of the Bullock Electric Manufacturing Company, followed with a paper in support of the same general argument. He discussed the various distribution systems and recommended a speed range of 3 to 1, with a minimum speed of 400 to 660 revolutions, dependent upon the output of the motor.

Mr. B. G. Fernald, of the Northern Electric Manufacturing Company; Mr. J. D. Maguire, President of the American Electric and Controller Company, and Mr. M. F. Reardon, of the General Electric Company, followed with remarks on the efforts which each of these companies is making in solving the question of motor drives.

The result of the discussion was the appointment of a committee, composed of Messrs. Woodward, Lodge, Geier, March, Tuechter, Binsee and Wetsel, to confer with motor manufacturers and submit recommendations as to standard mountings and dimensions.

The officers for the coming year are as follows: President, William Lodge; first vice-president, William P. Davis; second vice-president, F. E. Reed; secretary, P. E. Montanus; treasurer, Enoch Earle.

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

Editorial Correspondence.

Paris.

While it is necessary to make more than a brief visit to France to become sufficiently familiar with the locomotive practice there to put it on record with authority, a week spent in the study of French methods is sufficient foundation for the statement that they represent the most scientific treatment which is given anywhere to the locomotive to-day. For the past 19 years there has been a systematic and continuous effort to produce locomotives to meet the needs of French railways and the practice has crystallized into a type, for passenger service, which has been adopted by all of the important French railroads and it certainly is well adapted to France. This type began its development on the Northern Railway in 1885 when Mr. du Bousquet, of that road, consulted Mr. A. G. de Glehn, of the Societe Alsacienne de Constructions Mechaniques, concerning a method of increasing the capacity of a 4—4—0 engine without increasing its total weight. The history of this development has been written and need not be repeated here. It is sufficient to state that the co-operation of Mr. du Bousquet and Mr. de Glehn produced the type of locomotive widely known as the du Bousquet-de Glehn type. This construction has been most satisfactory and now no locomotives with separate tenders are being built of any other type for the French railroads. There is much that is interesting and instructive in the fact that instead of working in opposite and conflicting directions the locomotive superintendents of France saw the value of this construction. They were broad minded enough to lay aside personal prejudices and generous enough to adopt that which has proved itself to be the best to be had for their conditions. While France may be considered the home of the de Glehn compound its use has extended on the Continent and while it was developed originally for passenger service it is also extensively applied to freight service. Furthermore it has formed the basis for the work of other designers who have brought out four cylinder compounds, using a part but not the whole of the principle of the French engines.

There are no patents on the de Glehn construction and at present several builders are using the drawings which originated with such care at Mulhouse. This is an example which means much for the future of the locomotive in Europe. It is a case of a locomotive building concern producing, in connection with one of the leading railroads, a locomotive which was so much better than any in use in France as to lead to its general adoption to the exclusion of other types. It was developed from experience with two-cylinder and tandem compounds as well as simple locomotives and represents an effort to produce the best without undue regard to first cost of construction and without blindly worshiping simplicity. In France the coal question is exceedingly important. Coal is expensive and the best must be imported, the available supply of domestic coal being of poor quality. When the fine stuff is mixed with an adhesive substance and pressed into briquettes it makes an excellent fuel but is then more expensive than coal imported from England and Germany. The cost of coal in England, Germany and France explains the efforts put forth abroad to render the locomotives as economical as possible. In addition to the desire for greater economy there was another reason for approaching the design of a four-cylinder compound on the Northern Railway of France in 1885. Crank axles on the 4—4—0 simple engines of that road were breaking and it was evident that a division of the work among a larger number of parts was desirable. The first example of the new type was built for 11 kilograms pressure and weighed exactly the same as the simple engine and one ton lighter than a two-cylinder compound of the same date. The question of weight has always been important in France. This first four-cylinder compound is now running and remains to-day the most economical engine on the road. The next one was built in 1891, after five years experience with the first one. There are now about 1,800 engines of this type in service in Europe. The Great Western Railway of England has bought one of the latest type of those in use on the Northern Railway of France and one was built last winter (see American Engineer, June, 1904) at Belfort for the Pennsylvania Railroad. The writer saw this engine during its construction and marveled at its beautiful design and workmanship.

After a careful but brief examination of the methods of designing these engines, which is always done under the personal direction of Mr. de Glehn; after studying the shop methods of construction at Belfort; after riding on the locomotives handling the fast trains on the Northern Railway and looking over many records of performance in the offices of the leading locomotive officials of France, the writer can not avoid the conclusion that the French railroads are supplied with locomotives which are better suited to their needs than are the railroads of any other country prominent in railroad progress. What these engines will do in England and in the United States will soon be known, and a great deal of valuable information may be expected from the tests of the Pennsylvania engine at St. Louis. Whatever may be learned of these engines out of France, American railroad managers, if they knew of their performances in France, would not delay in sending representatives to study them in their work at home.

English roads are up against a stone wall. They need more power without increasing size and weight. German roads are in very much the same condition. In the United States we have size and weight, but need to use these more scientifically in order to meet the exigencies of the present demands. Before trying something else, all should make sure that French practice does not supply the very thing that is necessary. The same sort of continuous, conscientious, broad-minded and consistent effort which justifies the writer in his enthusiasm concerning these French compounds must be applied in all of these countries before they will be even with France in the race for well adapted locomotives.

Locomotive development is also a development of men. Mr. de Glehn has personally superindended the design of every new type of locomotive built by his concern during the past 20 years. He has applied an experience which began in marine engine construction and he has been cordially assisted by the railroads. The railroads have learned that competitive passenger service cannot be satisfactorily conducted without good locomotives, that locomotives must necessarily be more complicated if they are to do the work required of them and they have risen to the occasion with methods of handling and of caring for these locomotives which are as necessary as they are effective. In the United States we make all machines more complicated in order to increase power and to save manual labor. For example, note the present machinery for rolling steel shapes and also note what it does. Likewise note the equipment of a modern blast furnace, of the air brake, of railroad signals and kindred mechanical combinations. We have not complicated the locomotive but we must not hesitate to do so if it becomes necessary.

Locomotives cannot be improved unless the men in charge and those who handle them also improve. There must also be an improvement in the status of the locomotive departments and an advancement of the standing of the men at the head of these departments before the American locomotive will be what it should be. These notes are not to say that we may learn from foreigners what we should do. They are not to say that we should take any locomotive from any other country, but they are to say, and to say it emphatically, that American railroads are making a serious mistake in their treatment of the locomotive department as a whole, in making it subordinate and in placing the head of the department in a position which is inferior to that of an official of a commercial enterprise who has but one-tenth of the responsibility, who requires but one-twentieth of the experience and possesses even a smaller proportion of all around ability. We cannot do much when a large road has four superintendents of motive power in as many years, and when it is possible for many of the best men for these positions to be attracted away to other fields of effort. Our railroad managements need to take heed of the appreciation of locomotive officials in Europe. Our locomotive departments are facing difficulties in the management of men which are unknown abroad and it is earnestly hoped that these words will not prove entirely ineffective. It is not a matter of sentiment but pure business to put our motive power officials in position to do things and to surround themselves with organizations which will make their lives worth living while they do them. There must also be something softer than the frozen world for them to drop on, at the end, when they are worn out. G. M. B.

(To be continued.)

POWERFUL PRAIRIE TYPE LOCOMOTIVE.

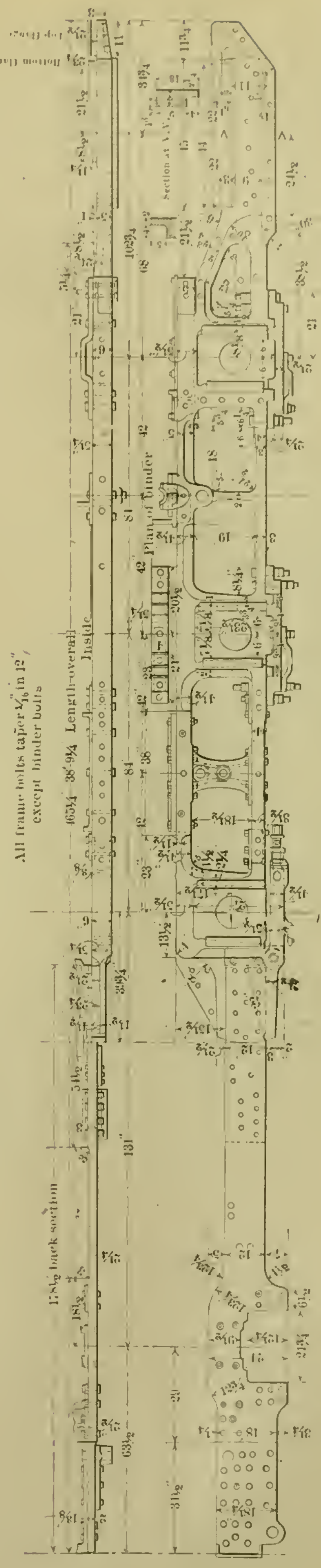
Lake Shore & Michigan Southern Railway.

On page 413 of our November number a description of the very powerful 2—6—2 type passenger locomotives of the Lake Shore & Michigan Southern was presented. Some of the details are now available.

These engines have cast steel frames, which are 6 ins. wide at their widest portion, as shown in the accompanying illustration. These frames are braced against twisting by cast steel bracing extending between the frames at the rear pedestal of the leading driving axle. They are braced again by a large flat steel casting on top of the frames between the second and third driving wheels and again at the slope of the frames over the splice in front of the throat sheet. This practice in frame bracing (American Engineer, January, 1904, page 12) has proven very satisfactory in service. The pedestal binders are rectangular in section except those at the rear axle, which are adjustable.

The fireboxes of these engines are 6 ft. wide and the firemen handle them more satisfactorily than the Class J fireboxes, which are 7 ft. wide, indicating that a foot in width makes a material difference to the firemen, who prefer a firebox 6 ft. wide and 9 ft. long to one which is 7 ft. wide and 7 ft. long.

Other interesting details of these locomotives will be presented next month. Special attention has been directed to the frames because of the serious and general difficulty which has been experienced with frame breakage.



CAST STEEL FRAMES FOR NEW 2—6—2 TYPE PASSENGER LOCOMOTIVES.

LAKE SHORE AND MICHIGAN SOUTHERN RAILWAY.

AGGREGATE TRACTIVE POWER OF AMERICAN LOCOMOTIVES.

According to the 16th annual report of the Interstate Commerce Commission, the total number of locomotives in service in this country June 30, 1903, and their capacities are as follows:

CONDENSED STATEMENT OF CLASSIFICATION OF LOCOMOTIVES.

Item.	Single expansion. Total.	Single expansion. Average.	Four-cylinder compound. Total.	Four-cylinder compound. Average.	Two-cylinder compound. Total.	Two-cylinder compound. Average.
Number	40,443	......	1,953	......	849	......
Tractive power ....pounds	855,609,361	21,156	59,665,313	30,551	26,640,866	31,379
Grate surface ....square feet	1,088,007	27	96,704	50	31,092	37
Heating surface ....square feet	64,322,427	1,590	5,276,640	2,702	2,166,132	2,551
Weight, exclusive of tender ....tons	2,306,763	57	194,010	99	69,932	82
Weight of drivers ....tons	1,862,194	46	137,236	70	57,702	68

From the above statement it appears that the total number of single expansion locomotives on June 30, 1903, was 40,443, giving an aggregate of tractive power, measured in pounds, of 855,609,361. This gives an average of 21,156 lbs. tractive power per locomotive of this class. Of four-cylinder compound locomotives, there were on the date named 1,953, with an aggregate tractive power of 59,665,313 lbs., being an average of 30,551 lbs. per locomotive. The total number of two-cylinder compound or cross-compound locomotives on the same date was 849, with an aggregate tractive power of 26,640,866, or an average tractive power of 31,379. Estimating the average tractive power of the 626 locomotives unclassified at below those of single-expansion locomotives, the aggregate tractive power of the locomotives in service on June 30, 1903, may be safely estimated at 950,000,000 lbs.

A. C. ELECTRIC TRACTION FROM GAS POWER.

A somewhat unique departure from established methods in electric traction has recently been undertaken at Warren, Pa. The Warren & Jamestown Street Railway Company is equipping an A. C. single-phase electric railway system to operate between Warren, Pa., and Jamestown, N. Y., for which power will be supplied by gas engines operating upon natural gas. The equipment is now being constructed by the Westinghouse companies at East Pittsburg, Pa.

The power station will be located at Stoneham, Pa., two miles from Warren. The initial equipment will consist of two Westinghouse gas engines, each of 500 brake horse-power capacity. They will be of the horizontal single-crank double-acting type, direct connected to two 260 kw. Westinghouse generators, furnishing current at voltage sufficient for direct use upon the high tension transmission line. The power equipment also comprises a 55 h. p. Westinghouse gas engine for operating an air compressor and exciter unit. Natural gas will be used, which has a calorific value of about 1,000 b. t. u. per cu. ft.

Transformer sub-stations, five in number, will be located along the right of way. These will receive the high tension current from the transmission line and reduce the voltage to such an extent as to render it more suitable for use in single-phase motors. The present motive power equipment will comprise four quadruple sets of Westinghouse single-phase motors, each approximately 50 h. p. capacity. An interesting feature of the system is the arrangement for operating the alternating current motors upon the direct current trolley lines within the city limits of the termini.

RAPID LOCOMOTIVE CONSTRUCTION.

An interesting and important example of the possibilities of modern shop equipment and methods is furnished by the record of construction of 20 locomotives recently built at the Schenectady Works of the American Locomotive Company for the Canadian Pacific Railway. These engines are illustrated in this issue.

The contract was closed in Montreal under a guarantee that the first two engines were to be shipped within thirty days (Sundays included) from the date of the contract, and the balance at the rate of two each working day thereafter until the order was completed. This schedule was carried out exactly. The locomotive company had practically no material in stock, and it was necessary to order the principal items, which was done either by telephone or telegraph, on the day the contract was made. Special mention should be made of the boiler, firebox and tank plates, which were ordered from the Worth Brothers Company, Coatesville, Pa., by telephone on the day the contract was placed, the formal order, with details, reaching them the following day. All of the principal plates were shipped within five days from receipt of the formal order. The shops of the American Locomotive Company began work on the plates six days after the contract was placed, and the first boiler was in the erecting shop on the seventeenth day.

The patterns for the steel castings were in the Montreal shops of the locomotive company. These were sent by express the day after the contract was placed, arriving at the foundry of Pratt & Letchworth Company the next day, and were in the sand the same afternoon. The first shipment of steel castings, which included frames, wheel centers, etc., was made by Pratt & Letchworth Company six days after receipt of the patterns, and the entire order was completed by them in twelve days.

HIGH SPEED TOOL STEEL.

This article considers the treatment and use of high speed tool steel and is abstracted from a paper on "The Development and Use of High Speed Tool Steel," read by Mr. J. M. Gledhill before the Iron and Steel Institute.

What may be said to determine a high speed steel, as compared to an ordinary tool steel, is its capability of withstanding the higher temperatures produced by the greatly increased friction between the tool and the work due to the rapid cutting. An ordinary carbon steel containing, say, 1.20 per cent. carbon, when heated slightly above the critical point and rapidly cooled by quenching in water becomes intensely hard. Such a steel gradually loses this intense hardness as the temperature of friction reaches, say, 500 degrees F. With rapid cutting steels the temperature of friction may be greatly extended, even up to 1,100 to 1,200 degrees F., and it has been proved that the higher the temperature for hardening is raised above the critical point and then rapidly cooled, the higher will be the temperature of friction that the tool can withstand before sensibly losing its hardness.

In the heat treatment of high speed steel, one of the most important points is the process of thoroughly annealing it after working into bars. Accurate annealing is of much value in bringing the steel into a state of molecular uniformity, thereby removing internal strains that may have arisen, due to casting and tilting, and at the same time annealing renders the steel sufficiently soft to enable it to be machined into any desired form for turning tools, milling cutters, drills, taps, screwing dies, etc. Further advantage also results from careful annealing by minimizing risks of cracking when the steel has to be reheated for hardening. In cases of intricately shaped milling tools having sharp square bottom recesses, fine edges or delicate projections, and on which unequal expansion and contraction are liable to operate suddenly, annealing has a very beneficial effect toward reducing cracking to a minimum. Increased ductility is also imparted by annealing, and this is especially requisite in tools that have to encounter sudden shocks due to intermittent cutting.

In preparing high speed steel ready for use the process may be divided principally into three stages: Forging, hardening and grinding. It is very desirable that high speed steel should be capable of attaining its maximum efficiency, and yet only require treatment of the simplest kind, so that an ordinarily skilled workman may easily deal with it. The steel may be raised to a yellow heat for forging, say, 1,850 degrees F., at which temperature it is soft and easily worked into any desired form, the forging proceeding until the temperature lowers to a good red heat, say, 1,500 degrees F., when work on it should cease and the steel be reheated.

In heating a bar of high speed steel preparatory to forging (which heating is best done in a clear coke fire) it is essential that the bar be heated thoroughly and uniformly, so as to insure that the heat has penetrated to the center of the bar, for if the bar is not uniformly heated, leaving the center comparatively cold and stiff, while the outside is hot, the steel will not draw or spread out equally, and cracking will probably result. A wise rule in heating is to "hasten slowly."

The temperature for hardening high speed steel varies somewhat according to the class of tool being dealt with. When hardening turning, planing or slotting tools, and others of similar class, the point or nose of tool only should be gradually raised to a white melting heat, though not necessarily melted, but even should the point of the tool become to some extent fused or melted no harm is done. The tool should then be immediately placed in an air blast and cooled down, after which it only requires grinding and is then ready for use.

Another method which may be described of preparing the tools is as follows: Forge the tools as before, and when quite cold grind to shape on a dry stone or dry emery wheel, an operation which may be done with the tool fixed in a rest and fed against the stone or emery wheel by a screw, no harm resulting from any heat developed at this stage. The tool then requires heating to a white heat, but just short of melting, and afterward completely cooling in the air blast. This method of first roughly grinding to shape also lends itself to cooling the tools in oil, which is specially efficient where the retention of a sharp edge is a desideratum, as in finishing tools, turret and automatic lathe tools, brass workers' tools, etc. In hardening where oil cooling is used the tools should be first raised to a white heat, but without melting, and then cooled down either by air blast or in the open to a bright red heat, say, 1,700 degrees F., when they should be instantly plunged into a bath of rape or whale oil, or a mixture of both.

Referring to the question of grinding tools, nothing has yet been found so good for high speed steels as the wet sandstone, and the tools ground thereon by hand pressure, but where it is desired to use emery wheels it is better to roughly grind the tools to shape on a dry emery wheel or dry stone before hardening. By so doing the tools require but little grinding after hardening, and only slight frictional heating occurs, but not sufficient to draw the temper in any way, and thus their cutting efficiency is not impaired. When the tools are ground on a wet emery wheel and undue pressure is applied, the heat generated by the great friction between the tool and the emery wheel causes the steel to become hot, and water playing on the steel while in this heated condition tends to produce cracking. *(To be concluded.)*

The results of the German high speed traction experiments thus far conducted have justified the following conclusions:

1. Permanent way, constructed in accordance with the standard specifications for first-class main lines of the German Government railways, is sufficient for electric trains running at a speed of 125 miles an hour, but the radius of any curve should not be less than 660 ft.

2. The collector used in the Zossen experiments is well adapted for conveying electric energy at high tension and at high speeds from fixed conductors to cars.

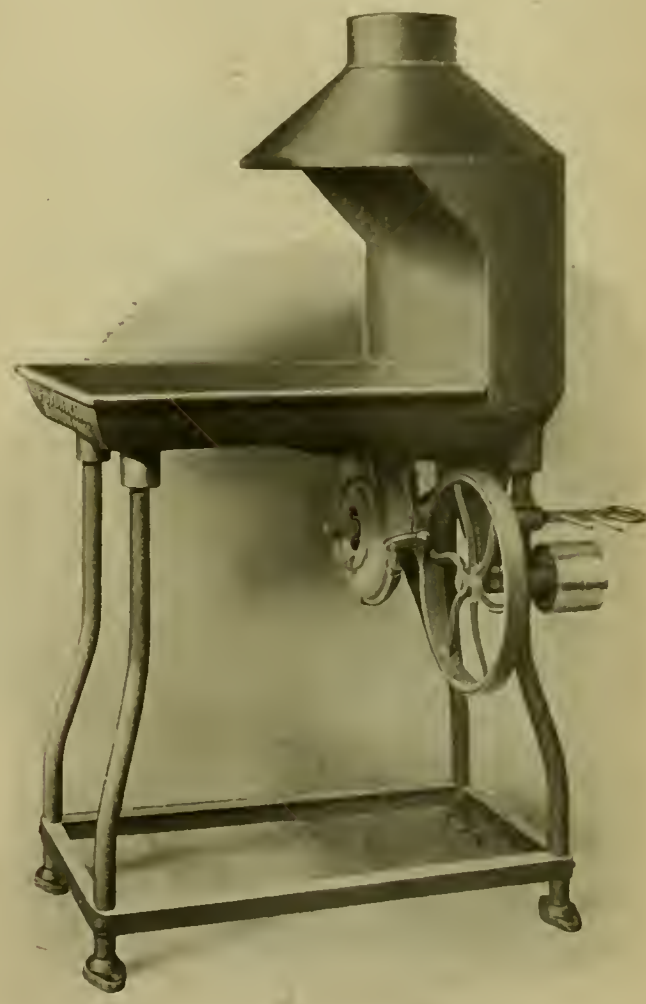
3. The construction of the fixed conductor employed in the German high speed trials has been proven equal to the service.

4. The Zossen trials have demonstrated that high tension current can be used direct without the intervention of transformers.—*Alexander Siemens, International Engineering Congress.*

STURTEVANT PORTABLE FORGES.

The portable forges built by these manufacturers have stood the test of years of service all over the world and now the list of sizes has grown to 31. Not only has the number of sizes increased, but the designs have been perfected in every detail in order to improve their service under the most exacting conditions. The sheet metal work is of heavy steel plate; the running gear is heavy, strong and easy of operation. The tuyeres, are made specially strong to resist the action of the fire and the fire pan is of two metal plates, with asbestos between them to prevent the heat from cracking the main pan or affecting the running gear. The blowers used are of the well-known Sturtevant pressure type, with babbited journal boxes, which have been re-designed to give increased capacity.

These forges are made in seven distinct types, being classified with respect to their capacity and the purpose for which they are to be used. The forge selected for illustration is of the C type, fitted with a blower driven by pulley put on the forge, which is belt-connected to the line shaft or other drive. The C forges are made in four sizes, fitted with a tight or loose pulley, by which a continuous blast may be provided, which is easily regulated by a blast grate underneath the fire pan. The Sturtevant portable forges are adapted for the light work of jewelers and the heaviest work for which portable equipment is used. They are manufactured by the B. F. Sturtevant Company of Hyde Park, Mass., who are prepared to furnish complete forge equipment, including portable and stationary forges, blowers and hand blowers for producing the blast; exhaust fans for the removal or smoke, heating systems and other similar equipment. Further information concerning these forges may be had from the manufacturers.



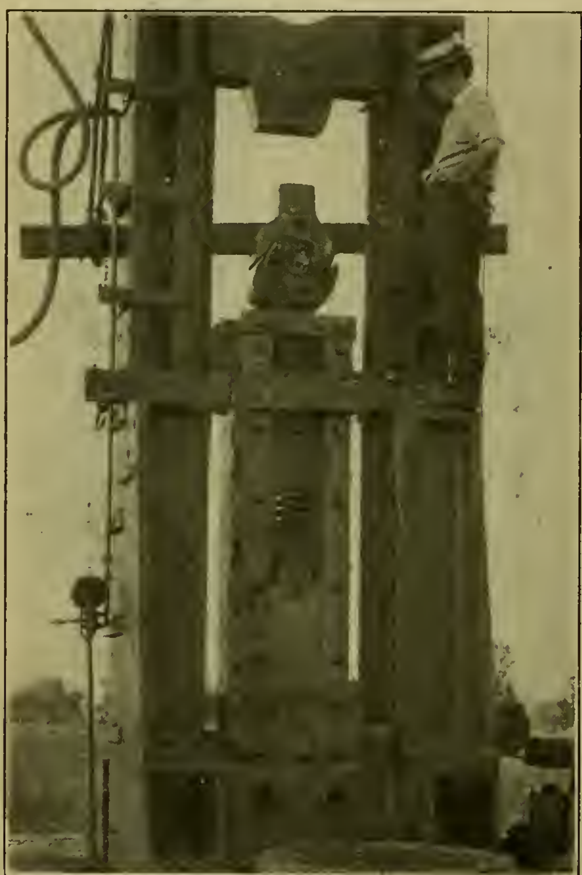
STURTEVANT PORTABLE FORGE.

REMARKABLE TEST OF SPRING DRAFT GEAR.

The Farlow draft gear was illustrated on page 365 of the September issue of this journal. A twin spring arrangement was shown. Records of a remarkable test of a single spring gear, of the same make, upon the M. C. B. drop testing machine at Purdue University, September 12, 1904, have been received, and they admirably support the claims of those who pin their faith to spring gears. From the official report signed by Professor W. F. M. Goss, interesting facts are taken.

The first six blows were at 5, 7, 10, 15, 20 and 25 ft., respectively. Then followed 5 blows at 34 ft., the full height of the machine. The next day two more blows were given at 34 ft.

The second blow, at 7 ft., brought the horn of the coupler in contact with the end sill. Blows from 10 and 15 ft., respectively, were successfully withstood without any apparent effect. Slight bending of the angle plate occurred after a blow at 20 ft. A blow at 25 ft. resulted in a slight bending of the links. After this 7 blows at 34 ft. were delivered, the gear being examined after each blow. Under this very severe treatment there was a gradual increase in the distortion of the metal parts, and a yielding of the timber work supporting them, but the gear was entirely operative at the conclusion of the test. The photograph reproduced in the accompanying engraving represents the condition of the gear at the *end of the test.*



FARLOW DRAFT GEAR AFTER THE TEST.

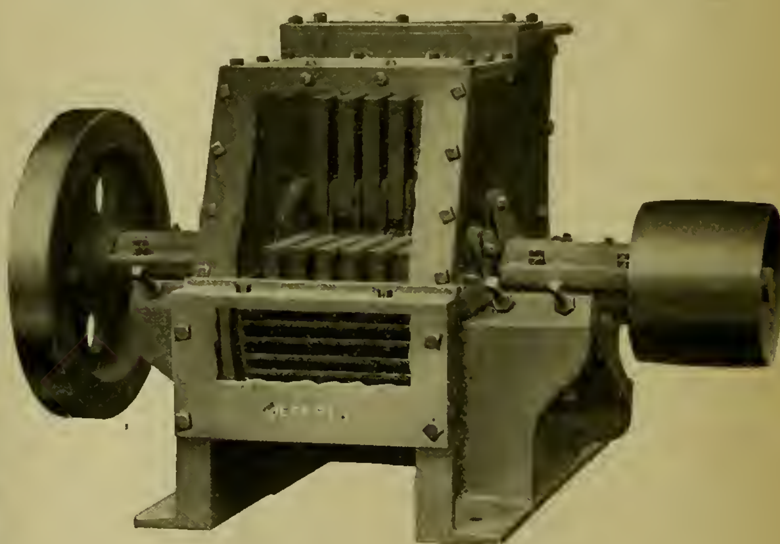
Professor Hatt made an effort to determine the pressure equivalent of a blow of the 1,640-lb. tup, falling from a height of 34 ft. Two copper plugs 2 ins. in diameter and 18 ins. high were placed on the squared end of the upper coupler. The blow of the hammer compressed these blocks 0.282 in. each. A similar block was placed in the static Riehle testing machine of the laboratory, and it was found that a load of 176,000 lbs. was required to produce a similar effect of compression. If these two tests may be directly compared on the basis of equal compression of copper, the force due to the blow of the drop testing machine on the Farlow draft gear is twice 176,000, or 352,000 lbs. It is not claimed that this method is in the slightest degree scientific, but it may be accepted as an approximate measure.

The wooden draft arms when examined by the writer were undamaged. This may suggest to railroad men the possibility that wooden draft arms need not be abandoned because of the liability of the old type of draft gear to be destroyed. These draft arms were not even damaged at the ends next to the coupler. After this punishment this test gear was taken apart in 8 minutes by men who were not accustomed to the work and who did not know they were being timed.

This is certainly a remarkable test, illustrating even unexpected possibilities in spring gears. Further information concerning this test may be had from Mr. M. A. Garrett, vice-president of the Farlow Draft Gear Company, Monadnock Block, Chicago.

JEFFREY HAMMER PULVERIZER.

This type of pulverizer has recently been taken up by the Jeffrey Manufacturing Company, of Columbus, Ohio. The illustration shows the interior or crushing parts. It is designed for crushing and pulverizing a large variety of material, including coal, and is designed with a special view of simplicity. Its special features are its simple beater hammer, its V-shaped screening surface, simple adjustment of the beater arms to accommodate wear, the substantial and adjustable dust proof pillow blocks and large capacity hopper, which permits material to be partly crushed while in suspension. By taking out the rear plate and the side hand hole plates the beater arms may be changed and the screening surface renewed. The latter is made up in sections, so that the change from one size to another is quickly made. Its capacity ranges from 50 to 100 tons of coal per hour, dependent upon the degree of fineness. The machine is in extensive use and has passed the experimental stage. The Jeffrey Manufacturing Company offers to make crushing tests, showing the capability of the machine, for those interested. Further information may be obtained from the manufacturers.



THE JEFFREY HAMMER PULVERIZER.

A NEW FAN WHEEL FOR MECHANICAL DRAFT.

Because of difficulties occurring in induced draft work, which are not met in other uses of fans, the builders have found it necessary to prepare special designs. These have usually employed two or three spiders, except in the very small sizes. Fans for ordinary service have usually had a bearing on each side, making the distance between the bearings comparatively short, with no tendency toward deflection to the shaft, but when fans must handle hot gases the bearings must be removed from the gases in order to avoid heating them. This necessitates overhanging wheels, or placing one bearing outside of the inlet chamber built on to the side of the fan. The American Blower Company has devoted special attention to the development of details which will overcome the difficulties of the deflection of the shaft and the effect of the heat upon the housing in work of this character. Fig. 1 shows their latest construction, which is giving good results in service. It has a spider of I beams in order to secure maximum strength. In addition to this, every plate is braced with braces from the outer rim to the center to overcome tenden-

FIG. 1.

cies to twist. In the side of the fan housing a deep cone is placed. The inner bearing is jacketed and carried on a special arm of cantilever construction; this is placed at the apex of the cone, and the distance from the apex to the end of the projecting shaft seldom exceeds 12 ins. A fan wheel mounted on a shaft with a direct-coupled engine, constructed in this way, is shown in Fig. 2. The extension of the base of the engine, as shown, is not always used. In some cases an I

FIG. 2.

beam grillage is built into the brick foundation, the engine being set on top of the outer ends of these beams, and anchored down, which makes practically a complete unit of the entire outfit. Two large units represented by Fig. 2 have been furnished the Wilkesbarre & Wyoming Construction Company of Wilkesbarre, Pa. These wheels are fixed in a three-quarter steel plate housing; the wheels being 11 ins. in diameter and being driven by 12 x 10-in. vertical engine. They will furnish induced draft in the power house of that company.

PERSONALS.

Mr. J. I. Cunningham has been appointed master mechanic of the Pennsylvania Railroad at Columbus, Pa.

Mr. F. J. Pease has been appointed general foreman of the Lake Erie & Western Railway at Lima, Ohio.

Mr. C. H. Hinsdale has been appointed general foreman of the shops and roundhouse of the Pittsburg & Lake Erie Railroad at McKees' Rocks, Pa.

Mr. J. T. Flavin has been appointed assistant master mechanic of the Indiana, Illinois & Iowa Railroad, with headquarters at Kankakee, Ill.

Mr. C. H. Welch has been appointed master mechanic of the Midland Valley Railroad, with headquarters at Fort Smith, Ark.

Mr. A. W. Horsey has been promoted from the position of chief draughtsman to that of mechanical engineer of the Canadian Pacific Railway, with office in Montreal.

Mr. T. H. Goodnow has been appointed general foreman of the car department of the Lake Shore & Michigan Southern Railway at Air Line Junction, Ohio.

Mr. George Thompson has been appointed general foreman of the car department of the Indiana, Illinois & Iowa Railroad, at Kankakee, Ill.

Mr. I. S. Downing has been appointed master car builder of the Lake Shore & Michigan Southern Railway at Englewood, Ill., to succeed Mr. L. G. Parish.

Mr. Joseph Chidley has been appointed assistant master mechanic of the Lake Shore & Michigan Southern Railway at Elkhart, Ind., to succeed Mr. Peter Maher, resigned.

Mr. D. H. Deeter has been appointed master mechanic at the Reading locomotive shops of the Philadelphia & Reading Railroad to succeed Mr. R. Atkinson, resigned.

Mr. H. S. Hunter has been appointed master mechanic of the New York & Philadelphia division of the Philadelphia & Reading Railroad to succeed Mr. D. H. Deeter, promoted.

Mr. L. L. Collier has been appointed master mechanic of the Newton & Northwestern Railroad, with headquarters at Boone, Iowa.

Mr. John Mailer, heretofore master mechanic of the Minnesota & Northern Wisconsin, has been appointed master mechanic of the Fort Smith & Western, with headquarters at Fort Smith, Ark., to succeed Mr. K. P. Alexander, resigned.

Mr. J. A. McRae has been appointed mechanical engineer of the Boston & Albany Railroad with headquarters in Boston, Mass., reporting to Mr. F. M. Whyte, general mechanical engineer of the New York Central lines.

Mr. W. S. Clarkson has been appointed general master mechanic on the Northern Pacific Railway, with office at Livingston, Mont., and will have charge of the Montana division, including the shops at Livingston.

Walter H. Barnes died at his home in Brookline, Mass., November 14, at the age of 70. He was for many years general manager of the Boston & Albany Railroad, and one of the best-known railroad men in New England.

Mr. George D. Brooke, formerly superintendent of motive power of the St. Paul & Duluth, and afterward of the Iowa Central, has been appointed superintendent of motive power of the Panama Canal Commission.

Mr. R. M. Crosby has resigned as master mechanic of the Chicago, Great Western Railway at Oelwein, Iowa, to accept an appointment as shop superintendent on the Northern Pacific Railway at South Tacoma.

Mr. F. F. Gaines, recently resigned as master mechanic of the Lehigh Valley at Wilkesbarre, Pa., has been appointed mechanical engineer of the Philadelphia & Reading, with headquarters at Reading, Pa.

Mr. Grant Hall has been appointed assistant superintendent of motive power of the Western lines of the Canadian Pacific Railway, with headquarters at Winnipeg, Manitoba. He is transferred from a similar position on the Eastern lines.

Mr. Peter Maher has resigned as master mechanic of the Lake Shore & Michigan Southern Railway to accept the position of superintendent of motive power of the Toledo, St. Louis and Western Railroad, with headquarters at Frankfort, Ind.

Mr. R. H. Gilmour, superintendent of the Brooks Works of the American Locomotive Company, died suddenly in Schenectady, October 26, where he was attending a meeting of the works managers of the company.

Mr. W. H. V. Rosing has resigned as assistant superintendent of motive power of the Illinois Central to become mechanical engineer of the Missouri Pacific Railway, with headquarters at St. Louis, Mo.

Mr. William Moir has been appointed general master mechanic on the Northern Pacific Railway, with office at Tacoma, and will have charge of the Rocky Mountain, Idaho, Pacific and Seattle divisions, not including the shops at South Tacoma.

Mr. F. T. Hyndman has resigned as superintendent of motive power of the Buffalo, Rochester & Pittsburg, to become general master mechanic of the New York, New Haven & Hartford, with headquarters at New Haven, Conn., succeeding Mr. F. B. Smith.

Mr. A. W. Wheatley has been appointed general master mechanic on the Northern Pacific Railway, with office at St. Paul, Minn., and will have charge of the St. Paul, Minn., Lake Superior, Dak., and Yellowstone division, not including the shops at Como and Brainerd.

Mr. F. M. Gilbert has been appointed mechanical engineer of the New York Central & Hudson River Railroad with headquarters in the Grand Central Station, New York, to succeed Mr. F. M. Whyte, recently appointed general mechanical engineer of the New York Central lines. Mr. Gilbert has served as chief draftsman for the past four years.

C. F. Thomas, who died October 25 at Albuquerque, New Mex., was an exceptionally bright and able mechanical officer, who will be sadly missed by many friends. His death is a loss to the railroads, because such men are greatly needed to cope with the problems of the present. His leading characteristics were unselfishness and integrity. He did not count the cost of efforts in behalf of others. He entered the service of the Pennsylvania Railroad in 1875 as an apprentice at Renovo. After serving his apprenticeship he went to the Mobile & Montgomery. After that he was connected successively with the Louisville & Nashville, the Chesapeake & Ohio, the East Tennessee, Virginia & Georgia, the Richmond & Danville, the Southern, and in 1902 he became general inspector of the Richmond Works of the American Locomotive Company. Mr. Thomas was a member of the Master Mechanics' and the Master Car Builders' associations, and served these organizations actively and effectively. He was studious and enterprising, and gave a great deal of thought to improvement in shop methods and devices. By his personal qualities he endeared himself to many friends.

BOOKS.

Some After Dinner Speeches. With a Few Anecdotes of Famous Men. Published by the Bookkeeper Publishing Company, 61 West Fort street, Detroit, Mich. Price $1.00.

This little book of 220 pages will be found convenient by those who are not apt entertainers and are occasionally called upon to respond to a toast. It contains a number of speeches by well known public men and some excellent stories.

American Railway Master Mechanics' Association. Proceedings of the Thirty-seventh annual convention held at Saratoga, N. Y., June, 1904. Edited by the secretary, Mr. J. W. Taylor, Rookery Building, Chicago.

In addition to the rules, and standards this volume contains a number of valuable individual papers and committee reports. The secretary is to be complimented upon the short time required to get out this report, which covers over 550 pages.

Proceedings of the Eleventh Annual Convention of the Air Brake Association. Held at Buffalo, May, 1904. Edited by the Secretary, F. M. Nellis, 26 Cortlandt street, New York.

This volume of 282 pages contains the reports, proceedings and discussions of this organization, which is devoting its efforts to the following object: "To obtain a higher efficiency in air brake service." It is an important volume to those who have to do with the air brake. This volume contains, among others, exceedingly important papers concerning the advisability of increasing brake pressures and the friction of brake shoes, both of which are vital subjects in the present air brake situation.

Railway Storekeepers' Association. Proceeding of the first annual meeting.

This association met in Chicago last May and the record of proceedings indicates a very successful convention. The book of 209 pages opens with an elaborate list of subjects of papers which is followed by the discussions which cannot fail to bring very valuable results to the railroads because of improved methods of handling supplies. Among the illustrations are engravings of the store department supply cars used on the Lake Shore & Michigan Southern Railway. This association has been most successfully launched and promises to be an important source of improvement of methods of handling storehouse material. Managers and motive power officials should read the discussions carefully. Mr. J. P. Murphy, general storekeeper of the Lake Shore & Michigan Southern Railway, is president of the association.

Report of the United States Naval "Liquid Fuel" Board. Government Printing Office, Washington, D. C.

This elaborate report of 450 pages records the tests of the "Hohenstein Boiler" and the "Liquid Fuel" Boards, constituting the most authentic and exhaustive information collected by the Navy Department under the direction of Rear Admiral G. W. Melville. It is undoubtedly the best work ever written on this subject and contains information and studies in oil burning which are of greaat value in the use of this fuel for other than naval purposes. The classification of burners occupies 26 pages. Those who are burning oil in locomotive service should carefully study this remarkable report. Presumably copies may be obtained through members of Congress.

Poor's Manual of Railroads, 1904. Thirty-seventh Annual Number. Published by Poor's Railroad Manual Company, 68 William street, New York. Price $10.00.

This volume, just from the press, contains 1,600 pages of tables and summaries of railroad statistics. It presents detailed statements of the operations and condition of every railroad company in the United States, Canada and the leading lines of Mexico. It also contains 24 colored plates, state and group maps and 44 maps of leading railroads. According to the statistics the railroads completed up to the first of the current year aggregate 207,603.53 miles, with 717.54 miles completed since the close of their fiscal years. Poor's Manual represents 203,052 miles of line in its statistics, indicating the value of the figures as representing the railroad situation of the country. The tables are very complete and are arranged to show the progress of freight and passenger traffic for 13 years, the statement of railroad construction for four years and other statistics concerning periods sufficiently long to permit of making intelligent comparisons of progress. This book needs no introduction to our readers. It is sufficient to say that the present volume maintains, in every way, the reputation of the previous ones.

Master Car Builders Association. Proceedings of the Thirty-eighth annual convention held at Saratoga, N. Y., June, 1904. Edited by the secretary, Mr. J. W. Taylor, Rookery Building, Chicago.

The convention reports and proceedings in connection with the interchange rules and the standards and recommended practice constitute a volume of 584 pages and a large number of folded plates. Considerable credit is due the secretary for its early issue.

American Railway Shop Systems. By Walter G. Berg, chief engineer Lehigh Valley Railroad, Pa. 198 pages, illustrated. Published by *The Railroad Gazette*, 83 Fulton street, New York, 1904. Price $2.

Mr. Berg is well known as a painstaking writer, who approaches his subjects in a logical, systematic way. In this work he has assembled plans and information concerning all of the important railroad shops built in this country during the past 14 years, and these are classified and studied in order to draw conclusions as to tendencies of design. Instead of presenting original ideas, it is a record of practice as shown in existing structures. The author has with great care presented in a book of moderate size all the railroad shops which are worth considering by railroad officials who contemplate building new shop plants. There is no other book on railroad shops; and readers who are called upon to design or construct new shops will find this work invaluable. The author discusses longitudinal vs. cross erecting shops--but from the standpoint of an engineer rather than a shop manager. His chapters include: Classification and general layout, general repair shops, locomotive repair shops, passenger and freight car shops, store houses, power plant and machinery, structural work, and presents a very useful bibliography of descriptions of shops from the technical press. Thirty-six shop plans are shown, and the most interesting are illustrated in half-tone engravings and cross sectional drawings. The book is the work of an engineer rather than an expert who knows the merits of various shop arrangements because he is or has been "up against" the problem of keeping down the cost of repairs, but it is the best record of existing practice and, in fact, the only convenient record available. Mr. Berg has put railroad officials under heavy obligations to him for this admirable book. No new railroad shop should be built without carefully consulting and studying this work. It should be in every railroad drafting room, every motive power and manager's office, and the technical schools giving special attention to railroad subjects should use it as a text book.

Locomotive Operation: A Technical and Practical Analysis. By George R. Henderson, Member A. S. M. E. Cloth, 6 by 9 ins.; 536 pages, 142 illustrations and 5 folding plates. Published by The Railway Age, Monadnock Block, Chicago, Ill. Price, $3.50.

This book would make a high reputation for the author, if he had not earned it previously, as a railroad officer. His object was to study the locomotive and what it will do, how it does it and what it costs in fuel, placing the whole subject before the reader through an investigation of the results accomplished, which are presented in detail. The work is a book of reference on the locomotive without specifically treating of the details of design. It shows the relation between theory and practice as measured by practical results. It is a scientific study by a man who has been responsible for operation as well as design and construction. Inertia, action of steam, resistance, slipping and braking preface the chapters on hauling power and economical speeds. Water and fuel consumption follow. The author reproduces a number of discussions of important factors from other authorities, and discusses the laws governing the subjects. The book is rich in original diagrams graphically representing the conclusions of the text, which are exceedingly convenient for consultation in solving problems in locomotive performance. The most important feature is the study of economical hauling of trains, and in presenting this subject Mr. Henderson places the railroad officials of the world under obligations to him, as he does in the articles on the same subject now appearing in the pages of this journal. The book is original and covers ground never before attempted in any work on the locomotive. The student will find the mathematics worked out in detail, while the manager and motive-power officer will use the diagrams for direct application to his problems. Aside from its interest to the student, operating official and motive-power superintendent, Mr. Henderson's book must necessarily exert a much needed influence tending in the direction of a clearer understanding of the locomotive in motion. In this its effect will be timely in connection with the promising tendency of the time toward more intelligent railroad operation in which the locomotive is the leading feature. The book is not disappointing in any respect.

NEW CATALOGUES.

In writing for these catalogues please mention this paper.

PLANERS, HIGH SPEED.—Catalogue No. 1 from the Chandler Planer Company, Ayer, Mass.

LATHES.—Catalogue B from the Draper Machine Tool Company, Worcester, Mass.

RADIAL DRILLS.—Set of leaflets from the Fosdick Machine Tool Company, Cincinnati, O.

DISC GRINDERS.—Pamphlet from the Ransom Manufacturing Company, Oshkosh, Wis.

WOODWORKING MACHINERY.—Catalogue A from the "Oliver" Machinery Company, Grand Rapids, Mich.

UPRIGHT DRILLS.—Catalogue No. 61, 2nd edition, from the W. F. & John Barnes Company, Rockford, Ill.

LATHES.—Catalogue No. 23 from the Bradford Machine Tool Company, Cincinnati, O.

WOOD WORKING MACHINERY.—Catalogue 194 from the Defiance Machine Works, Defiance, Ohio.

DRILLS, LATHES, WATER TOOL GRINDER.—B. F. Barnes Company, Rockford, Ill.

BOLT AND NUT MACHINERY.—The National Machinery Company, Tiffin, Ohio.

REAMERS, UNIVERSAL ADJUSTABLE.—F. B. McCrosky Manufacturing Company, Meadville, Pa.

PUNCHES AND SHEARS.—Catalogue D from the New Doty Manufacturing Company, Janesville, Wis.

BORING AND TURNING MILLS, A TREATISE ON.—Catalogue D-11 from the Bullard Machine Tool Company, Bridgeport, Conn.

HORIZONTAL BORING MACHINES.—Catalogue and treatise No. 3 from the Binsse Machine Company, Newark, N. J.

TAPS, DIES, SCREW PLATES, ETC.—Catalogue and price list from the S. W. Card Manufacturing Company, Mansfield, Mass.

WATERPROOF LEATHER BELT.—Circulars issued by the Graton & Knight Manufacturing Company, Worcester, Mass.

VERTICAL BORING AND TURNING MILL, 64-INCH.—Bulletin just issued by the Gisholt Machine Company, Madison, Wis.

CHUCKS.—Catalogue No. 7 describing the Sweetland chuck made by the Hoggson & Pettis Manufacturing Company, New Haven, Conn.

BORING TOOLS, CHICAGO ADJUSTABLE.—Pamphlet issued by C. A. Nordquist, 39 W. Randolph street, Chicago, Ill.

WOOD WORKING MACHINERY.—A loose leaf catalogue from the S. A. Woods Machine Company, Boston, Mass., describing tools applicable to railroad shop work.

BORING AND TURNING MILL.—Pamphlet from the Colburn Machine Tool Company, Franklin, Pa., describing their 72 in. widened pattern vertical mill.

GRINDING MACHINES.—Leaflets describing the universal and plain machines made by the Landis Tool Company, Waynesboro, Pa.

MACHINE TOOLS.—Catalogue T from the Hilles & Jones Company, Wilmington, Del., describing tools for working plates, bars and structural shapes.

MACHINE TOOLS.—Bulletins 530 to 538 inclusive from The C. E. Sutton Company, Toledo, Ohio, describing their punches and shears, forging machines, milling machines and lathes.

MILLING MACHINE IN COMBINATION WITH PLANER.—Catalogue from the Adams Company, Dubuque, Iowa.

EMERY AND CORUNDUM WHEELS.—Catalogue and price list from the Hampden Corundum Wheel Company, Brightwood, Springfield, Mass.

INDEX CENTER FOR SHAPER.—Circular from the Stockbridge Machine Company, Worcester, Mass., describing their No. 2 Index Center.

Coburn Trolley Track.—The round trough track for shop and warehouse trolleys, with trolleys and supports is described in a pamphlet received from the Coburn Trolley Track Manufacturing Company, Holyoke, Mass.

Pneumatic Tools.—The Chicago Penumatic Tool Company have just issued a very attractive catalogue of 122 pages which describes the various tools made by them. It also contains some interesting information concerning the comparative cost of hand and hammer riveting.

"Jackohol."—A leaflet from the Watson-Stillman Company, 204 East 43d street, New York, describing this improved liquid for hydraulic jacks, which is a non-corrosive and lubricating compound, will not thicken in freezing weather, nor cause the valves to stick or clog, and which can be produced at about one-half the cost of the standard formula.

Gas Producers.—"Catalogue B" of the Wile Power Gas Company of Rochester, N. Y., describes gas producers for making gas from bituminous or anthracite coal. The gas is suitable for heating furnaces as well as for running gas engines. This company also presents information as to the uses and cost of producing gas, in their "Catalogue A."

Hydraulic Turbines and Governors.—Publication No. 112 issued by the Department of Publicity of the Allis-Chalmers Company, Milwaukee, Wis. It describes the Escher Wyss & Company turbines, the Francis type turbine, the Allis-Chalmers high-pressure impulse turbine and the hydraulic and universal governor made by this company.

Russo-Japanese War Atlas.—The Continuous Rail Joint Company of America, Newark, N. J., are distributing an excellent atlas as a souvenir of the St. Louis World's Fair. It includes Russia-in-Europe, Russia-in-Asia, Japan, Korea, Manchuria and China. It is just the thing wanted in order to understand the reports of the far eastern conflict. The atlas is by Rand, McNally & Company.

Shade Rollers and Accessories.—A new catalogue of 30 pages has been issued by the Stewart-Hartshorn Company, E. Newark, N. J. The product of these well-known manufacturers is illustrated and described with prices and dimensions. Special rollers for railroad cars, tin rollers, self-acting wood rollers, new bottom clips, shade pulls, guides, clasps and brackets are shown in detail. This company has devoted many years to the development of shade rollers and their methods of manufacture insure the production of rollers of the highest standard.

Gisholt Boring & Turning Mills.—The general line of Gisholt vertical and horizontal mills is described in a beautifully illustrated catalogue issued by the Gisholt Machine Company of Madison, Wis. The machines are described, but without detailed dimensions. Sufficient information is given to indicate the size of work for which each machine is adapted, and the machines themselves are illustrated by means of excellent engravings. The pamphlet also includes an illustrated description of turret lathes and of the Gisholt tool grinder. These builders lay special stress upon strength, simplicity, convenience, and the production of rapid and accurate work.

Dry Kilns for Timber Products.—A handsome 78-page catalogue of dry kilns and accessories has been issued by the American Blower Company of Detroit. It is really a brief treatise on kiln drying and illustrates the system and the apparatus manufactured and employed by this company. It is handsomely illustrated, treats of the theory of lumber drying and explains the "A. B. C." moist air dry kiln, its construction and operation. Heaters, fans, apartment kilns and dry kiln appurtenances are illustrated in detail and a number of kilns are shown from photographs of working plants. The pamphlet also contains a large number of favorable reports from users.

NOTES.

Electric Controller & Supply Company.—This company of Cleveland, Ohio, announce that they have been awarded the first prize for their exhibit at the St. Louis Exposition. This consists of their various controllers, magnetic friction and stop brakes, cushion type solenoids, electric lifting magnets, etc.

Nut Locks at the Exposition.—In the transportation exhibits the nut locks on a number of the cars attracted the attention of the writer. Those on the cars exhibited by the Pressed Steel Car Company and also other cars were manufactured by the Bartley Nut and Bolt Fastener Company of Pittsburgh.

Pneumatic Drills.—The United States Government has just purchased from the Rand Drill Company 27 Imperial pneumatic hammers and drills. These are to be used in connection with the Manila harbor improvements.

Chicago Pneumatic Tool Company.—This company has been awarded two gold medals or the highest awards covering their exhibit at the Louisiana Purchase Exposition. They have secured the highest awards at all exhibitions both foreign and domestic since there first exhibit, which was made at the Cotton State Exposition at Atlanta in 1895. Mr. J. W. Duntley, president of this company sailed for Europe on November 8 on a four weeks' business trip.

Northern Electric Generators.—The new isolated plant installed in the 23rd Regiment Armory, Brooklyn, N. Y., will contain two 75 K. W. Northern generators direct connected to Harrisburg engines operating at 275 r.p.m. They also have a 35 K. W., 600 r.p.m. Northern generator belted to a Nash gas engine

Prizes to the Westinghouse Companies.—Twelve grand prizes, 8 gold, 4 silver medals and one bronze medal were awarded to the Westinghouse Companies for their elaborate and instructive exhibits at the St. Louis Exposition. This is probably the longest and most comprehensive list of high honors ever received by associated interests at any world's fair. In addition to these prizes a special award was granted for the best, most complete and most attractive installation in the department of machinery.

Falls Hollow Stay Bolts.—An order has just been received from Japan for 28,000 lbs. of 1⅛-in., 18,000 lbs. 1¼-in. and 12,000 lbs. of 1⅜-in. Falls hollow round bars 10 ft. long, which is to be made into stay bolts by the Kiushiu Railway. Other railways of Japan and the Japanese Government are also receiving large quantities. The Norwegian State Railway uses this material exclusively for fire boxes of their locomotives, and numerous inquiries are coming from other European roads.

The Standard Roller Bearing Company of Philadelphia announces the purchase of additional land, on the main line of the Pennsylvania, at Girard avenue and Forty-eighth street, Philadelphia, and also a tract adjoining the factory on the west, with a frontage on the railroad. Upon this property a steel casting plant will be erected, also an addition to the foundry and a large addition to the factory for making steel balls. The increase in the business of the company has necessitated the purchase of a large number of tools and other equipment, which will provide increased facilities for meeting the demands from the purchasers. Mr. S. S. Eveland, manager of the company, is in charge of the improvements.

A Large Heater Installation.—Over twenty-five miles of 1-in. steam pipe is being put into 111 "A B C" heaters in the new Wanamaker building in Philadelphia by the American Blower Company of Detroit, Mich. The heating surface varies from 5,500 to 5,600 ft. in each heater. The installation includes 28 "A B C" fans, the largest being 220 in. high and the smallest 30 in. The completed apparatus will make a 10-car load shipment. Similar apparatus is being supplied by the same company for the Wanamaker building in New York. The American Blower Company has also received a contract for heating apparatus for the shops of the Philadelphia Rapid Transit Company in Philadelphia. The apparatus consists of a heater containing 5,700 ft. of 1-in. pipe and 10-ft. fan with a 7-ft. wheel operated by direct connected motor.

Electric Traction on Long Island Railroad.—The Westinghouse Electric & Manufacturing Company has sold to the Pennsylvania Railroad double motor equipments for 122 cars, with Westinghouse multiple unit control for these cars and for 61 trailers. These equipments will be used by the Pennsylvania for its Long Island suburban traffic, and will be put into operation next spring. The motors will be of the latest Westinghouse type, with a rating of 200 h.p. each; they will embody the most modern ideas in both electrical and mechanical design, and will possess an extremely liberal overload capacity. The Westinghouse Company has been very successful in the design of railway motors, and in the design of this equipment will undoubtedly maintain its very enviable reputation. The machinery for the Long Island power plant which is now being installed is supplied by the Westinghouse Company, and will include three-turbo-generators, each having a capacity of 5,500 kilowatts as a notable part of the plant.