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WE GUARANTEE, that of this issue 7,350 copies were printed; that of these 7,350 copies 6,729 were mailed to regular paid subscribers, 11 were provided for counter and news company sales, 224 were mailed to advertisers, 8 were mailed to employees and correspondents and 378 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 7,350, an average of 7,350 copies a week.

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EDITORIALS

Controlling Production in Railroad Shops

The problems of management in railroad shops are quite different from those of most other industries. In the average manufacturing plant, the production of the product is an end in itself. In railroad shops the repair of locomotives and cars is an important, but yet an incidental, part in the production of transportation. The output of the shops is necessarily subordinated to operating requirements and the result is often very unfavorable. There is scarcely a day when there is not some emergency work requiring the attention of the shop executives. These constant disruptions of plans for handling work are probably the most serious handicaps to the introduction of a well-planned system of railroad shop management.

It is apparent that the management of a railroad shop is in many ways more difficult than the management of an industrial plant, which in general operates under fairly uniform conditions, yet in spite of this fact, practically every railroad shop officer has to depend on his own resources in organizing the operations of the shop. There is no one to whom he can delegate the work of making a systematic analysis of conditions and means of improving them. It would seem that one of the prime needs in many shops is some method of obtaining definite information on which to base recommendations for changes in methods. At every large shop, at least, there should be a man to check up the processes of the shop and devise new methods of cutting costs. He would find a wide field of usefulness and, with the proper co-operation, would no doubt be able to reduce the waste that now exists because of lack of systematic analysis of costs. Among the subjects to which he might give attention are the routing of work; the improvement or replacement of obsolete tools; methods for quantity production by the use of jigs and fixtures; the regulation of speeds and feeds of machine tools; methods of handling material about the shops and labor turnover. These are items which shop officers cannot give sufficient attention and their neglect is responsible for a great deal of waste and inefficiency.

Boiler Plant Efficiency

Some pertinent test data and conclusions regarding actual and ideal boiler plant efficiency are included in an article in this issue. As a rule, the power plants which furnish power, heat and light for railroad shops and engine terminals receive little attention by higher officers as long as they function without interruption. It is true that taken in the aggregate, however, they represent an immense investment with great possibilities either in the way of inefficient and costly, or efficient and economical operation. The difference between these two conditions may be represented by the difference between boiler efficiencies of 45.3 and 78.1 per cent, or in an ideal case 90 per cent. It would not be difficult to get a comparatively close estimate of the number of thousand tons of coal utilized in railway power plants and figure out what this difference in boiler efficiency means in dollars and cents.

It is undoubtedly true that many existing railway boiler installations can be improved in efficiency at a comparatively slight cost, either by the adoption of means to reduce excess air to the required amount, eliminate excessive flue gas temperature, insure complete combustion, or reduce the carbon loss in ash. The features of an ideal boiler installation are summarized in the last part of the article and it is suggested that by comparing actual conditions with those necessary for the most efficient boiler operation, power plant engineers can ascertain the changes which in any individual case are needed to produce important savings.

There is an awakening appreciation on the part of railroad men of the possibilities of economy in power plant operation and this fact is demonstrated in the replies to a questionnaire recently sent out to leading railroads. These replies showed that in many cases railroads are not only planning improved methods but are to purchase new power plant equipment, including boilers, automatic stokers, economizers, modern air compressors and other improved power plant machinery. The watchwords adopted by American industry for 1922 are—Eliminate Waste, Increase Efficiency and Stimulate Production—and it is to be hoped that this program will be adopted and carried out in all departments of railroads, including the mechanical department which is responsible for back shop, engine terminal and power plant operation.

Look After Air Leak Losses

The day when compressed air was looked upon mainly as a convenience, and when the requirements of the ordinary railroad shop or roundhouse could be supplied by one or more second-hand air-brake pumps, when the air mains were of small size pipe extended indefinitely, has long since passed. Today compressed air is so vitally essential to the economical operation of a railroad shop, no matter what the size, that it is common to find a central station well equipped with suitable motor or steam driven air compressors. The modern shop has a well laid out and conveniently located system of air mains of a size suitable to eliminate excessive losses due to air friction.

The importance of an adequate supply of compressed air is well recognized and if the compressors are of a sufficient capacity to meet the demands it is all too often assumed that conditions are satisfactory. Leakage may, however, be forcing the compression of a much larger amount of air than is used for the actual work done. Inasmuch as the leakage of compressed air, unlike steam or water, is invisible, the magnitude or even the existence of such losses is often unrecognized. The expense resultant from a small but continuous drain on the air supply will in a short time run up to a sum, the extent of which all too few realize.

One of the best checks, and one which should be applied at regular intervals, is to pump up the air to full pressure with all air tools or machines shut down, and then note the number of strokes being made by the compressor, and then shut down the compressor and note the rate at which the air pressure falls. From the size of the compressor or from the capacity of the air reservoirs and mains an approximation of the leakage losses can be calculated and an estimate made of the cost of such losses. This test usually will have to be made at night or some time when the consumption of air can be entirely, or at least nearly suspended. How many, we wonder, would care to give out the results of such a test?

Part of the leakage is usually traceable to leaks at pipe joints or at gaskets and can be detected by a systematic application of the well-known soap suds test. Much of the loss is also in many instances caused by leaky stop cocks or valves. Another large source of waste of a different character occurs where an air nozzle is used for blowing out or cleaning purposes. The orifice is frequently larger than necessary and the air consumption is correspondingly increased. Then again the air may be used for a larger period than necessary. To reduce air consumption the valve used in connection with a blowing nozzle invariably should be of the self-closing type that will not remain open longer than it is held open by the operator.

Systematic tests and regular inspections for leakage are of as much importance in connection with the shop compressed air system as in connection with the air brake piping system of cars and locomotives. If properly attended to, and mains, cocks and air tools kept in good working condition, the resultant saving will repay all effort and expense involved.

The New National Working Rules

It would probably be difficult to enumerate all of the causes which led to the complete loss of morale suffered by railway shop organizations during the war. But it may be stated with assurance that the sudden and amazing dissolution of the bonds of discipline was very largely brought about by the policies of the United States Railroad Administration. While listening with a sympathetic ear to every plea from the ranks, the impression was allowed to grow unchallenged that all officers charged with responsibility were of evil origin and intent. Hence it seemingly became a matter of high moral duty to circumvent these creatures of the devil in the exercise of their authority. If any doubts were ever felt as to the orthodoxy of this attitude they were finally set at rest by the terms of the national agreement which, with the interpretation thereto, developed into a cunningly devised labyrinth of obstructions wherein to entangle and hinder the supervisory forces in the pursuit of their purposes. The punitive and restrictive features of the old national agreements, bad as they were in their direct effect, were indirectly even more vicious in the stamp of approval which they seemed to place on the practice of insubordination and peaceful sabotage.

In their case before the Labor Board the railroads pled for the abrogation of national rules and working conditions. In a decision rendered April 14, 1921, the Labor Board directed the officers and employees on each road to negotiate local agreements in accordance with the terms of the Transportation Act. The power of the Railway Employees Department of the American Federation of Labor, acquired during Federal control, was great enough, however, to prevent local modifications of the rules and in the absence of local or regional boards of adjustment the whole controversy was forced back before the Labor Board for final settlement. Obviously, any settlement other than on a national basis would have been extremely difficult if not impossible from a national body acting on evidence presented by the railroads as a whole. The perpetuation of national rules may therefore be attributed largely to the loss of morale and antagonism created between the men and railroad officers during the war. Had a reasonable degree of co-operation been possible, unhindered by outside influences, satisfactory local agreements might have been negotiated.

There are undoubtedly many features of the rules that are still unnecessarily restrictive. It is highly encouraging, however, to find a large measure of consideration for the practical necessities of railroad operation in the revised rules, which carries with it the inference at least that the purposes of railway officers in the discharge of their responsibility may not be entirely of evil origin. The fact that where the new rules are similar to those in the so-called national agreement they do not carry with them the interpretations of the United States Railroad Administration or its adjustment boards is further justification for a feeling of hope, since the general trend of the new rules suggests that a spirit of helpfulness may prevail in the establishment of future interpretations.

It is also worthy of note that where local agreements have been established, they are not disturbed by the new national rules. This fact, together with the provision of a new rule to protect unorganized or minority employees in representation of their own choosing in the handling of grievances, suggests that the whole course of future negotiations between the railroads and their shop employees depends largely on the nature of the relations that local officers are able to establish between themselves and their employees. A foundation has been laid on which it may be possible to rebuild a structure of mutual respect and co-operation, which in the long run will do more to restore efficient and economical maintenance of equipment than the complete elimination of all rules and working conditions, accomplished at the price of increased dissatisfaction and suspicion on the part of the shop employees.

Selecting Machine Tools

During the past year, the *Railway Mechanical Engineer* has given considerable space to the problem of properly selecting machine tools for railroad shops. Doubtless the greatest present difficulty is in getting necessary appropriations to pay for new machinery, but the problem of second importance is to know what machines should be purchased in order that appropriations already secured may be spent to the best advantage. It is felt, therefore, that in view of the great importance of the subject, another article on the "Selection of Railroad Shop Machine Tools," written by an expert on the subject and published elsewhere in this issue, will be read with interest.

The article is quite general in character and discusses the uses and advantages of different types of machines, but places particular emphasis upon production machine operations as performed on modern milling and grinding machines. It is pointed ont that the plain and vertical knee-type milling machines have outgrown their toolroom days and reached a size and power warranting use for more general machine operations in railroad shops. There are many parts, such as pedestal shoes and wedges, rod keys and brasses, valve motion rods and many others too numerous to mention, for the machining of which knee-type millers are most effective tools. High production can be secured when using coarse tooth, high-speed steel cutters, adaptable to heavy feeds and speeds. In the case of the vertical spindle machine, both cutting feeds and speeds can be increased wherever the nature of the work permits steadying the lower end of the cutter by a supporting bracket bolted to the column of the machine.

Holding fixtures are extremely important and often limit the ontput, so neither time nor expense should be spared in providing a sufficient number of these capacity-increasing devices. It is pointed out, and truly, that many machine manufacturers maintain engineering service departments composed of experts whose duty it is to assist purchasers in getting the best results from modern machines. The railroads should benefit from the knowledge and experience of these men and consult them in designing special holding fixtures and determining the most effective methods of setting up work. The advantages of slab and heavy vertical millers for rod work are more generally understood by railroad men and receive only passing comment in the article.

In discussing the importance of grinding the statement is made that "In the railway shop of the future every smooth bearing surface that can be reached by a grinding wheel will be finished by grinding." This is a venturesome prophecy which may, and we hope will, be fulfilled in the near future, but the length of time needed to bring about the fulfillment can be greatly reduced by a more open-minded, receptive attitude on the part of many railroad shop men. Grinding machines deserve a fair trial, which they have seldom had in railroad shops. It is not the purpose of this editorial to discuss the advantages of grinding at any great length, but as a machine operation it has proved invaluable in the automotive and other industries. Is there any essential reason why similar economies could not be effected by its use in railroad shops? Some railroad shop men are now awake to the value of grinding machines, but it is to be feared that many others do not realize the full possibilities. Doubters can be convinced by the simple expedient of visiting manufacturing plants and a few railroad shops now profiting by advanced grinding practice and seeing with their own eyes what is actually being accomplished.

Modern grinding machines are adapted to finishing certain machine parts from the rough, but probably their most effective use is in the rapid, smooth and accurate finishing of parts already roughed out on some other type of production machine. In addition to piston and valve rods, the plain cylindrical grinder is recommended for grinding both locomotive and car axles and the hope is expressed that manufacturers will some day develop a machine for grinding locomotive driving journals with the wheels mounted. For the heavy surface grinder, especially when equipped with a magnetic chuck, there are uses without number.

Another point strongly emphasized in the article is that the introduction of almost any modern machine will be followed by the development of unexpected uses. For example, a planetary, internal grinder was installed at a certain shop with more or less misgivings on the part of the management for fear there would not be enough internal grinding on valve motion levers, rod bushing and knuckle pin fits, etc., to keep the machine busy and pay interest on the investment. What was the result? It developed that triple valves could be reclaimed on this machine by grinding the worn cylinders and soon triple valves from all over the system were being sent in for repairs; the machine was overcrowded with work and it was found necessary to install a second one.

There is food for thought in the author's concluding statement: "If the manufacturers who are in the business to make money find grinding a paying proposition, the process must possess merits that railroad men cannot afford to ignore."

NEW BOOKS

Material Handling Cyclopedia. Edited by Roy V. Wright and John G. Little. Bound in cloth and leather; 850 pages, 1,500 illustrations. 11½-in. by 8½-in. Published by the Simmons-Boardman Publishing Company, Woolworth Building, New York City. Price, cloth $10.00, leather, $15.00.

This is the latest addition to the library of transportation literature published by the Simmons-Boardman Publishing Company. The volume is a companion book of the Car Builders' Dictionary and Cyclopedia, the Locomotive Dictionary and Cyclopedia, the Shipbuilding Cyclopedia and the Maintenance of Way Cyclopedia.

The purpose of this cyclopedia has been to bring together in a single volume complete, practical working information about the many types of material handling devices used in industry. It has been the aim to make the contents of interest and value alike to the executive interested in reducing handling costs and to the operating man who is seeking information as to the types of material handling machines best suited for his needs, how they operate and where they may be obtained.

The Definition Section in addition to its purpose as a dictionary of material handling items, methods and devices, serves as an index to other sections of the book. Following the definition of each device receiving further treatment in the book is a reference to the page in the Text Section or Catalog Section on which the additional information appears. Thus, from the definition the reader is referred not only to the detail description, method of operation, and illustration of the device given in the Text Section, but as well to the page in the Catalog Section where the device which he has selected as best suited for his needs is described authoritatively by the manufacturers.

The Illustrated Text Section, which directly follows the Definition Section, has been sub-divided into divisions corresponding to the general classification of machines. Thus the text contains separate sections devoted to Hoisting Machinery; Conveyors; Elevators; Industrial and Motor Trucks, Tractors and Trailers; Industrial Rail Transportation Track, Cars and Locomotives, and Handling Systems. Each section is fully illustrated, the illustrations showing typical applications of the various machines as well as their general characteristics and appearances.

A Catalog Section of 150 pages supplements the information shown elsewhere in the book. In it the manufacturers of machines present detail descriptions and illustrations of particular devices referred to in the other sections of the book.

A General Subject Index covering the entire contents of the book is an additional help in making the information readily available.

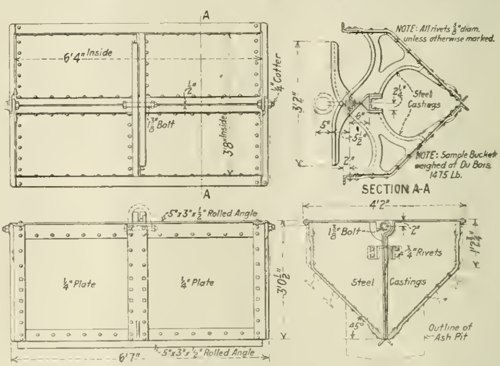
COMMUNICATIONS

A Substantial Cinder Pit Bucket

Du Bois, Pa.

To the Editor:

On page 707 of the November *Railway Mechanical Engineer* there is an article entitled "Construction and Maintenance of Cinder Pits," describing and illustrating forms of pits and apparatus for handling cinders, as employed by a number of railroads.

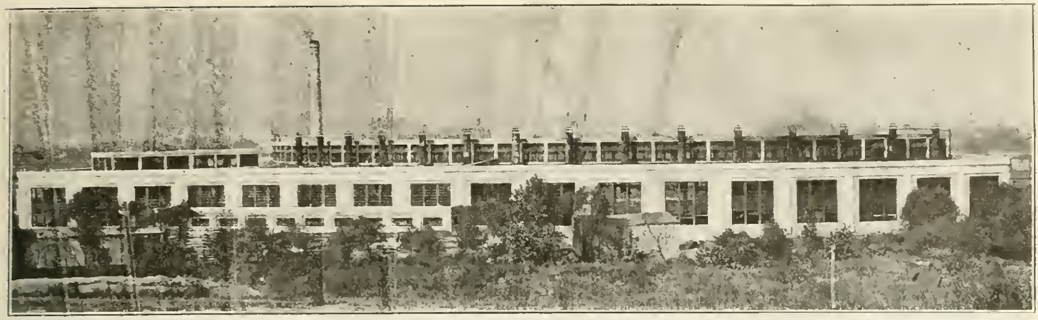


Cinder Grab Bucket Made with Cast Steel Ends, Tie Members and Scissor Arms

Fig. 4, page 708, describes a type of pit employed by the Buffalo, Rochester & Pittsburgh. When first put in service the buckets used with this arrangement were constructed of rolled shapes, plates and forgings, and the rapidity with which they were destroyed on account of the hot ashes and the resultant warping and corrosion was rather alarming.

With a view to prolonging the life of the buckets, a design was prepared and buckets built having cast steel ends, cast steel tie members and cast steel scissor arms. The accompanying drawing illustrates the buckets now used from which long service is obtained at a small cost for upkeep.

William J. Knox,
Mechanical Engineer, B. R. & P.



The Simplicity and Harmony of the Design Is Admirably Shown Here

New Roundhouse and Shops for Central of Georgia

Columbus, Ga., Locomotive Terminal a Compact, Well Equipped, United Plant, Designed for Economical Operation

By W. H. Fetner

Superintendent of Motive Power, Central of Georgia

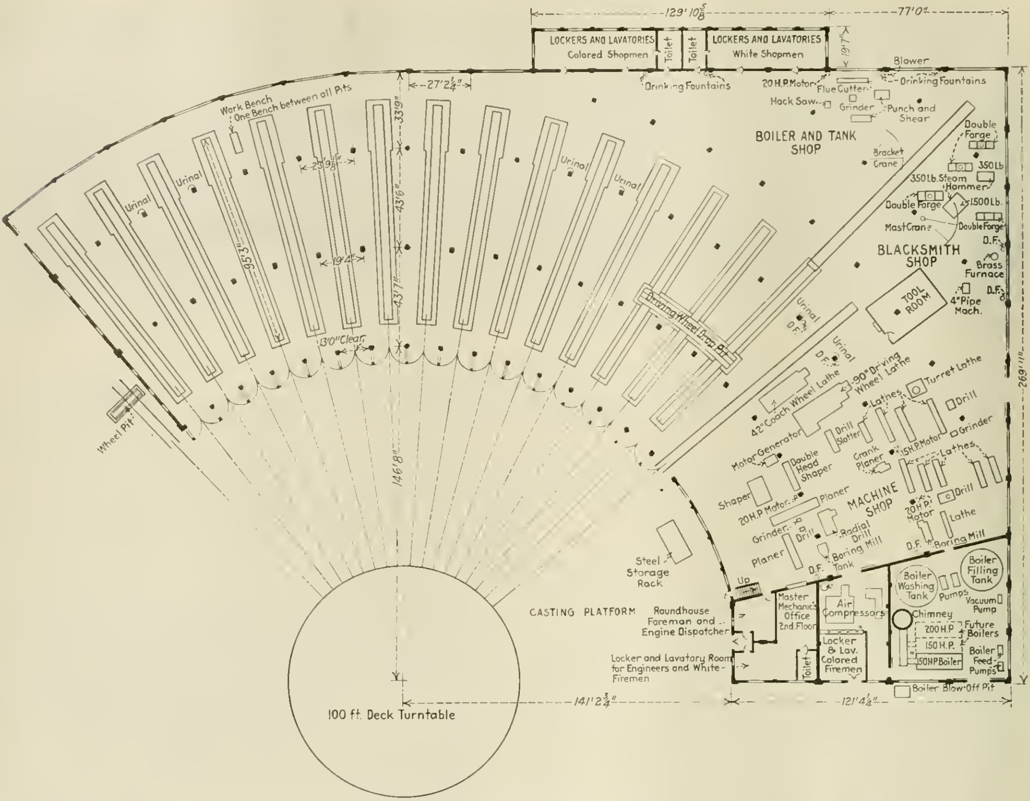
THE Columbus division of the Central of Georgia, between Birmingham, Ala., and Columbus, Ga., carries a heavy traffic from the Birmingham coal and iron fields. For handling this business locomotives of the 2-6-6-2 Mallet type are used. The Eastern terminus of this division is at Columbus which is 100 miles from Macon, Ga., where the principal shops of the road are located. In order to take care of this power properly, the Central of Georgia has replaced the terminal facilities at this point, which were formerly inadequate, with a new terminal which is equipped with all the facilities needed for making running or heavy repairs to the Mallet engines. The new terminal is really a combined shop and roundhouse, as the one building has 15 radial tracks served by a traveling crane, and a machine, boiler and blacksmith shop all under one roof. This arrangement was chosen because experience with a combined roundhouse and shop on another division had proved economical in operation, especially as regards supervision.

The shape of the building was largely determined by the site on which it is located. The stalls are laid out in the usual manner around a 100-ft. turntable. Fifteen stalls have now been built, but the plan provides for nine more stalls whenever the space is needed. The shop is located in an extension of the roundhouse. The outer walls of the building follow the pits for the first seven stalls, and then extend out in a straight line, forming one wall of the shop section. The other wall of the shop extends at right angles, making the outline of the house partly circular and partly rectangular and giving a triangular space for the shop between the walls and the outer ends of the pits, in addition to that formed by extending the circle beyond the stalls.

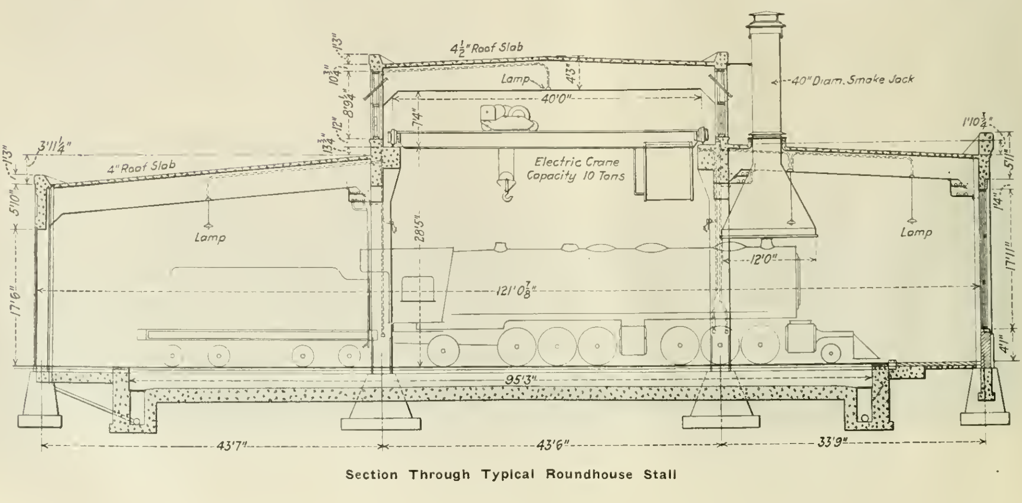
The roundhouse is of reinforced concrete construction throughout with wood block floors. The stalls are 120 ft. long divided into three sections, the center section forming a monitor and being equipped with a 10-ton electric overhead crane which serves the 15 pits and the machine shop as well. The long spans in the roundhouse increase the cost of the building somewhat, but the unobstructed working space between the pits is a decided advantage. The distance from the center of the turntable to the inner wall of the roundhouse has been made great enough to give a 13 ft. clear door opening without having the tracks cross before reaching the turntable, thus avoiding frogs which are expensive to maintain. The 100-ft. turntable is operated by a 30 h.p. motor.

A continuation of the roundhouse, equivalent to four stalls, is now used in conjunction with the triangular portion of

The Effectiveness of the Lighting and Ventilation Produces a Clear Interior



General Floor Plan of Roundhouse and Shops



Section Through Typical Roundhouse Stall the building for machine tools. The three stalls adjacent to the machine shop are fitted up with drop pits to take care of all driving wheel repairs. All three pits are connected and equipped with an air jack and truck. A tender wheel drop pit with an air jack is provided outside of the building.

Two cinder pits are located in the yard, the ashes being handled by two double bucket conveyors.

The equipment of shop tools is adequate for taking care of the heaviest class of repair work. The layout has been carefully planned to give the most convenient arrangement. The two heaviest tools, a heavy duty 90-in. driving wheel lathe and a 42-in. wheel lathe, both with individual motor drive, have been located close to the drop pits and wheel tracks and under the traveling crane. In addition, the following tools are also served by the crane:

One 100-ton hydraulic press.
One 6-ft. radial drill—motor-driven.
One 18-in. rapid production slotter—motor-driven.
One 25-in. heavy duty lathe—motor-driven.
One 24-in. crank planer—motor-driven.

The remaining machine tools are arranged in three groups, each group being motor driven and consisting of the following:

GROUP NO. 1

One 26-in. double-head shaper.	One 20-in. emery grinder.
One 20-in. single-head shaper.	One 51-in. boring mill.
Two 36-in. planers.	One 16-in. shaper.
One twist drill grinder.	One 20-in. double head grinder.

GROUP NO. 2

One 27-in. lathe.	One 4-ft. drill.
One 24-in. lathe.	One 2-in. double head bolt cutter.
Two 18-in. lathes.	One 36-in. vertical turret.

GROUP NO. 3

One 36-in. lathe.	One 4-ft. radial drill.
One 24-in. lathe.	One 12-in. brass lathe.
One 14-in. lathe.	One 3-in. by 36-in. turret lathe.
One 18-in. turret lathe.	One sensitive drill.
One 3-in. turret lathe.	One horizontal boring mill.

A 10-ton capacity overhead traveling electric crane operates the entire length of the center bay, passing over the 15 engine pits in the roundhouse, the drop pits and the machine shop. Jib and bracket cranes are provided in the machine and blacksmith shops.

The Beginning of the Radial Section—A Business-Like Round House

The pipe shop is equipped with a 4-in. motor-driven pipe machine. A tilting brass furnace using crude oil as fuel, two coke metal fires and a portable fuel oil burner are used for heating and metaling crosshead shoes, etc.

A tool room 20 ft. by 20 ft. is located in a position convenient for the machine shop and roundhouse forces and is well equipped with shelving and racks for holding the equipment.

The blacksmith shop is equipped with two double forges with space for doubling this capacity in the future. There is also one open or heavy fire served by a two-ton mast crane which also serves the 1,500-lb. steam hammer. A 350-lb. steam hammer takes care of the small work. Other tools

An Interior View Showing the Crane Bay

and facilities have been installed in quantity and character necessary to round out the facilities in making economical repairs. A No. 7 blower supplies the blast for the forges and fires in the blacksmith shop and also takes care of the flange fire in the boiler shop.

The boiler shop is provided with two punching and shearing machines, a double head grinder, a hack saw and a flue cutter. The flange fire is served by a two-ton bracket crane. The boiler and power house contains one water-tube boiler of 150 hp. capacity. Foundations have been provided for the future installation of additional boilers. The chimney of reinforced concrete, 110 ft. high, is located in the boiler room and is designed to care for 500 boiler hp. A creosoted timber trestle is located outside of the boiler room and provides for the delivery of coal by gravity to the boiler room door.

The air compressor room contains two compressors of the two-stage type, one of 1,000 cu. ft. capacity and one of 320 cu. ft. capacity, both motor driven. The whole plant is liberally supplied with air pipe lines and drops.

A strictly modern boiler washing plant is located in the boiler room. This consists of pumps, tanks, etc., with a pipe line and drop running to each engine stall. The boiler feedwater is taken from these tanks by a duplex plunger pump and delivered to the boiler at 160 deg. F. This arrangement supplies the boiler with clean, hot water and a feedwater heater is not required.

No provision was made for generating electric current as the current for light and power is obtained from a local hydro-electric company at a reasonable rate. A fireproof brick and concrete transformer house, just south of the main building, receives current at 11,000 volts which is stepped down to 440 volts for use in the shops. A motor-generator set supplies the direct current required for the motor-driven wheel lathes and other machines where alternating current can not be used.

The buildings are unusually well provided with windows for natural light and, in addition, a very effective lighting system has been worked out. The absence of shadows is particularly noticeable.

Shops, locker rooms and offices are heated by a direct radiation vacuum-return, low-pressure steam system. Cast-iron wall radiators are located in the columns and on the brick walls beneath the windows. Radiation in the engine pits is not necessary in this climate.

Ample provision has been made for locker room and toilet facilities, separate accommodations being provided for white and colored employees. Individual wash basins are used and shower baths with hot and cold water are supplied as well as sanitary water closets and steel lockers. Similar conveniences and accommodations have been provided for the engineers and firemen. Sanitary drinking fountains and urinals are conveniently located in the roundhouse and shops.

Additional terminal developments in Columbus which will be made at some future time include a modern coaling station and inspection pit and a rearrangement of the freight yard.

Excellent Facilities Are Provided in the Machine Shop

New Freight Locomotives for Russia

The first of an order of 1,000 locomotives of the 0-10-0 type for the Russian government has recently been delivered by the Nydquist and Holm Aktiebolag of Trollhattan, Sweden. The company's contract calls for the delivery of 50 locomotives this year, 200 next year, and 250 in each of the three subsequent years.

Many of the principal dimensions of these locomotives correspond closely with the Russian 2-10-0 type built by American and Canadian companies during the war, some of which are now in service in this country. The locomotives built in Sweden, however, have slab frames and Belpaire fireboxes. The tabulation shows a comparison of the principal dimensions of the Swedish built 0-10-0 and the American built 2-10-0 types.

Type	0-10-0	2-10-0
Gage	5 ft.	5 ft.
Cylinders, diameter	25.59 in.	25 in.
Cylinders, stroke	27.56 in.	28 in.
Driving wheels, diameter	51.97 in.	52 in.
Boiler heating surface	2,229.2 sq. ft.	2,610 sq. ft.
Superheater surface	548.2 sq. ft.	579 sq. ft.
Working pressure	170.6 lb. per sq. in.	180 lb. per sq. in.
Grate area	48 sq. ft.	64.6 sq ft.
Tractive effort	38,590 lb.	51,506 lb.
Weight in working order	178,000 lb.	201,000 lb.
Maximum height above rail	17 ft. 1 in.	16 ft. 11 in.

On account of the extreme height of these engines and the broad gage, it was necessary to dismantle them and ship them on trucks, or special wheels by rail through Sweden and Finland.

New Rules for Shop Crafts Issued by Labor Board

Provisions Made More Elastic; Rights of Minorities Recognized—Many Old Rules Retained

An important decision announcing new rules governing the working conditions for the 400,000 employees in the mechanical departments of the railroads, was handed down by the Labor Board on December 1, becoming effective the same date. The board estimated that the rules might save the roads as much as $50,000,000 a year. In general, the new rules are similar to the National Agreement, but include revisions which eliminate some of the provisions which proved serious handicaps to the economical operation of shops and roundhouses. The most important changes are those relating to overtime and piecework which were announced earlier in Decision 222, issued by the Labor Board in August, and addendum No. 3 to Decision 222, issued in October.

In the announcement of the decision, the Labor Board stated that the rules had been made more elastic to secure greater efficiency. Many criticisms of the National Agreement have been met, but older rules sanctioned by experience are retained. The principle of collective bargaining and union recognition embodied in the Transportation Act is retained in the new rules while representation of minorities in grievance cases is provided for, thus doing away with that part of the National Agreement criticized as forcing the closed shop on the railroads.

The National Agreement contained 186 rules and of these 99 are to be continued. Of the remainder, 14 have been eliminated and minor changes have been made in the others. All of the rules outlining qualifications for the various classes of shopmen have been retained with the exception of a slight change in the case of electrical workers. The rules relating to the classification and services of apprentices, the eligibility of helpers for promotion to helper apprentices, and the differential rules for autogenous welders have been perpetuated. Of the rules eliminated, the most important is Rule 24 relating to court duties of employees.

Several changes have been made which undoubtedly will give railroad officers better control of shop conditions. Rule 27 has been changed so that shop hours may be reduced to 40 hours per week before reductions in the force are made. Another important change is included in Rule 40 which creates three classes of apprentices: regular, helper and special. Provisions are made for three-year special apprenticeships for young men with technical school training.

Rules 32 and 33 have been changed so that men at outlying points may be permitted to perform repair work other than that listed for their crafts instead of necessitating temporary transfers of employees at heavy expense. The rigid limitations on the work performed by each craft have been modified by changes in the rules which permit a machinist to do any connecting or disconnecting of wires, couplings or pipe connections, necessary to complete his work.

In general, the changes in the rules are such as to promote more economical and efficient operation, especially when compared with conditions during Federal control. It is significant that the decision closes with a statement that those rules which are identical with rules of the National Agreement are not to be understood as carrying with them the interpretations placed upon them by the Railroad Administration, or by the Adjustment Boards, or by other agencies acting under the administration.

The complete text of the new rules, including the special rules for each craft, is given herewith:

General Rules

NOTE—For the purpose of ready reference, the rules previously adopted and promulgated by the Labor Board are hereby reproduced and are indicated as follows: A single asterisk is used to designate the rules, effective August 16, 1921, which were approved by the Labor Board and promulgated in Decision No. 222. A double asterisk is used to designate the rules effective October 16, 1921, which were approved by the Labor Board and promulgated in Addendum No. 3 to Decision No. 222.

Hours of Service

**Rule 1—Eight hours shall constitute a day's work. All employees coming under the provisions of this agreement, except as otherwise provided in this schedule of rules, or as may hereafter be legally established between the carrier and the employees, shall be paid on the hourly basis.

This rule is intended to remove the inhibition against piece work contained in rule 1 of the shop crafts' national agreement and to permit the question to be taken up for negotiation on any individual railroad in the manner prescribed by the Transportation Act.

**Rule 2—There may be one, two or three shifts employed.* The starting time of any shift shall be arranged by mutual understanding between the local officers and the employees' committee based on actual service requirements.

The time and length of the lunch period shall be subject to mutual agreement.

**Rule 3, Rule 4, Rule 5—Provided for in Rule 2.

Overtime—Emergency Service—Road Work

Rule 6—All overtime continuous with regular bulletined hours will be paid for at the rate of time and one-half until relieved, except as may be provided in rules hereinafter set out.

Work performed on Sundays and the following legal holidays—namely, New Year's Day, Washington's Birthday, Decoration Day, Fourth of July, Labor Day, Thanksgiving Day and Christmas (provided when any of the above holidays fall on Sunday, the day observed by the State, Nation or proclamation shall be considered the holiday), shall be paid for at the rate of time and one-half, except that the employees necessary to the operation of power houses, millwright gangs, heat-treating plants, train yards, running-repair and inspection forces, who are regularly assigned by bulletin to work on Sundays and holidays, will be compensated on the same basis as on week days. Sunday and holiday work will be required only when absolutely essential to the continuous operation of the railroad.

*Rule 7—For continuous service after regular working hours, employees will be paid time and one-half on the actual minute basis with a minimum of one hour for any such service performed.

Employees shall not be required to work more than two hours without being permitted to go to meals. Time taken for meals will not determine the continuous service period and will be paid for up to 30 minutes.

Employees called or required to report for work and reporting but not used will be paid a minimum of four hours at straight-time rates.

Employees called or required to report for work and reporting will be allowed a minimum of four hours for two hours and 40 minutes or less, and will be required to do only such work as called for or other emergency work which may have developed after they were called and cannot be performed by the regular force in time to avoid delays to train movement.

Employees will be allowed time and one-half on minute basis for services performed continuously in advance of the regular working period with a minimum of one hour—the advance period to be not more than one hour.

Except as otherwise provided for in this rule, all overtime beyond 16 hours' service in any 24-hour period, computed from starting time of employees' regular shift, shall be paid for at rate of double time.

**Rule 8—Employees regularly assigned to work on Sundays or holidays, or those called to take the place of such employees, will be allowed to complete the balance of the day unless released at their own request. Those who are called will be advised as soon as possible after vacancies become known.

*Rule 9—Employees required to work during, or any part of, the lunch period, shall receive pay for the length of the lunch period regularly taken at point employed at straight time and will be allowed necessary time to procure lunch (not to exceed thirty minutes) without loss of time.

This does not apply where employees are allowed the 20 minutes for lunch without deduction therefor.

*Rule 10—An employee regularly assigned to work at a shop, engine house, repair track, or inspection point, when called for emergency road work away from such shop, engine house, repair track, or inspection point, will be paid from the time ordered to leave home station until his return for all time worked in accordance with the practice at home station and straight-time rate for all time waiting or traveling.

If during the time on the road a man is relieved from duty and permitted to go to bed for five or more hours, such relief time will not be paid for, provided that in no case shall he be paid for a total of less than eight hours each calendar day, when such irregular service prevents the employee from making his regular daily hours at home station. Where meals and lodging are not provided by railroad, actual necessary expenses will be allowed.

Employees will be called as nearly as possible one hour before leaving time, and on their return will deliver tools at point designated

If required to leave home station during overtime hours, they will be allowed one hour preparatory time at straight-time rate.

Wrecking-service employees will be paid under this rule, except that all time working, waiting or traveling on Sundays and holidays will be paid for at rate of time and one-half, and all time working, waiting or traveling on week days after the recognized straight-time hours at home station will also be paid for at rate of time and one-half.

Distribution of Overtime

Rule 11—When it becomes necessary for employees to work overtime they shall not be laid off during regular working hours to equalize the time.

At points where sufficient number of employees are employed, employees shall not (except as provided in rule 6 of Decision 222) work two consecutive Sundays (holidays to be considered as Sundays).

Record will be kept of overtime worked and men called with the purpose in view of distributing the overtime equally.

Temporary Vacancies

*Rule 12—Employees sent out to temporarily fill vacancies at an outlying point or shop, or sent out on a temporary transfer to an outlying point or shop, will be paid continuous time from time ordered to leave home point to time of reporting at point to which sent, straight-time rates to be paid for straight-time hours at home station and for all other time, whether waiting or traveling. If on arrival at the outlying point there is an opportunity to go to bed for five hours or more before starting work, time will not be allowed for such hours.

While at such outside point they will be paid straight time and overtime in accordance with the bulletin hours at that point, and will be guaranteed not less than eight hours for each day.

Where meals and lodgings are not provided by the company, actual necessary expenses will be allowed.

On the return trip to the home point, straight time for waiting or traveling will be allowed up to the time of arrival at the home point.

Overtime Changing Shifts

Rule 13—Employees changed from one shift to another will be paid overtime rates for the first shift of each change. Employees working two shifts or more on a new shift shall be considered transferred. This will not apply when shifts are exchanged at the request of the employees involved.

Overtime Regular Assigned Road Work

*Rule 14—Employees regularly assigned to road work whose tour of duty is regular and who leave and return to home station daily (a boarding car to be considered a home station), shall be paid continuous time from the time of leaving the home station to the time they return whether working, waiting or traveling, exclusive of the meal period, as follows:

Straight time for all hours traveling and waiting, straight time for work performed during regular hours, and overtime rates for work performed during overtime hours. If relieved from duty and permitted to go to bed for five hours or more, they will not be allowed pay for such hours. Where meals and lodging are not provided by the company when away from home station, actual expenses will be allowed.

The starting time to be not earlier than 6 a. m. nor later than 8 a. m. Where two or more shifts are worked, the starting time will be regulated accordingly.

Where employees are required to use boarding cars, the railroad will furnish sanitary cars and equip them for cooking, heating and lodging; the present practice of furnishing cooks and equipment, and maintaining and operating the cars, shall be continued.

Exception. In case where the schedule of trains interferes with the starting time an agreement may be entered into by the superintendent of the department affected and the general chairman of the craft affected.

*Rule 15—Employees regularly assigned to perform road work and paid on a monthly basis shall be paid not less than the minimum hourly rate established for the corresponding class of employees coming under the provisions of this schedule on the basis of 365 eight-hour days per calendar year. The monthly salary is arrived at by dividing the total earnings of 2,920 hours by 12; no overtime is allowed for time worked in excess of eight hours per day; on the other hand, no time is to be deducted unless the employee lays off of his own accord.

The regularly assigned road men under the provisions of this rule may be used, when at home point, to perform shop work in connection with the work of their regular assignments.

Where meals and lodging are not furnished by the railroad, or when the service requirements make the purchase of meals and lodging necessary while away from home point, employees will be paid necessary expenses.

If it is found that this rule does not produce adequate compensation for certain of these positions by reason of the occupants thereof being required to work excessive hours, the salary for these positions may be taken up for adjustment.

Filling Vacancies

Rule 16—When an employee is required to fill the place of another employee receiving a higher rate of pay, he shall receive the higher rate: but if required to fill temporarily the place of another employee receiving a lower rate, his rate will not be changed.

Rule 17—Employees serving on night shifts desiring day work shall have preference when vacancies occur, according to their seniority.

**Rule 18—When new jobs are created or vacancies occur in the respective crafts, the oldest employees in point of service shall, if sufficient ability is shown by trial, be given preference in filling such new jobs or any vacancies that may be desirable to them. All vacancies or new jobs created will be bulletined.

Bulletins must be posted five days before vacancies are filled permanently. Employees desiring to avail themselves of this rule will make application to the official in charge and a copy of the application will be given to the local chairman.

An employee exercising his seniority rights under this rule will do so without expense to the carrier; he will lose his right to the job he left; and if after a fair trial he fails to qualify for the new position, he will have to take whatever position may be open in his craft.

Rule 19—Mechanics in service will be considered for promotion to positions of foremen. When vacancies occur in position of gang foremen, men from the respective crafts will have preference in promotion.

Rule 20—Employees transferred from one point to another, with a view to accepting a permanent transfer, will, after 30 days, lose their seniority at the point they left, and their seniority at the point to which transferred will begin on date of transfer, senioriy to govern. Employees will not be compelled to accept a permanent transfer to another point.

Rule 21—When the requirements of the service will permit, employees, on request, will be granted leave of absence for a limited time with privilege of renewal. An employee absent on leave who engages in other employment will lose his seniority, unless special provisions shall have been made therefor by the proper official and committee representing his craft.

The arbitrary refusal of a reasonable amount of leave to employees when they can be spared, or failure to handle promptly cases involving sickness or business matters of serious importance to the employee, is an improper practice and may be handled as unjust treatment under this agreement.

Rule 22—In case an employee is unavoidably kept from work he will not be discriminated against. An employee detained from work on account of sickness or for any other good cause shall notify his foreman as early as possible.

Faithful Service

Rule 23—Employees who have given long and faithful service in the employ of the company and who have become unable to handle heavy work to advantage, will be given preference of such light work in their line as they are able to handle.

Paying Off

Rule 25—Employees will be paid off during their regular working hours, semi-monthly, except where existing State laws provide a more desirable paying-off condition.

Should the regular pay day fall on a holiday or days when the shops are closed down, men will be paid on the preceding day.

Where there is a shortage equal to one day's pay or more in the pay of an employee, a voucher will be issued to cover the shortage.

Employees leaving the service of the company will be furnished with a time voucher covering all time due within 24 hours where time vouchers are issued and within 60 hours at other points, or earlier when possible (Sundays and holidays excepted).

Rule 26—During inclement weather provision will be made where buildings are available to pay employees under shelter.

Reduction of Forces

Rule 27—When it becomes necessary to reduce expenses, the hours may be reduced to 40 per week before reducing the force. When the force is reduced, seniority as per rule 31 will govern, the men affected to take the rate of the job to which they are assigned.

Forty-eight hours' notice will be given before hours are reduced. If the force is to be reduced, four days' notice will be given the men affected before reduction is made, and lists will be furnished the local committee.

In the restoration of forces, senior lay-off men will be given preference in returning to service, if available within a reasonable time, and shall be returned to their former positions if possible, regular hours to be reestablished prior to any additional increase in force.

The local committee will be furnished a list of men to be restored to service. In the reduction of the force the ratio of apprentices shall be maintained.

Rule 28—Employees laid off on account of reduction in force, who desire to seek employment elsewhere, will, upon application, be furnished with a pass to any point desired on the same railroad.

Rule 29—When reducing forces, if men are needed at any other point, they will be given preference to transfer to nearest point, with privilege of returning to home station when force is increased, such transfer to be made without expense to the company. Seniority to govern all cases.

Rule 30—Employees required to work when shops are closed down, due to breakdown in machinery, floods, fires, and the like, will receive straight time for regular hours, and overtime for overtime hours.

Seniority

**Rule 31—Seniority of employees in each craft covered by this agreement shall be confined to the point employed in each of the following departments, except as provided in special rules of each craft: Maintenance of way (bridge and building where separate from maintenance of way department). Maintenance of equipment. Maintenance of telegraph. Maintenance of signals. Four subdivisions of the carmen as follows: Pattern makers, upholsterers, painters, other carmen.

The seniority lists will be open to inspection and copy furnished the committee.

Assignment of Work

Rule 32—None but mechanics or apprentices regularly employed as such shall do mechanics' work as per special rules of each craft, except foremen at points where no mechanics are employed.

This rule does not prohibit foremen in the exercise of their duties to perform work.

At outlying points (to be mutually agreed upon) where there is not sufficient work to justify employing a mechanic of each craft, the mechanic or mechanics employed at such points will, so far as capable, perform the work of any craft that may be necessary.

Rule 33—In compliance with the special rules included in this agreement, none but mechanics and their apprentices in their respective crafts shall operate oxyacetylene, thermit, or electric welders. Where oxyacetylene or other welding processes are used, each craft shall perform the work which was generally recognized as work belonging to that craft prior to the introduction of such processes, except the use of cutting torch when engaged in wrecking service or in cutting up scrap.

When performing the above work for four hours or less in any one day, employees will be paid the welders' rate of pay on the hourly basis with a minimum of one hour; for more than four hours in any one day, welders' rate of pay will apply for that day.

Foremanship, Filling Temporarily

Rule 34—Should an employee be assigned temporarily to fill the place of a foreman, he will be paid his own rate—straight time for straight-time hours and overtime rate for overtime hours—if greater than the foreman's rate; if it is not, he will get the foreman's rate. Said positions shall be filled only by mechanics of the respective craft in their departments.

Grievances

Rule 35—Should any employee subject to this agreement believe he has been unjustly dealt with, the case shall be taken to the foreman, general foreman, master mechanic, or shop superintendent, each in their respective order, by the duly authorized local committee or their representative. Nothing herein contained shall infringe upon the right of employees not members of the organization representing the majority to present grievances in person or by representatives of their own choice.

If stenographic report of the investigation is taken, the aggrieved employee or his representatives shall be furnished a copy.

If the result still be unsatisfactory, the right of appeal shall be granted; the appeal to be made, preferably in writing, to the higher officials designated to handle such matters in their respective order and conferences will be granted within ten days of application.

All conferences between local officials and local committees to be held during regular working hours without loss of time to committeemen or other employee representation.

Rule 36—Should the highest designated railroad official, or his duly authorized representative, and the aggrieved employee, or his representative, as provided in first paragraph of rule 35, fail to agree, the case shall then be handled in accordance with the Transportation Act, 1920.

Prior to the assertion of grievances as herein provided, and while questions of grievances are pending, there will neither be a shutdown by the employer nor a suspension of work by the employees.

Rule 37—No employee shall be disciplined without a fair hearing by a designated officer of the carrier. Suspension in proper cases pending a hearing, which shall be prompt, shall not be deemed a violation of this rule. At a reasonable time prior to the hearing such employee will be apprized of the precise charge against him. The employee shall have reasonable opportunity to secure presence of necessary witnesses and shall have the right to be there represented by counsel of his choosing. If it is found that an employee has been unjustly suspended or dismissed from the service, such employee shall be reinstated with his seniority rights unimpaired, and compensated for the wage loss, if any, resulting from said suspension or dismissal.

Rule 38—Included in rule 37.

Committees

Rule 39—The company will not discriminate against any committeemen who, from time to time, represent other employees, and will grant them leave of absence and free transportation when delegated to represent other employees.

Apprentices

Rule 40—There will be three recognized classes of apprentices—namely, regular, helper, and special.

All apprentices must be able to speak, read and write the English language and understand at least the first four rules of arithmetic.

Applicants for regular apprenticeship shall be between 16 and 21 years of age, and, if accepted, shall serve four years of 290 days each calendar year. If retained in the service at the expiration of their apprenticeship, they shall be paid not less than the minimum rate established for journeymen mechanics of their respective crafts.

In selecting helper apprentices, ability and seniority will govern and all selections will be made in conjunction with the respective craft shop committees.

Note—See special rules of each craft for additional apprentice rules.

Rule 40½—Special apprentices shall be selected from young men between the ages of 18 and 26 years who have had a technical school education, and shall serve three years of 290 days each calendar year.

Special apprentices shall receive training in the various departments in the different classes of work of the different crafts in the maintenance of equipment departments, and may be moved from place to place or on any class of work at the discretion of the management.

In computing the ratio of apprentices to mechanics, special apprentices will be included, the number of same not to exceed 5 per cent of the total.

If retained in the service at the completion of the three-year course, the apprentice may choose the craft he desires employment in and shall receive a special rate for the period of one year, at the expiration of which time he shall be classified and receive the minimum rate of the craft employed in.

The rate of pay for special apprentices for the first three years shall be not less than that of helper apprentices.

Rule 41—All apprentices must be indentured and shall be furnished with a duplicate of indenture by the company, who will also furnish every opportunity possible for the apprentice to secure a complete knowledge of the trade.

No apprentice will be started at points where there are not adequate facilities for learning the trade.

Rule 40 shall govern in the employment of apprentices.

FORM OF INDENTURE

This will certify that.......................................was employed as...................................apprentice by the.................... railroad at.......................................on....................19.... to serve four years, a minimum of 290 days each.

....

(Title of officer in charge.)

SERVICE PERFORMED DURING APPRENTICESHIP

....

....

....

This will certify that on........................19.......,.............. ....completed the course of apprenticeship specified above and is entitled, if employed by the........................ railroad, to the rates of pay and conditions of service of..................

....

(Title of officer in charge.)

Note—The above form is to be used both for regular and helper apprentices. (Helper apprentices to serve three years.)

Rule 42—The ratio of apprentices in their respective crafts shall not be more than one to every five mechanics.

Two apprentices will not be worked together as partners.

The distribution of apprentices among shops where general repairs are made on the division shall be as nearly as possible in proportion to the mechanics in the respective trades employed therein.

In computing the number of apprentices that may be employed in a trade on a division, the total number of mechanics of that trade employed on the division will be considered.

If within six months an apprentice shows no aptitude to learn the trade, he will not be retained as an apprentice.

An apprentice shall not be dismissed or leave the service of his own accord, except for just and sufficient cause, before completing his apprenticeship.

Apprentices shall not be assigned to work on night shifts. An apprentice shall not be allowed to work overtime during the first three years of his apprenticeship.

If an apprentice is retained in the service upon completing the apprenticeship, his seniority rights as a mechanic will date from the time of completion of apprenticeship.

Preference will be given to sons of employees in the selection of apprentices to the extent of at least 80 per cent of the number employed.

Rates of Pay

Rule 43—The minimum rates of pay are the rates established by the Labor Board's Decision No. 147 and Addenda thereto and therefore do not apply to the carrier named in Decision No. 290 or any other carrier where wage adjustments have been made in accordance with the provisions of the Transportation Act, 1920, and the decisions of the Labor Board; these rates shall be incorporated in and become a part of this agreement or schedule, and shall remain in effect until or unless changed in the manner provided by the Transportation Act, 1920.

Rule 44, Rule 45—Included in rule 43.

Applicants for Employment

**Rule 46—Applicants for employment may be required to take physical examination at the expense of the carrier to determine the fitness of the applicant to reasonably perform the service required in his craft or class. They will also be required to make a statement showing addresses of relatives, necessary four years' experience, and name and local address of last employer.

Conditions of Shops

Rule 47—Good drinking water and ice will be furnished. Sanitary drinking fountains will be provided where necessary. Pits and floors, lockers, toilets, and wash rooms will be kept in good repair and in a clean, dry, and sanitary condition.

Shops, locker rooms, and wash rooms will be lighted and heated in the best manner possible consistent with the source of heat and light available at the point in question.

Personal Injuries

**Rule 48—Employees injured while at work will not be required to make accident reports before they are given medical attention, but will make them as soon as practicable thereafter. Proper medical attention will be given at the earliest possible moment and, when able, employees shall be permitted to return to work without signing a release pending final settlement of the case.

At the option of the injured party, personal injury settlements may be handled by the duly authorized representatives of the employee with the duly authorized representative of the carrier. Where death or permanent disability results from injury, the lawful heirs of the deceased may have the case handled as herein provided.

Notices

Rule 49—A place will be provided inside all shops and roundhouses where proper notices of interest to employees may be posted.

Shop Trains

**Rule 50—Existing conditions in regard to shop trains will be continued unless changed by mutual agreement, or unless, after disagreement between the carrier and employees, the dispute is properly brought before the Labor Board and the Board finds the continuance of existing conditions unjust and unreasonable, and orders same discontinued or modified.

The company will endeavor to keep shop trains on schedule time, properly heated and lighted, and in a safe, clean and sanitary condition. This not to apply to temporary service provided in case of emergency.

Free Transportation

Rule 51—Employees covered by this agreement and those dependent upon them for support will be given the same consideration in granting free transportation as is granted other employees in service.

General committees representing employees covered by this agreement to be granted the same consideration as is granted general committees representing employees in other branches of the service.

Protection of Employees

Rule 52—Employees will not be required to work on engines or cars outside of shops during inclement weather, if shop room and pits are available. This does not apply to work in engine cabs or emergency work on engines or cars set out for or attached to trains.

When it is necessary to make repairs to engines, boilers, tanks, and tank cars, such parts shall be cleaned before mechanics are required to work on same. This will also apply to cars undergoing general repairs.

Employees will not be assigned to jobs where they will be exposed to sand blast and paint blowers while in operation.

All acetylene or electric welding or cutting will be protected by a suitable screen when its use is required.

Emery Wheels and Grindstones

Rule 53—Emery wheels and grindstones will be installed at convenient places in the shop and will be kept true and in order.

Help to Be Furnished

Rule 54—When experienced helpers are available, they will be employed in preference to inexperienced men.

Laborers when used as helpers will be paid the helpers' rate.

Miscellaneous

**Rule 55—Work of scrapping engines, boilers, tanks, and cars or other machinery will be done by crews under the direction of a mechanic.

Rule 56—No employee will be required to work under a locomotive or car without being protected by proper signals. Where the nature of the work to be done requires it, locomotives or passenger cars will be placed over a pit, if available.

Rule 57—In shops and roundhouses not now equipped with connections for taking the steam from engines, arrangements will be made to equip them so that steam from locomotives will not be blown off inside the house.

Rule 58—All engines will be placed under smokejacks in roundhouses, where practicable, when being fired up.

Rule 59—At shops and roundhouses equipped with electricity, electric light globes and extensions will be kept in tool rooms available for use.

**Rule 60—At the close of each week one minute for each hour actually worked during the week will be allowed employees for checking in and out and making out service cards on their own time.

Machinists' Special Rules

Qualifications

**Rule 61—Any man who has served an apprenticeship or has had four years' experience at the machinists' trade and who, by his skill and experience, is qualified and capable of laying out and fitting together the metal parts of any machine or locomotive, with or without drawings, and competent to do either sizing, shaping, turning, boring, planing, grinding, finishing, or adjusting the metal parts of any machine or locomotive whatsoever shall constitute a machinist.

Classification of Work

Rule 62—Machinists' work shall consist of laying out, fitting, adjusting, shaping, boring, slotting, milling and grinding of metals used in building, assembling, maintaining, dismantling and installing locomotives and engines (operated by steam or other power), pumps, cranes, hoists, elevators, pneumatic and hydraulic tools and machinery, scale building, shafting and other shop machinery, ratchet and other skilled drilling and reaming; tool and die making, tool grinding and machine grinding, axle truing, axle, wheel and tire turning and boring; engine inspecting; air equipment, lubricator and injector work; removing, replacing, grinding, bolting, and breaking of all joints on superheaters; oxyacetylene, thermit and electric welding on work generally recognized as machinists' work; the operation of all machines used in such work, including drill presses and bolt threaders using a facing, boring or turning head or milling apparatus; and all other work generally recognized as machinists' work. On running repairs, machinists may connect or disconnect any wiring, coupling or pipe connections necessary to make or repair machinery or equipment.

This rule shall not be construed to prevent engineers, firemen and cranemen of steam shovels, ditchers, clam shells, wrecking outfits, pile drivers and other similar equipment requiring repairs on line of road from making any repairs to such equipment as they are qualified to perform.

Machinist Apprentices

Rule 63—Include regular and helper apprentices in connection with the work defined by rule 62.

Machinist Helpers

Rule 64—Helpers' work shall consist of helping machinists and apprentices, operating drill presses (plain drilling) and bolt threaders not using facing, boring or turning head or milling apparatus, wheel presses (on car, engine truck and tender truck wheels), nut tappers and faces, bolt pointing and centering machines, car brass boring machines, twist drill grinders; cranemen helpers on locomotive and car work; attending tool room, machinery oiling, locomotive oiling, box packing, applying and removing trailer and engine-truck brasses, assisting in dismantling locomotives and engines, applying all couplings between engine and tender; locomotive tender and draft-rigging work except when performed by carmen, and all other work generally recognized as helpers' work.

Assignment to Running Repairs

**Rule 65—Machinists assigned to running repairs shall not be required to work on dead work at points where dead-work forces are maintained except when there is not sufficient running repairs to keep them busy.

Dead Work

**Rule 66—Dead work means all work on an engine which cannot be handled within 24 hours by the regularly assigned running-repair forces maintained at point where the question arises.

Dead-Work and Running-Repair Forces

**Rule 67—Dead-work forces will not be assigned to perform running-repair work, except when the regularly assigned running-repair forces are unable to get engines out in time to prevent delay to train movement.

Work at Wrecks

**Rule 68—In case of wrecks where engines are disabled, machinist and helper, if necessary, shall accompany the wrecker. They will work under the direction of the wreck foreman.

Apprentices, Classification of Work

Rule 69—Apprentices shall be instructed in all branches of the machinists' trade. They will serve three years on machines and special jobs. Apprentices will not be required to work more than four months on any one machine or special job. During the last year of their apprenticeship they will work on the floor. Apprentices shall not work on oxyacetylene, thermit, electric, or other welding processes until they are in their last year.

Helper Apprentices

Rule 70—Helpers who have had not less than two consecutive years' experience as machinist helpers at the point where employed, at the time application for apprenticeship is made, may become helper apprentices. When assigned as helper apprentices they must not be over 25 years of age.

Rule 71—Helper apprentices shall serve three years, a minimum of 290 days each calendar year, and shall be governed by the same laws and rules as govern regular apprentices.

Rule 72—The number of helper apprentices must not at any time exceed 50 per cent of the combined number of regular and helper apprentices assigned.

Rule 73—Helper apprentices shall receive the minimum helper rate for the first six months, with an increase of two cents per hour for every six months thereafter until they have served three years.

Rule 74—Helpers, when used in any way in connection with machinists' work, shall in all cases work under the orders of the machinist, both under the direction of the foreman.

Rule 75—When vacancies occur under classification of machinist helper (temporarily or permanent), machinist helpers in the service will be given preference in promotion to position paying either same or higher rate at station employed, seniority to govern.

Rule 76—Eliminated.

Differentials for Machinists

**Rule 77—At points where there are ordinarily fifteen or more engines tested and inspected each month, and machinists are required to swear to Federal reports covering such inspection, a machinist will be assigned to handle this work in connection with other machinists' work and will be allowed five cents per hour above the machinists' minimum rate at the point employed.

At points or on shifts where no inspector is assigned and machinists are required to inspect engines and swear to Federal reports, they will be paid five cents per hour above the machinists' minimum rate at the point employed for the days on which such inspections are made.

Autogenous welders shall receive five cents per hour above the minimum rate paid mechanics at the point employed.

Boilermakers' Special Rules

Qualifications

**Rule 78—Any man who has served an apprenticeship, or has had four (4) years' experience at the trade, who can with the aid of tools, with or without drawings, and is competent to either lay out, build or repair boilers, tanks, and details thereof, and complete same in a mechanical manner, shall constitute a boilermaker.

Classification of Work

Rule 79—Boilermakers' work shall consist of laying out, cutting apart, building, or repairing boilers, tanks, and drums; inspecting, patching, riveting, chipping, calking, flanging, and flue work; building, repairing, removing and applying steel cabs and running boards; laying out and fitting up any sheet-iron or sheet-steel work made of 16 gage or heavier (present practice between boilermakers and sheet-metal workers to continue relative to gage of iron), including fronts and doors; ash pans, front end netting and diaphragm work, engine tender steel underframe and pressed steel tender truck frames, except where other mechanics perform this work; removing and applying all stay bolts, radials, flexible caps, sleeves, crown bolts, stay rods, and braces in boilers, tanks and drums; applying and removing arch tubes; operating punches and shears for shaping and forming, pneumatic stay-bolt breakers, air rams and hammers; bull, jam, and yoke riveters; boilermakers' work in connection with building and repairing of steam shovels, derricks, booms, housing, circles, and coal buggies, I-beam, channel iron, angle iron, and T-iron work; all drilling, cutting and tapping and operating rolls in connection with boilermakers' work; oxyacetylene, thermit, and electric welding on work generally recognized as boilermakers' work, and all other work generally recognized as boilermakers' work. It is understood that present practice in the performance of work between boilermakers and carmen will continue. On running repairs, boilermakers may connect or disconnect any wiring, coupling or pipe connections necessary to make or repair machinery or equipment.

This rule shall not be construed to prevent engineers, firemen and cranemen on steam shovels, ditchers, clam shells, wrecking outfits, pile drivers and other similar equipment requiring repairs on line of road, from making any repairs to such equipment as they are qualified to perform.

Boilermaker Apprentices

Rule 80—Include regular and helper apprentices in connection with the work as defined by rule 79.

Boilermaker Helpers

Rule 81—Employees assigned to help boilermakers and their apprentices, operators of drill presses, and bolt cutters in the boiler shop, boiler washers, punch and shear operators (cutting only bar stock and scrap), and employees removing and applying grates and grate rigging, and all other work properly recognized as boilermaker helpers' work.

Running-repair Work

Rule 82—Boilermakers assigned to running repairs may be used to perform other work.

Boilermakers assigned to locomotive general repair work may be used to perform running-repair work when the regular assigned running-repair forces are unable to get engines out to meet service requirements.

Boilermakers who have been working on hot work will not be required to work on cold work until given sufficient time to cool off.

Special Services

Rule 83—Flange turners, layer outs, and fitter ups shall be assigned in shops where flue sheets and half side sheets or fire boxes are flanged, removed, and applied. One man may perform all these operations where the service does not require more than one man. If not fully engaged on the above work, these employees may be assigned to any work of their craft.

Boiler inspectors—stay-bolt inspectors will be assigned to all points where monthly stay-bolt and boiler inspection of 15 or more engines is required. When such employees have no inspection work to perform, they may be assigned to other boilermakers' work.

Protection for Employees

Rule 84—Boilermakers, apprentices and helpers will not be required to work on boilers or tanks while electric or other welding processes are in use or when tires are being heated, unless proper protection is provided.

Rule 85—Not more than one oxyacetylene welding or cutting operator or electric operator will be required to work in firebox or shell of boiler at the same time, unless proper protection is provided.

Rule 86—Oxyacetylene welding or cutting operator or electric operator will be furnished with helper when necessary, or when it is essential for personal safety.

Rule 87—Should it become necessary to send oxyacetylene welder or cutter or electric operator out of the shop in cold weather, he will be given ample time to dry off before being sent out.

Rule 88—When it is necessary to renew, remove, or replace flue, door, side, or crown sheets by means of oxyacetylene or other cutting or welding processes, such portion of the ash-pan wings and grates as interfere with the operator, will be removed. Dome caps will be removed and front ends opened up if required, for proper ventilation.

Rule 89—Boilers will have steam blown off and be reasonably cooled before boilermakers or apprentices are required to work in them; blowers will be furnished when possible to do so.

Fireboxes, front ends, and ash pans will be properly cleaned out before boilermakers or apprentices are required to work in them. Fire brick interfering with the work to be performed will be removed.

Rule 90—Two boilermakers, or one boilermaker and a competent apprentice with at least two years' experience, will be used to operate a long stroke hammer, that is, an air hammer capable of driving stay bolts or rivets five-eighths inch diameter or larger, or of expanding flues or tubes. Double-gun work will not be permitted. Air jacks not to be considered double guns.

When rolling or expanding superheater flues, two boilermakers, or one boilermaker and a competent apprentice with at least two years' experience, will be used.

Rule 91—No tapping or reaming will be done in fireboxes when same is near enough to endanger the men working on inside of firebox. A space of 10 rows of stay bolts will be considered sufficient, it being understood that the helper will protect the men with a sleeve over a tap when tapping is being done.

Furnishing Help

Rule 92—Boilermakers engaged on running repair work will be furnished a helper when necessary, or when it is essential for personal safety.

Rule 93—Boilermakers sent out on the road to do boilermakers' work will have helper furnished when necessary

Removal of Flues

Rule 94—When flues (other than burst flues) are to be removed, the front end will be opened and such parts of the draft appliances as interfere with the boilermaker will be removed. Center arch pipes in engine, other than those equipped with combustion chambers, which interfere with boilermakers in the performance of their work, will be removed.

Helpers on Flange Fires

Rule 95—Regular assigned help will be furnished on flange fires.

Rule 96—Helpers on flange fires will not be asked to go outside of shop to handle fuel during cold weather.

Rule 97—Eliminated.

Helpers

Rule 98—There will be sufficient help furnished boilermakers or apprentices in breaking down stay bolts with hand ram.

Rule 99—Eliminated.

Rule 100—Holding on all stay bolts and rivets, striking chisel bars, side sets, and backing out punches, and heating rivets (except when performed by apprentices) will be considered boilermaker helpers' work.

Rule 101—When rivets are to be cut off or backed out, a barrier or sufficient help will be furnished to prevent accidents or personal injury.

Rule 102—Boilermakers or apprentices when using compound motors will be furnished sufficient competent help.

Rule 103—Sufficient help will be furnished when holding on rivets with wedge bars.

Rule 104—Included in rule 81.

Helper Apprentices

Rule 105—Fifty per cent of the apprentices may consist of boilermaker helpers who have had not less than two consecutive years' experience as boilermaker helper at the point where employed at the time application for apprenticeship is made.

They shall be between the ages of 21 and 40 years and shall serve three years, a minimum of 290 days each calendar year.

Helper apprentices shall be governed by the same laws and rules as regular apprentices.

Apprentices shall not work on oxyacetylene, thermit, electric, or other welding processes until they are in their last year.

They shall receive the minimum helpers' rate for the first six months, with an increase of two cents per hour for every six months thereafter until they have served their apprenticeship.

Schedule of Work, Regular Apprentices

Rule 106—The following schedule for regular apprentices showing the division of time on the various classes of work is designed as a guide and will be followed as closely as the conditions will permit:

Six months—Heating rivets and helping boilermakers.
Six months—Tank repairing and sheet-iron work.
Six months—Rolling flues; ash-pan work.
Six months—Stay bolts and setting flues.
Fifteen months—General boiler work.
Three months—Electric or oxyacetylene welding.
Six months—Laying out and flanging.

Schedule of Work, Helper Apprentices

Rule 107—The following schedule for helper apprentices showing the division of time on the various classes of work is designed as a guide and will be followed as closely as the conditions will permit:

Six months—Tank repairing and sheet-iron work.
Six months—Rolling flues; ash-pan work.
Six months—Stay bolts and setting flues.
Nine months—General boiler work.
Three months—Electric or oxyacetylene welding.
Six months—Laying out and flanging.

Differentials for Boilermakers

Rule 108—Boilermakers assigned as boiler inspectors, also flangers, layer outs, and autogenous welders shall receive five cents per hour above the minimum rate paid boilermakers at the point employed.

At points or on shifts where no inspector is assigned and boilermakers are required to inspect boilers, they will be paid five cents per hour above the boilermakers' minimum rate at the point employed for the days on which such inspections are made.

Rule 109—Helpers on flange fires shall receive five cents per hour above the helpers' rate at point employed.

Blacksmiths' Special Rules

Qualifications

Rule 110—Any man who has served an apprenticeship or who has had four years' varied experience at the blacksmiths' trade shall be considered a blacksmith. He must be able to take a piece of work pertaining to his class and, with or without the aid of drawings, bring it to a successful completion within a reasonable length of time.

Classification of Work

Rule 111—Blacksmiths' work shall consist of welding, forging, heating, shaping, and bending of metal; tool dressing and tempering, springmaking, tempering and repairing, potashing, case and bichloride hardening; flue welding under blacksmith's foreman; operating furnaces, bulldozers, forging machines, drop-forging machines, bolt machines, and Bradley hammers;

hammersmiths, drop-hammermen, trimmers, rolling mill operators; operating punches and shears doing shaping and forming in connection with blacksmiths' work; oxyacetylene, thermit and electric welding on work generally recognized as blacksmiths' work, and all other work generally recognized as blacksmiths' work.

Blacksmith Apprentices

Rule 112—Include regular and helper apprentices in connection with the work as defined by rule 111.

Blacksmith Helpers

Rule 113—Helpers' work shall consist of helping blacksmiths, and apprentices, heating, operating steam hammers, punches and shears (cutting only bar stock and scrap), drill presses and bolt cutters; straightening old bolts and rods, cold; building fires; lighting furnaces, and all other work properly recognized as blacksmith helpers' work.

Helper Apprentices

Rule 114—Fifty per cent of the apprentices may consist of helpers who have had not less than two consecutive years' experience in shop on the division where advanced.

Seniority shall prevail in the selection of helper apprentices; those selected to be not over 30 years of age.

Apprentices selected from helpers shall serve three years, a minimum of 290 days each calendar year. When started as an apprentice they shall receive the minimum helpers' rate of pay for the first six months; at the end of that time they shall receive two cents per hour increase, and two cents per hour increase each succeeding six months while serving their apprenticeship.

Helper apprentices shall be governed by the same laws and rules as regular apprentices.

If after the first three months they show no aptitude to learn the trade, they shall be set back to helping and retain their former seniority as a helper.

After completing their apprenticeship they shall receive prevailing rate paid blacksmiths if retained in the service.

Apprentices, Miscellaneous

Rule 115—Apprentices shall be given an opportunity to learn all branches of the trade and will not be kept on any one class of work longer than four months. Apprentices shall not work on oxyacetylene, thermit, electric, or other welding processes until they are in their last year.

Rule 116—Eliminated.

Helpers Building Fires

Rule 117—Blacksmith helpers required to prepare or build coal or coke fires outside their regular working hours, shall be allowed thirty minutes straight time for each fire built or furnace prepared. Helpers assigned to start oil or gas furnaces outside their regular working hours will receive one and one-half time for such service, on the minute basis.

Rule 118—Eliminated.

Coal and Oil to Be Furnished

Rule 120—Coal and oil suitable for smithing purposes will be furnished whenever possible.

Steam-hammer Operators

Rule 121—Competent steam-hammer operators will be furnished.

Road Work

Rule 122—Blacksmiths sent out on the road to do blacksmiths' work will be accompanied by helper when necessary.

Rule 123—Included in Rule 113.

Sheet-Metal Workers' Special Rules

Qualifications

Rule 125—Any man who has served an apprenticeship, or has had four or more years' experience at the various branches of the trade, who is qualified and capable of doing sheet-metal work or pipe work as applied to buildings, machinery, locomotives, cars, et cetera, whether it be tin, sheet iron, or sheet copper, and capable of bending, fitting and brazing of pipe, shall constitute a sheet-metal worker.

Classification of Work

Rule 126—Sheet-metal workers' work shall consist of tinning, coppersmithing and pipefitting in shops, yards, buildings, on passengers coaches and engines of all kinds; the building, erecting, assembling, installing, dismantling (for repairs only), and maintaining parts made of sheet copper, brass, tin, zinc, white metal, lead, black, planished, pickled and galvanized iron of 10 gage and lighter (present practice between sheet-metal workers and boilermakers to continue relative to gage of iron), including brazing, soldering, tinning, leading, and babbitting (except car and tender truck journal bearings), the bending, fitting, cutting, threading, brazing, connecting and disconnecting of air, water, gas, oil and steam-pipes; the operation of babbitt fires (in connection with sheet-metal workers' work); oxyacetylene, thermit and electric welding on work generally recognized as sheet-metal workers' work, and all other work generally recognized as sheet-metal workers' work.

In running repairs, other mechanics than sheet-metal workers may remove and replace jackets, and connect and disconnect pipes where no repairs are necessary to the jackets or pipes in question.

Sheet-metal Worker Apprentices

Rule 127—Include regular and helper apprentices in connection with the work as sheet-metal workers' helpers.

Sheet-metal Worker Helpers

Rule 128—Employees regularly assigned as helpers to assist sheet-metal workers and apprentices in their various classifications of work, shall be known as sheet-metal workers' helpers.

Protection for Employees

Rule 129—Sheet-metal workers shall not be required to remove or apply blow-off or surface pipes or ash-pan blowers on boilers under steam.

Road Work

Rule 130—Sheet-metal workers will be sent out on line of road and to outlying points, when their services are required, but not for small, unimportant running-repair jobs.

Assignment of Running-repair Force to Dead Work

Rule 131—Sheet-metal workers assigned to running repairs shall not be required to work on dead work at points where dead-work forces are maintained, except when there is not sufficient running repairs to keep them busy.

Assignment of Dead-work Force to Running Repairs

Rule 132—Dead-work forces will not be assigned to perform running-repair work, except when the regularly assigned running-repair forces are unable to get engines out in time to prevent delay to train movement.

Miscellaneous

Rule 133—Sheet-metal workers will not be assigned to work not applicable to them, except in emergency cases.

Helper Apprentices

Rule 134—Fifty per cent of the apprentices may be selected from helpers of this craft who have had not less than two consecutive years' experence as a sheet-metal-worker helper at the point where employed, and shall not be more than thirty years of age; such apprentice shall serve three calendar years, a minimum of 290 days each calendar year, seniority to govern.

Rule 135—Helper apprentices will start at the third classification of regular apprentices' schedule when entering their apprenticeship, and continue through as regular apprentices. Helper apprentices will receive the minimum helpers' rate for the first six months, with an increase of two cents per hour for every six months thereafter until their have served three years.

Rule 136—Eliminated.

Apprentice Schedule of Work

Rule 137—Regular apprentices' schedule and division of time:

Six months—Helping.

Six Months—Light pipe work.

Twelve months—Tinning, babbitting and brazing, laying out and forming.

Twelve months—Engine and car work.

Twelve months—General work, including one month's experience with the oxyacetylene torch.

Differentials for Sheet-metal Workers

Rule 138—Autogenous welders shall receive five cents per hour above the minimum rate paid sheet-metal workers at point employed.

Electrical Workers' Special Rules

Qualifications

Rule 139—Any man who has served an apprenticeship or who has had four years' practical experience in electrical work and is competent to execute same to a successful conclusion within a reasonable time will be rated as an electrical worker.

An electrician will not necessarily be an armature winder.

Classification of Electricians

Rule 140—Electricians' work shall include electrical wiring, maintaining, repairing, rebuilding, inspecting and installing of all generators, switchboards, meters, motors and controls, rheostats and controls, static and rotary transformers, motor generators, electric headlights and headlight generators, electric welding machines, storage batteries (work to be divided between electricians and helpers as may be agreed upon locally), axle lighting equipment, all inside telegraph and telephone equipment, electric clocks and electric lighting fixtures; winding armatures, fields, magnet coils, rotors, transformers and starting compensators; inside and outside wiring at shops, buildings, yards, and on structures and all conduit work in connection therewith (except outside wiring provided for in rule 141), steam and electric locomotives, passenger train and motor cars, electric tractors and trucks; include cable splicers, high-tension power house and substation operators, high-tension linemen, and all other work properly recognized as electricians' work.

Classification of Linemen, etc.

Rule 141—Linemen's work shall consist of the building, repairing, and maintaining of pole lines and supports for service wires and cables; catenary and monorail conductors; trolley and feed wires, overhead and underground, together with their supports; maintaining, inspecting, and installing third rail and cables for third rail that carry current to or from third rail and track rail; pipe lines or conduits for these cables; bonding of third rail or cables; all outside wiring in yards, and other work properly recognized as linemen's work not provided for in rule 140.

Signal maintainers who, for 50 per cent or more of their time, perform work as defined in rules 140 and 141.

Men employed as generator attendants, motor attendants (not including water service motors), and substation attendants who start, stop, oil, and keep their equipment clean and change and adjust brushes for the proper running of their equipment; power switchboard operators, coal-pier car dumpers and coal-pier conveyor-car operators in connection with loading and unloading vessels.

This to include operators of electric traveling cranes, capacity 40 tons and over.

Classification of Groundmen, etc.

Rule 142—Groundmen's work shall consist of assisting linemen in their duties, when said work is performed on the ground, but shall not include those who perform common labor in connection with linemen's or groundmen's work. Electric crane operators for cranes of less than 40-ton capacity.

Rule 143—Coal-pier elevator operators and coal-pier electric hoist operators in connection with loading and unloading vessels.

Apprentice Electrical Workers

Rule 144—Include regular and helper apprentices in connection with electrical workers.

Electrical Worker Helpers

Rule 145—Employees regularly assigned as helpers to assist electrical workers and apprentices, including electric lamp trimmers who do no mechanical work, also to perform such battery work as may be agreed upon locally as being helpers' work.

Helper Apprentices

Rule 146—Fifty per cent of the apprentices may consist of electrical workers' helpers who have had two years' continuous service at the point where employed. When assigned as helper apprentices, they must not be over 25 years of age, and shall serve three years, a minimum of 290 days each calendar year.

Regular Apprentice Schedule of Work

Rule 147—The following schedule for regular apprentices, showing the division of time on the various classes of work, is designed as a guide and will be followed as closely as possible:

Twelve months—Inside wiring and electrical repairing.
Six months—Outside line work.
Six months—Locomotive headlight work.
Six months—Car lighting department.
Six months—Armature winding.
Twelve months—General electrical work.

Helper Apprentice Schedule of Work

Rule 148—Helper apprentices will receive the minimum helpers' rate for the first six months, with an increase of two cents per hour for every six months thereafter until their apprenticeship is completed. If within six months they show no ability to acquire the trade, they will be set back to helping and retain their former seniority as a helper. After completing their apprenticeship, they shall receive the minimum rate paid for the work to which they are assigned, if retained in the service.

Rule 149—The following schedule for helper apprentices, showing the division of time on the various classes of work, is designed as a guide and will be followed as closely as possible.

Six months—Inside wiring and electrical repairing.
Six months—Outside line work.
Six months—Locomotive headlight work.
Six months—Car lighting department.
Six months—Armature winding.
Six months—General electrical work.

Miscellaneous

Rule 150—Laborers or similar class of workmen shall not be permitted to do helpers' work as outlined in rule 145 if regular electrical-worker helpers are available.

Rule 151—Men engaged in the handling of storage batteries and mixing acid must be provided with acid-proof rubber gloves, hip boots, and aprons.

Rule 152—Autogenous welders shall receive five cents per hour above the minimum rate paid electrical workers at point employed.

Carmen's Special Rules

Qualifications

Rule 153—Any man who has served an apprenticeship or who has had four years' practical experience at car work, and who with the aid of tools, with or without drawings, can lay out, build, or perform the work of his craft or occupation in a mechanical manner, shall constitute a carman.

Classification of Work

Rule 154—Carmen's work shall consist of building, maintaining, dismantling (except all-wood freight-train cars), painting, upholstering and inspecting all passenger and freight cars, both wood and steel, planing mill, cabinet and bench carpenter work, pattern and flask making and all other carpenter work in shops and yards, except work generally recognized as bridge and building department work; carmen's work in building and repairing motor cars, lever cars, hand cars and station trucks, building, repairing and removing and applying locomotive cabs, pilots, pilot beams, running boards, foot and headlight boards, tender frames and trucks; pipe and inspection work in connection with air brake equipment on freight cars; applying patented metal roofing; operating punches and shears, doing shaping and forming; work done with hand forges and heating torches in connection with carmen's work; painting with brushes, varnishing, surfacing, decorating, lettering, cutting of stencils and removing paint (not including use of sand blast machine or removing in vats); all other work generally recognized as painters' work under the supervision of the locomotive and car departments, except the application of blacking to fire and smoke boxes of locomotives in engine houses; joint car inspectors, car inspectors, safety appliance and train car repairers; oxyacetylene, thermit and electric welding on work generally recognized as carmen's work; and all other work generally recognized as carmen's work.

It is understood that present practice in the performance of work between the carmen and boilermakers will continue.

Carmen Apprentices

Rule 155—Include regular and helper apprentices in connection with the work as defined by rule 154.

Carmen Helpers

Rule 156—Employees regularly assigned to help carmen and apprentices, employees engaged in washing and scrubbing the inside and outside of passenger coaches preparatory to painting, removing of paint on other than passenger cars preparatory to painting, car oilers and packers, stock keepers (car department), operators of bolt threaders, nut tappers, drill presses, and punch and shear operators (cutting only bar stock and scrap), holding on rivets, striking chisel bars, side sets, and backing out punches, using backing hammer and sledges in assisting carmen in straightening metal parts of cars, rebrassing of cars in connection with oilers' duties, cleaning journals, repairing steam and air hose, assisting carmen in erecting scaffolds, and all other work generally recognized as carmen's helpers' work, shall be classed as helpers.

Wrecking Crews

Rule 157—Regularly assigned wrecking crews, not including engineers, will be composed of carmen, where sufficient men are available, and will be paid for such service under rule 10, Decision No. 222. Meals and lodging will be provided by the company while crews are on duty in wrecking service.

When needed, men of any class may be taken as additional members of wrecking crews to perform duties consistent with their classification.

Rule 158—When wrecking crews are called for wrecks or derailments outside of yard limits, a sufficient number of the regularly assigned crew will accompany the outfit. For wrecks or derailments within yard limits, sufficient carmen will be called to perform the work.

Inspectors

Rule 159—Men assigned to inspecting must be able to speak and write the English language, and have a fair knowledge of the A. R. A. (American Railway Association) rules and safety appliance laws.

Rule 160—Inspectors and other carmen in train yards will not be required to take record, for conducting transportation purposes, of seals, commodities, or destination of cars where record clerks, yardmasters, agents or yard clerks are employed.

Safety Appliance Men

Rule 161—Men assigned to follow inspectors in yards to make safety appliance and light running repairs, shall not be required to work on cars taken from trains to repair tracks, except when there is not sufficient work in train yards to fully occupy their time.

Protection for Repairmen

Rule 162—Switches of repair tracks will be kept locked with special locks and men working on such tracks shall be notified before any switching is done. A competent person will be regularly assigned to perform this duty and held responsible for seeing that it is performed properly.

Rule 163—Trains or cars while being inspected or worked on by train yard men will be protected by blue flag by day and blue light by night, which will not be removed except by men who place same.

Miscellaneous

Rule 165—Air hammers, jacks, and all other power driven machinery and tools, operated by carmen or their apprentices, will be furnished by the company and maintained in safe working condition.

Rule 166—Crayons, soapstone, marking pencils, tool handles, saw files, motor bits, brace bits, cold chisels, bars, steel wrenches, steel sledges, hammers (not claw hammers), reamers, drills, taps, dies and lettering and striping pencils and brushes will be furnished by the company.

Rule 167—Included in rule 154.

Rule 168—When necessary to repair cars on the road or away from the shops, carman, and helper when necessary, will be sent out to perform such work as putting in couplers, draft rods, draft timbers, arch bars, center pins, putting cars on center, truss rods, and wheels, and work of similar character.

Rule 169—Shops, repair yards, and train yards, where carmen are employed, shall be kept clean of all rubbish.

Apprentices

Rule 170—Regular apprenticeships will be established in all branches of the trade. Apprentices shall be governed by the general rules covering apprentices.

Rule 171—Apprentices shall not work on oxyacetylene, thermit, electric, or other welding processes until they are in their last year.

Helper Apprentices

Rule 172—Fifty per cent of the apprentices may be selected from carmen's helpers who have had not less than two consecutive years' experience at the point employed at the time application for apprenticeship is made.

Helper apprentices shall not be over 30 years of age and will serve three years, a minimum of 290 days each calendar year.

Helper apprentices shall be governed by the same laws and rules as regular apprentices.

Helper apprentices shall receive the minimum helpers' rate for the first six months, with an increase of two cents per hour each succeeding six months until they have served three years. At the completion of their apprenticeship period, if retained in the service, they shall receive the mechanics' rate of pay.

Painter Apprentices, Regular

Rule 173—Regular apprentices—Division of time for painter apprentices: The following schedule for regular apprentices, painter, showing the division of time on the various classes of work, is designed as a guide and will be followed as closely as the conditions will permit:

Six months—Freight-car painting.
Six months—Color room, mixing paint.
Six months—General locomotive painting.
Twelve months—Brush work, passenger equipment.
Eighteen months—Lettering, striping, varnishing, and such laying out and designing as the shop affords.

Schedule of Work, Painter Helper Apprentices

Rule 174—Helper apprentices—Division of time for painter apprentices: The following schedule for helper apprentices, painter, showing the division of time on the various classes of work, is designed as a guide and will be followed as closely as the conditions will permit:

Four months—Freight-car painting.
Four months—Color room, mixing paint.
Four months—General locomotive painting.
Ten months—Brush work, passenger equipment.
Fourteen months—Lettering, striping, varnishing, and such laying out and designing as the shop affords.

Regular Apprentices, Carmen Schedule of Work

Rule 175—The following schedule for regular apprentices, showing the division of time on the various classes of work, is designed as a guide and will be followed as closely as the conditions will permit. Where sufficient passenger car department work is not available without exceeding the regular ratio of apprentices in the passenger car department, apprentices will complete their apprenticeship in the freight car department:

Eighteen months—General freight work, wood and steel.
Six months—Air-brake work.
Six months—Mill machine work.
Eighteen months—General coach work, wood and steel.

Helper Apprentice, Carmen Schedule of Work

Rule 176—The following schedule for helper apprentices, showing the division of time on the various classes of work, is designed as a guide and will be followed as closely as the conditions will permit. Where sufficient passenger car department work is not available without exceeding the regular ratio of apprentices in the passenger car department, apprentices will complete their apprenticeship in the freight car department.

Twelve months—General freight work, wood and steel.
Six months—Air-brake work.
Six months—Mill machine work.
Twelve months—General coach work, wood and steel.

Rule 177—In the event of not being able to employ carmen with four years' experience, regular and helper apprentices will be advanced to carmen in accordance with their seniority. If more men are needed helpers will be promoted. If this does not provide sufficient men to do the work, men who have had experience in the use of tools may be employed. They will not be retained in service when four-year carmen become available.

Note:—Helpers advanced as above will retain their seniority as helpers.

Differentials for Carmen

Rule 178—Autogenous welders shall receive five cents per hour above the minimum rate paid carmen at point employed.

Coach Cleaners

Rule 179—Coach cleaners to be included in this agreement and will receive overtime as provided herein. Coach cleaners at outlying points may be worked eight hours within a period of ten consecutive hours. They may be assigned to any other unskilled work during their eight-hour period of service.

Miscellaneous

Scope of General and Special Rules

Rule 180—Except as provided for under the special rules of each craft, the general rules shall govern.

Rule 181—Eliminated.

Rule 182—Eliminated.

Revision of Agreement

Rule 183—Should either of the parties to this agreement desire to revise or modify these rules, 30 days' written advance notice, containing the proposed changes, shall be given and conferences shall be held immediately on the expiration of said notice unless another date is mutually agreed upon.

Rule 184—Eliminated.

Rule 185—This agreement shall be effective as provided in the several decisions of the United States Railroad Labor Board hereon and shall continue in effect until it is changed as provided for in rule 183 or under the provisions of the Transportation Act, 1920.

Rule 186—Eliminated.

General Instructions

Sec. 1—Application of Adopted Rules

The rules approved by the Labor Board shall apply to each of the carriers parties to the dispute in Docket 475 (Decision No. 222 and addenda thereto), except in such instances as any particular carrier may have agreed with its employees upon any one or more of such rules, in which case the rule or rules agreed upon by the carrier and its employees shall apply on said road.

Sec. 2—Disposition of Eliminated Rules

The rules eliminated by the Labor Board shall cease and terminate, except in such instances as any particular carrier may have agreed with its employees upon any one or more of such rules, in which case the rule or rules agreed upon by the carrier and its employees shall apply on said road.

Sec. 3—Formulation of Preamble or Caption

The formulation of a preamble or caption to agreements or contracts is hereby remanded to the carriers and their employees, severally, and in connection therewith the parties are referred to Decision No. 205, issued by the Labor Board.

Sec. 4—Disposition of Omitted Rules

The Labor Board believes that certain subject matters now regulated by the rules of the national agreement may not be covered in all localities by rules of general application, and require further consideration by the parties directly concerned. The rules governing these matters are indicated herein by the omission of any reference to the numbers thereof as used in the national agreement, and all such rules which involve a dispute between a particular carrier and its employees are hereby remanded to said carrier and its employees for the purpose of adjustment under the provisions of Section 301 of the Transportation Act, 1920.

Sec. 5—Interpretation of This Decision

The rules herein adopted, where similar to the rules in the so-called national agreement, are not to be understood or construed as carrying with them the interpretations placed on same by the United States Railroad Administration, by the adjustment boards or by other agencies acting under said administration, but are to be considered and construed as new rules adopted by the Labor Board in accordance with the Transportation Act, 1920, and the principles announced in Decision No. 119.

Should a dispute arise between the management and the employees of any of the carriers as to the meaning or intent of this decision which cannot be decided in conference between the parties directly interested, such dispute shall be handled in the manner provided by the Transportation Act, 1920.

A Novel Explanation of a Locomotive Boiler Explosion

On November 11 a locomotive on the London & Northwestern Railway of England burst at Buxton. The driver and fireman were killed and there was considerable damage to property. E. R. Calthrop, commenting on the explosion in The Engineer (London), suggests that the cause of the unusual severity of the explosion may be found in the spheroidal state of boiling water, in which condition shock or vibration can convert the whole mass of water instantly into an equivalent volume of steam.

Mr. Calthrop calls attention to the fact that it is hardly conceivable that there should have been any defect in the safety valve or any negligence on the part of the engineer or fireman. The complete destruction of the engine indicated an explosion of extraordinary intensity, resembling what would be expected as a result of the explosion of a charge of dynamite placed in the position occupied by the boiler. It would seem that this explosion has many points in common with the extraordinary explosion that occurred at San Antonio, Tex., several years ago.

Meeting of Railroad Division of A. S. M. E.

Papers on Elimination of Waste in Design of Motive Power and in Operation of Locomotives and Cars

THE elimination of waste in industry was the general topic discussed at the annual meeting of the American Society of Mechanical Engineers held in New York the week of December 5. In conformity with this subject, the Railroad Division of the society, at its meeting on December 6, presented two papers on avoidable waste in locomotives and cars of special interest to men in the mechanical department. The first of these papers, by James Partington, on Avoidable Waste in Locomotives as Affected by Design, was published in the *Railway Mechanical Engineer* of November, 1921, page 673. Discussion of Mr. Partington's paper and the second paper, by W. C. Sanders appears below.

Avoidable Waste in Car Operation—The Container Car

By Walter C. Sanders

The container car was an outcome of the railroad congestion during the war and was first put in operation last year by A. H. Smith, president of the New York Central Lines, to reduce the transportation losses due to congestion which tied up industry. It is hoped that mail, express and freight robberies, breakage, checking and rehandling, delays to shippers, and many other railroad evils may also be materially reduced by the container-car system.

Loss of and damage to freight has grown in recent years into one of the heaviest leaks in the transportation industry

Freight Type Container Loaded on a Motor Truck. The Larger Containers Which Originally Formed Part of the Equipment Are No Longer Used, the Size Shown Being Standard

and strenuous campaigns which included maintenance of extensive police and supervisory forces, together with educational campaigns among shippers and railroad employees to secure stronger packing, careful handling and suppression of theft, have failed to stop this economic waste.

The proportions of this tranportation problem may be judged from the fact that in the year 1914 American railroads paid out $33,000,000 in claims for loss of and damage to freight, and for the year 1920 this amounted to a total of $125,000,000, the incidental injury to business affected being considerably greater. Under the ordinary system of handling less-than-carload lots or shipments the goods are checked and handled item by item from shipper to truck or dray, from truck to depot platform or warehouse, and from the platform to the car. They are subject to handling and checking at each stage of the journey, and when finally they reach their destination this handling and checking is all done over again. It is therefore necessary to maintain armies of employees to act as freight handlers, clerks, checkers and station overseers, as well as switchmen to shunt cars to fixed locations where loading and unloading are possible.

The container system provides that the portable container shall be loaded and locked at the shipper's own store door, conveyed by motor truck to the railroad yard, and lifted by crane aboard the container car, where steel bulkheads and sides form absolute protection against opening the container in transit. At the destination the locked container is unloaded by a crane and carried by motor truck directly to the warehouse or consignee's door, to be unloaded at his convenience. This simple system of handling goods will make it possible to greatly reduce the force of employees now necessary.

Another advantage of the container-car system expected to prove most valuable is the greatly increased use of container rolling stock in moving service, which is particularly important when traffic expands to its peak and when the prime need is to shorten layovers of cars in yards and stations for loading and unloading, and to limit their idleness and obstruction through misuse for storage purposes. In busy times the need is to keep every wheel turning as continuously as possible to secure maximum transportation. With ample supplies of the removable containers, which in their several classes are of uniform size and interchangeable, one carload of containers may be removed and sent with their loads to consignees, and another set immediately hoisted into place and the car be ready to proceed within a matter of minutes in most instances. The locked containers may remain on station platforms or at the stores of shippers for loading or unloading at convenience without tying up costly rolling stock at points where track capacity is limited and congestion quickly obstructs the flow of traffic unless the cars are kept moving. With this rapid handling of the containers on and off the car the mileage per year made by the ordinary piece of rolling stock may be doubled, and it is predicted that the tremendous expense of maintaining box cars and other rolling stock equal to all emergencies will be materially cut down.

The container car may make costly packing and crating unnecessary because goods packed in flimsy pasteboard boxes or even bound with heavy paper are protected against breakage, theft, and water or weather damage.

There are at present in service on the New York Central Lines three container cars, one of the mail or express type, and two that are being used for valuable freight, such as silks and woolens. Three new mail cars of improved design which are now being constructed will be equipped with an improved type of all-steel container. A new freight-type container car is being designed, and refrigerator and tank container cars are contemplated.

General Description of the Container Car

The container car is nothing more than a long car with a steel side or fence, similar to a low-side gondola, loaded with large steel safes or containers, made as light as possible, in which commodities of all kinds travel from consignor to consignee, inviolate against thieves, fire, weather and breakage. The safes or containers are lifted on and off the car by cranes or hoisting devices, permitting the "parent" rolling stock to continue in transportation circulation.

[Mr. Sanders' paper included a detailed description of the express container cars as illustrated and described in the *Railway Mechanical Engineer* for March, 1921, page 171, and the freight container cars.—Editor.]

Containers and Container Cars Now Under Construction

The three new mail-type container cars now being built will carry eight containers of a new, improved design, the outside measurements being, length 7 ft. 2½ in., width 9 ft. 3½ in., clear height 8 ft. 2 in., with 5 ft. 9 in. by 3 ft. 6 in. door on the length side. The cubic capacity will be 438 cu. ft., light weight 3,000 lb. and capacity 7,000 lb.

Tests conducted in the last few months on the New York Central Lines have demonstrated that the express type of container car can be emptied of the nine containers by an ordinary crane in 21 min. and reloaded with other containers and the car put back in circulation in about the same time. This test was made with an ordinary moving track crane, since no special cranes or handling devices have as yet been constructed for use in handling the containers. With the special handling devices contemplated it will be possible to unload the containers with greater speed directly to waiting motor trucks, platforms, or on the ground.

During May, 1921, at the request of the Postmaster General, a mail test was run from New York City to Chicago, Ill., and return with the express type of container car. Upon arrival at Chicago the nine containers, containing 37,000 lb. of mail, were unloaded onto waiting Post Office motor trucks in 21 min., which is one-fifth of the time used in unloading an ordinary mail storage car. At Chicago connections were made with western mail trains that have never been made before. Upon the arrival at New York on the return trip the containers were removed from the car in 18 min.

It is believed that the use of containers in mail service (1) will prevent the loss in transit of valuable registered mail, parcels post and other mail; (2) will mean a saving to the government in handling mail, both in trucking and checking as well as a material saving to the railroads in the use of equipment; (3) will make possible a quick transfer at important gateway points and the maintaining of close railway connections otherwise impossible; and (4) will afford an increased weight and capacity as compared with the average load now handled in mail storage or baggage cars, the average weight of mail now carried in mail storage cars being approximately 30,000 lb.; 37,000 lb. of mail were carried on the run to Chicago.

Summary

A summary of prime advantages of the container car system is as follows:

(*a*) It will furnish a means of expediting delivery of less-than-carload lots of commodities by eliminating the time and expense of rehandling, checking and trucking.

(*b*) It will eliminate costly crating and packing.

(*c*) The immediate unloading and loading of containers at terminal points eliminates the item of demurrage, at the same time promptly releasing rolling stock, clearing the yards of cars and reducing congestion.

(*d*) It will eliminate the piecemeal loading of cars at railway sidings in exposure to all kinds of weather.

(*e*) It will tend to keep the car moving at all times, making possible double the mileage as made now by an ordinary piece of rolling stock.

(*f*) Containers are fire- and weather-proof, and also burglar-proof in that they cannot be opened while on the car or while being transferred by handling devices to and from the car.

The increased service capacity of each unit by the development of the container-car system is thought to hold far-reaching economic possibilities in railroad operations of the future, as well as in the co-ordinated use of the motor truck and the electric railway.

Discussion

R. H. Newcomb (Boston & Maine), told of experiments with container cars manufactured by the River and Rail Transportation Company on the Boston and Maine. This design differs from the container car described by Mr. Sanders in that the containers can be transferred from the car to motor trucks without the use of cranes or other lifting devices. The container method of transportation seems particularly well adapted for use on the railroads in New England and it was thought that by this system less than carload freight could be handled with one-third the number of cars now used. Replying to questions, Mr. Newcomb stated that no trouble was encountered due to containers freezing to the car underframe in winter and no difficulty was experienced in meeting the requirements of the Safety Appliance Act.

A. E. Ostrander (American Car & Foundry Company), brought out the fact that high-grade commodities, such as furniture, were frequently shipped in the bodies of vans which were removed from the running gear and loaded onto freight cars. The container car affords a much better method of handling such traffic which should be advantageous to the railroads and also to the shippers. The container method of transportation should open up to the railroads a profitable traffic field in the handling of raw and finished silks which are now shipped principally by auto truck.

Representatives of the railway mail service emphasized the value of the container car in expediting the delivery of mail and in handling parcel post matter.

F. S. Gallagher (New York Central) stated that the application of the container system to the transportation of milk was now being considered. By using suitable insulation around the tanks, no icing in transit would be required.

Discussion of Paper by James Partington

The discussion of the paper on Avoidable Waste in Locomotives as Affected by Their Design, by James Partington, published in the *Railway Mechanical Engineer* of November, 1921, page 673, brought out some striking suggestions for modifications in the design and types of motive power as the following extracts from the discussion will show:

John L. Nicholson (Locomotive Firebox Co.): Among the newly developed locomotive attachments that make for increased efficiency and economy the thermic syphon may be mentioned, by reason of its already ascertained influence over the avoidable waste in locomotive design and operation. On all tests made thus far the thermic syphon has never failed to reduce the amount of fuel consumed per drawbar horsepower. In some cases the installation of these syphons has resulted in a 25 per cent fuel saving. An average saving of 15 to 19 per cent is now well established.

The second efficiency requirement proposed by Mr. Partington is that a drawbar horsepower be produced for the minimum amount of weight of locomotive and tender.

Locomotive 50000 was built back in 1910; and Mr. Partington therefore refers to a number of newly developed attachments which make for increased efficiency and economy. Along with these the thermic syphon, also of fairly recent development, should be considered. Indeed, consideration of thermic syphons, as if applied to locomotive 50000, will at once demonstrate the fundamental character of the improvement which the thermic syphon has accomplished in locomotive design. I will assume that the boiler horsepower of this locomotive is 2250 as stated in the paper. I have also assumed that all of Mr. Partington's figures relating to boiler horsepower are based upon the formulas devised by F. J. Cole of the American Locomotive Company and have used this method in estimating the capacity increasing ability of the thermic syphon; although, over and beyond the increase brought about by the addition of radiant heat absorbing surface in the firebox, consideration must be given the very rapid circulation which the syphons impart to all the water in the boiler, and the effect which this circulation has in further increasing the capacity of the boiler.

The thermic syphon is an inverted triangular water leg that is positioned vertically above the fire in the firebox, and which by thermal action draws water from the throat and barrel of the boiler, and discharges it through and above the crown sheet of the firebox. Thereby the firebox heating surface is much increased and a vigorous fore-and-aft circulation of boiler water is set up. Both factors contribute to a marked increase of capacity, as well as economy.

If two syphons were applied to locomotive 50000 they would add approximately 62 sq. ft. to the radiant heat absorbing surface of the firebox. The effect of this installation would be to add 164 boiler horsepower to the capacity of the locomotive, although I again desire to emphasize the point that this is, at best, a theoretical approximation which in actual practice is far exceeded due to the improved circulation effected throughout the entire boiler.

Allowing for the net additional weight of the syphons, the result of such installation in locomotive 50000 would be to reduce the weight of this locomotive to 113 lb. per boiler horsepower as compared with 119.6 pounds without syphons.

Further in the case of locomotive 50000, the application of thermic syphons as described would increase the boiler horsepower to 100 per cent of the cylinder horsepower. This increase in boiler capacity is alone sufficient to insure a substantial improvement in fuel economy.

Let us see what thermic syphons have actually contributed toward the elimination of avoidable waste in recent locomotive construction. For an example, consider the Mountain type locomotives which were constructed by the American Locomotive Company for the Chicago, Rock Island and Pacific last year. These locomotives are each equipped with three syphons and have a calculated boiler horsepower of 2,855. Without syphons the capacity of these boilers would be reduced to 2,550 horsepower. As these locomotives weigh 369,000 lb., their weight with syphons is 129.3 lb. per boiler horsepower, while without syphons, their weight would be increased to 144.7 lb. per boiler horsepower.

Clearly, this is an instance of a most practical avoidance of waste in locomotive design. Moreover, it is obvious that by employing syphons in these locomotives, the railroads also eliminated avoidable waste in first cost, besides securing a more efficient locomotive that will continue to eliminate waste of fuel and upkeep every day that it is operated. The only conclusion that can be drawn from the foregoing is that locomotives built or operated without syphons must now be taken as representing avoidable wastes, from the standpoints of both fuel economy and unnecessary weight. An examination of the actual facts will convince anyone that syphon maintenance is a negligible factor; and further, that the syphon affords a potential safeguard against disastrous boiler explosions. Already 26 railroads have ordered and purchased thermic syphons. There are now more than 300 thermic syphons in actual use and it is a notable fact that to date, syphons have never caused an engine failure.

C .C. Trump (Stumpf Una-Flow Engine Co.): Perhaps many have wondered why the una-flow engine has not been as much used in locomotive as in stationary work where there are now nearly a million horsepower in service here and abroad. The difficulty has been to find room on the present locomotive for cylinders of a proper size on account of tunnel and bridge clearances. From the latest information from Prof. Stumpf, it appears that he has overcome this and other difficulties.

By using the energy in the exhaust steam with an ejector action, he is able to lower the back pressure in the una-flow cylinder by as much as 4 or 5 lb. per sq. in., especially at heavier loads. He is thereby able to reduce both the length and diameter of his una-flow cylinder for a given draw-bar pull. This also applies to booster engines. He also obtains a better and steadier draft on his fire with less losses. He requires a smaller boiler, but a larger superheater because of the reduced temperature of the flue gases.

With a three or four cylinder locomotive he expects still better vacuum and better drawbar horsepower for weight of locomotive and amount of fuel. Tests are now being conducted on locomotives of this type abroad.

With respect to higher pressure steam, it seems to me that the una-flow engine offers promise of remarkable economies. It is probably no use to go above 400 lb. gage with a simple engine. But data we have from Europe recently indicates that 700 to 800 lb. pressure with a compound una-flow engine and well designed condenser, economizer, etc., might well compete in fuel economy and even in simplicity with a Diesel locomotive engine. It would have great advantages over the Diesel in starting torque and traction and in being able to burn any kind of fuel, solid, liquid or powdered.

W. F. Kiesel, Jr. (Pennsylvania System): The paper is of particular interest, due to its presentation of locomotives designed on basic values adopted by different designers, but compared on American Locomotive Company's formulae. Such formulae, being empirical, must be changed from time to time to keep pace with new theories introduced in locomotive design. Even then, they are useful only as a preliminary approximation of desired values.

Mr. Partington refers to 100 per cent maximum steam requirements of the cylinders. On referring to American Locomotive Company's Bulletin 1017, this, for superheater locomotives, is found to be based on a horsepower H. P. $= .0229PA$, in which $P =$ boiler pressure and $A =$ cylinder area. That formula is reasonably satisfactory, for locomotives having equal cut-off in full gear, but falls short of forming a basis on which to compare a locomotive with 90 per cent cut-off with one having 50 per cent cut-off.

The test of the Decapod locomotive, Class I1S, showed that in full gear, at low speed, the steam per indicated horsepower was 38 per cent less than the steam rate for a locomotive with 90 per cent cut-off. Under average service conditions the saving in steam is at least 15 per cent.

If the empirical formulae are changed to meet cut-off effect, such as obtains in the Pennsylvania System I1S locomotive, some of the values in the second table would be affected. With a saving of steam of 15 per cent, the steam rate, calculated, pound-per-horsepower-hours, which is given as 20.8 would be 17.68 which compares favorably with test results. The best actual test for steam rate per indicated horsepower was 14.9 pounds.

The empirical formulae also fall short for comparison due to relative freedom of draft, especially in the smokebox which seriously affects size of nozzle and cylinder back pressure. Furthermore, the beneficial effect of large combustion chamber volume has not been clearly demonstrated. The freedom of the draft and large combustion chamber volume greatly affect the maximum boiler horsepower.

The locomotives listed in the first and second columns of table 1 are respectively, the American Locomotive Company No. 50000, and the Pennsylvania System Class K4S. The test results for these locomotives are as follows:

	No. 50000	K4S
Low rate, one test, coal lb. per I. H. P.	2.12	1.52
Low rate, one test, steam lb. per I. H. P.	16.5	14.96
Maximum I. H. P.	2,216	3,184
Weight of locomotive per maximum I. H. P.	121.4	97

This shows that the K4S is actually far ahead of No. 50000 on every count, instead of being inferior as the comparison based on the antiquated empirical formulae would indicate.

Although these figures show the fallacy of empirical formulae in serving as a basis for comparative tabulation, they do not detract from the substance of the matter presented by Mr. Partington, which shows the method of procedure and the strides made in design and construction during the past few years to make the locomotive a truly economical powerplant

C. J. Mellin (American Locomotive Company) commenting on the discussion by W. F. Kiesel, Jr., pointed out that the formulae used by Mr. Partington are intended for purposes of design and therefore all values have been taken on a very conservative basis. Furthermore, a careful study of locomotive proportions has resulted in an improved design since the formulae were originated, and in practice better results are always obtained than are indicated by the formula.

F. H. C. Coppus (Coppus Engineering and Equipment Company): In my opinion the steam locomotive can be developed to such a high degree of efficiency that its drawbar-horsepower would be so cheap and its capacity increased so that electrification for the sake of economy would be out of the question, at least on a large scale, for some time.

The logical order of locomotive development as far as combustion is concerned should be the following: 1. Mechanically induced draft in the front end. 2. Condensing the exhaust steam and carrying the condensate to the tender. 3. Pumping the hot water from the tender through a waste steam and waste gas heater into the boiler. 4. Under-grate forced draft in the ash pan.

By the carrying out of these developments I look forward with confidence to the reduction of the operating expense of the locomotive to an equivalent of 50 per cent of the present coal consumption. The suggested improvements can be added to all locomotives now in use and at a cost that they will pay for themselves inside of a year.

Elmer A. Sperry discussed the application of the Diesel engine to locomotive service, stating that this is one of the principal problems confronting designers and builders of Diesel engines. The fuel efficiency obtained with the Diesel type of engine is so striking that, in Mr. Sperry's opinion, it is bound to come to the fore. He felt that there was an encouraging outlook for the application of the compound Diesel engine which has recently been developed.

Reconstructing the Pennsylvania L1S Locomotive From a Fragment

By Lawford H. Fry

In presenting this article the author expresses the hope that it will not be taken too seriously. It is not intended to be an exact treatise on locomotive design, but to call attention to the fact that through all parts of a well proportioned locomotive there must run an ordered harmony which links together such apparently unconnected dimensions as those of the main pin bearing and of the heating surface.

It is said that Cuvier, the famous anatomist, could, from a single prehistoric bone, determine all the characteristics and habits of the animal from which it came. In the dim and far off future when electricity has superseded steam as a motive power and has in its turn passed into the discard will there come, we wonder, some Cuvier of the mechanical world to show his students that from a single locomotive part the type and most of the important dimensions of the engine can be determined? Frankly we don't know whether he will or not, but if he should, we can foretell the lines along which he must work, and it may be interesting and instructive to see how they run. Of course not every part will give the same information, but suppose our fortieth century scientist has unearthed the piece of driving wheel shown as Exhibit A, from which the stroke, the wheel diameter and the dimensions of the main pin can be found. We can imagine that after due measurement and careful calculation his announcement to his class would run as follows:

"Gentlemen, the ancient fragment before you has been studied in the light of our knowledge of the early days and I am able to tell you that it belonged to a freight locomotive dating from the beginning of the twentieth century. I have not been able to recover any other parts of the engine, but this is sufficient to enable us to say that the locomotive to which it belonged was of the Mikado or 2-8-2 type, and

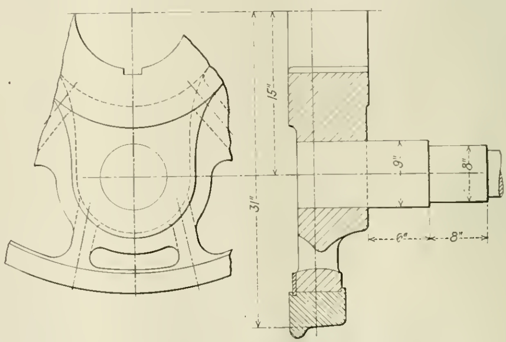


Exhibit A—The Fragment From Which the Dimensions of the Locomotive Are Determined

that the total weight of the locomotive was approximately 330,000 lb. in working order, of which about 240,000 lb. was on the driving wheels. My calculations show further that the heating surface was approximately 4,000 sq. ft.

and that the cylinders gave a maximum tractive effort of approximately 60,000 lb. The cylinder diameter was 26 or 27 in., but the exact dimensions cannot be settled without further information." "Now, gentlemen," our professor might continue, "I see some of you, and particularly you, sir, from Jefferson City, who look incredulous. Let me show you how the dimensions I have given can be elicited from the part before us:

"Our point of departure is the main rod bearing on the main pin which measures, you will observe, 8 in. by 8 in., thus having a projected bearing area of 64 sq. in. Now as good practice permits a maximum piston thrust of 1,800 lb. per square inch of projected area, this bearing would be adapted for a maximum thrust of $64 \times 1,800 = 115,000$ lb. The side rod bearing on which a pressure of 1,600 lb. per square inch is proper has $9 \times 6 = 54$ sq. in. of projected area and is thus proportioned for a thrust of $1,600 \times 54 = 86,400$ lb., which is 75 per cent of the total thrust on the pin. It is evident that this main pin was designed to transmit three-quarters of the pin thrust to the coupled axles, one-quarter of the thrust being taken up by the main axle. There must, therefore, have been three other axles coupled to the main axle. The locomotive must have been of the eight-coupled species.

"Now the maximum piston thrust which we have estimated at 115,000 lb. is the thrust of a single piston with full boiler pressure behind it. The relation between this and the rated tractive effort, that is the tractive effort delivered at the rail by two cylinders with 85 per cent of boiler pressure as mean effective pressure, is:

$$\frac{\text{Tractive Effort}}{\text{Maximum Piston Thrust}} = 1.08 \frac{\text{Stroke}}{\text{Driving Wheel Diameter}}$$

which gives 60,000 lb. for the tractive effort. This with a factor of adhesion of 4.0 gives 240,000 lb. as the weight of driving wheels. From the cylinder tractive effort to the boiler dimensions, connection is made by the Boiler Demand Factor, or B.D., which is:

$$\frac{\text{Tractive Effort} \times \text{Driving Wheel Diameter}}{\text{Heating Surface}}$$

A probable value for this factor for an eight-coupled engine of this period with 62 in. drivers would be 900,* which leads to the equation:

$$\frac{60,000 \times 62}{\text{Heating Surface}} = 900$$

This shows a heating surface of 4,010 sq. ft."

At this point the professor stops a moment partly to catch his breath, partly for rhetorical effect and partly to see how his deductions are being received. Noting for a second time a critical gleam in the eye of the Missourian, whom he had already singled out, the professor continues, "In the matter of heating surface, you will doubtless remind me that for a proper choice of the B.D. factor we must know whether the locomotive used saturated or superheated steam. I have assumed superheat and for these reasons: My examination of the crank pin shows it to be made of heat treated steel, while what we have of wheel center shows care in design. We may, therefore, conclude that the early designer was abreast of his times and would not have been so lacking in judgment to build an eight coupled engine with 60,000 lb. tractive effort without equipping it with superheat. In the period to which our fragment evidently belongs, it was usual to make the superheating surface 23 per cent of the heating surface, which gives for our reconstruction about 920 sq. ft. of superheated surface.

"From the heating surface we are led to the total weight in working order, by knowing that a well designed superheater locomotive weighs about 80 lb. for each square foot of heating surface. On this basis we have $4,010 \times 80 = 320,800$ lb. total weight. We concluded previously that 240,000 lb. was carried on the four coupled axles so that the difference of 80,000 lb. is to be carried on a truck or trucks. Now, gentlemen," we hear the professor saying, "the adhesive weight of 240,000 lb. was carried on four axles, from which we may assume that the maximum allowable axle load was not greatly in excess of 60,000 lb. Certainly the truck load of 80,000 lb. is too great for a single axle. We, therefore, know that the engine must have had four driving and two truck axles. It is possible that this was a 4-8-0 type, but this type was unusual, particularly in the part of the country in which our fragment was unearthed; I am therefore confident that it belonged to the 2-8-2 or Mikado type. The size fixes its date as early in the twentieth century."

With his reconstruction thus completed our professor accepts with a satisfied smile the applause of his audience. Looking critically at his deductions we find them generally sound, his only unsupported assumption being that the fragment came from a correctly proportioned locomotive. Indeed, the fact that he carried his speculations no further is most creditable to his self restraint. In his place, twenty centuries away from the possibility of checking the reconstruction against the original, we doubt if we should succeed in maintaining such an admirably conservative tone. It would be all too easy to hazard a couple of plausible guesses, which would start a new series of calculations and lead to the revelation of practically everything except the engineer's first name.

If it should happen that any of the students attempt to check up their professor by a search of the old records, it is possible that they will find that the main wheel and pin on which he has hung his parable have the same dimensions as the corresponding parts of the Pennsylvania Railroad 2-8-2 type locomotive, this company's class L1S, the principal dimensions of which are:

Cylinder diameter	27 in.
Cylinder stroke	30 in.
Boiler pressure	205 lb. per sq. in.
Driver diameter	62 in.
Tractive effort	61,500 lb.
Maximum piston thrust	117,374 lb.
Heating surface	4,018 sq. ft.
Superheating surface	1,172 sq. ft.
Grate area	70 sq. ft.
Weight in working order on driving wheels	240,200 lb.
Total locomotive	320,700 lb.

FACTORS:—

$$A = \frac{\text{Weight on drivers}}{\text{Tractive effort}} = 3.82$$

$$B = \frac{\text{Tractive effort}}{\text{Heating surface}} = 15.3$$

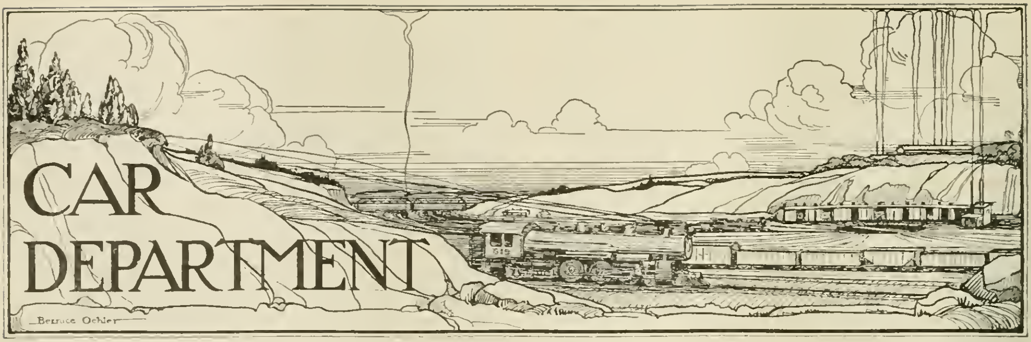
$$C = \frac{\text{Heating surface}}{\text{Grate area}} = 57.5$$

$$BD = \frac{\text{Tractive effort x driv. diameter}}{\text{Heating surface}} = 950$$

$$E = \frac{\text{Total weight}}{\text{Heating surface}} = 78.6$$

A Carload of Mail Containers Ready for Delivery to the Post Office

*Apparently the professor has had access to the *Railway Mechanical Engineer* of April 1921, page 215



Does It Pay to Repair Foreign Freight Cars?*

Some Relations Between Freight Car Repairs, Transportation Expenses and the Income Account

By N. D. Ballantine
Superintendent Transportation, Union Pacific System

MASTER Car Builders' Rule No. 1 reads as follows: "Each railroad is responsible for the condition of all cars on its line, and must give to all equal care as to inspection and repairs, regardless of responsibility for expense of repairs." This rule, however, was not followed even under Federal control. In support of the conclusion that the same condition still exists, a brief consideration of the bad order situation may be worth our while.

We can doubtless agree that mass figures, involving a large number of items, probably reflect a situation more correctly than similar data compiled by an individual carrier. Before proceeding further, however, it may be well to see if we can also agree that there has been no material change in the manner in which roads repair cars or report their bad order situation now, as compared with practices in vogue under Federal control.

Data deduced from some records kept while with the Car Service Division of the U. S. Railroad Administration covering the repairs given to freight cars during the years 1918 and 1919, indicates that with about forty-five billion freight car miles produced during the two years, there were about forty million repairs, heavy and light, given to freight cars. This means that each freight car moved an average of 811 loaded and empty miles before being switched to the repair track for repairs. The same factor obtained in each year. The figures also indicated that of the total cars bad ordered, 9.6 per cent were for heavy repairs in 1918, and 9.4 per cent in 1919, or approximately 10 per cent during the period.

Would it not seem reasonable to assume that unless there has been some fundamental change in the methods of making repairs or reporting bad orders, we could safely continue to use for the country as a whole, 811 miles as the average service which will create a bad order car?

In the table, the total freight car miles has been divided by 811 to obtain the column headed "Bad Order Cars Produced." With this exception, the figures shown are taken from statistics furnished by the Bureau of Railway Economics and Car Service Division of the A. R. A.

It will be agreed that we have no absolute basis with which to measure car repairer's efficiency, but during the period of comparison I believe it will generally be conceded that the output per car repairer increased materially.

Factors in the Bad Order Car Situation of Class I Railways of the United States

Month, 1920	Home cars on home roads	Average bad order cars on hand	Bad order cars produced	Car repairers
October	731,699	177,655	2,657,471	95,068
November	749,774	181,595	2,397,046	91,188
December	790,933	189,490	2,275,218	84,123
1921				
January	1,074,661	209,667	2,118,640	70,307
February	1,396,048	234,506	1,772,067	60,319
March	1,612,185	260,230	1,923,808	54,537
April	1,689,225	296,233	1,836,170	50,051
May	1,744,907	329,850	1,969,360	52,919
June	1,764,612	351,465	1,980,122	54,410

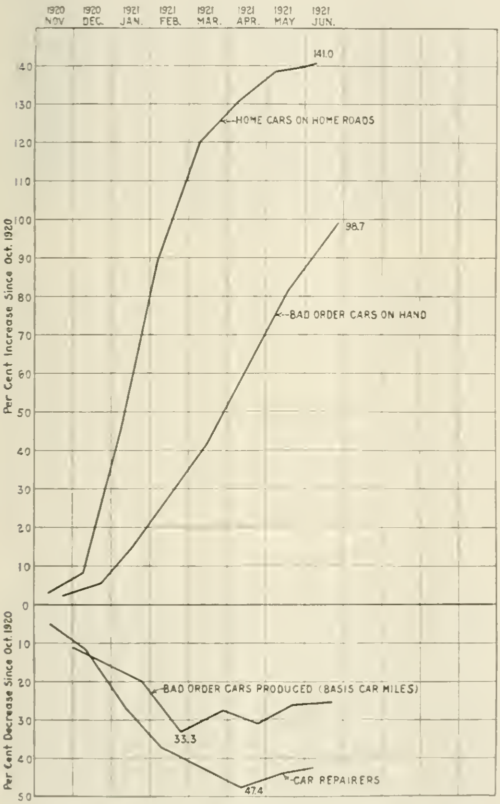
From time to time we read in the newspapers and lately even in the Railway Age reference to the abnormally poor condition of the freight equipment of the country, conclusions generally being drawn, I infer, from a comparison of tabulations made by the Car Service Division as to the bad order cars on hand. The real situation as to condition of freight equipment should not be concealed nor, on the other hand, magnified. However, I feel that the figures for bad order cars on hand, taken alone, are prone to mislead as to the real condition, for the reason that during the period under consideration, a very unusual situation developed in connection with the return of cars to their owners. Had M.C.B. Rule 1 been generally observed in spirit or letter, the effect of relocation of cars to home lines would not have been accompanied by such a substantial increase of bad orders, but surely our mechanical friends who are at all familiar with actual conditions will agree that during the period referred to, and probably up to the present time, their practice was to card a large percentage of system cars "Bad Order," while a foreign car having, as nearly as could be determined, the same defects, but safe to run, was not so carded, but sent home—there to be carded. What really happened then, is that while there was a substantial decrease in the factors producing bad orders car repairers were decreased somewhat in proportion, slightly more, but their efficiency increased, while bad orders reported mounted at an extremely rapid rate, following the trend of the rapid return of cars to owners.

The chart on the following page, which is self-explanatory,

*A paper read before the Western Railway Club, November 21, 1921.

may help to visualize the relations existing, and would seem clearly to indicate that until such time as M.C.B. Rule 1 is generally observed, in proportion as home cars on home roads increase, the bad order reports will show an increasing number of bad orders, although there may be no real difference in the actual physical condition of car conditions as a whole.

Manifestly, M.C.B. Rule 1 will not be observed until such time as allowances for the repairs to foreign cars are equal at least to a sum sufficient to compensate a road for doing such work, including supervision, shop overhead, interest, depreciation, insurance and taxes covering the facilities used in making car repairs, together with the cost for switching and the per diem equivalent while cars are out of revenue service to be repaired. Owing to the widely varying conditions and



Percentage Variations In Car Conditions Since October, 1920

ideas existing with respect to the cost of overhead and the other items above referred to and lack of sufficiently reliable data covering the matter, this phase of the subject will not be dwelt upon. These factors can only be determined through an actual and careful study of local conditions.

My object will be to point out a basis upon which a study could be made to include some important relations which exist, in order that a proper policy may be adopted, having in mind the best interests of a property as a whole, without regard to departmental lines.

Direct and Indirect Expense

Let us define direct expenses as all items affecting freight car repairs which can be, and generally are, charged directly to the particular job, and indirect expenses as all other items affecting freight car repairs which can properly be included in the overhead and other items already referred to and which cannot be directly charged.

Owing to the difficulty of determining the "indirect expense," and for want of a better basis from which to draw conclusions, I shall confine myself to some deductions or comparisons from the item, "direct expense."

The relation between the prices allowed under M.C.B. rules and the direct expense involved in doing that particular piece of work should represent the allowance for the indirect expense. For example, if labor costs 72 cents an hour and M.C.B. rules permit billing for labor at $1.20 an hour, then 66.6 per cent of the direct labor expense is to apply on the indirect expense A comparison on the above basis, covering labor and various other items which go to make up the principal material used in car repairs might be of interest and value to any road.

Per Diem

While per diem does not directly affect any operating account nor a road's operating ratio, it does affect a road's net income through the "hire of equipment" account. Therefore time is an important element in the matter of repairs to foreign cars in its effect upon that portion of the M.C.B. allowance covering the indirect expense as the following illustration will show.

Assume that an average of $15 per day direct expense could be economically applied on a foreign car, and that it had been determined through the method above outlined that 33.3 per cent of its direct expense was available to apply on the indirect expense. Then $5 would represent the indirect portion. As seven days per diem would be paid covering six working days it would be equivalent to $1.17 per day and would absorb 23 per cent of the indirect allowance. If, however, it should take two days to spend such a sum, then 46 per cent of the indirect allowance would be absorbed by the per diem paid out while undergoing repairs. Therefore, in proportion as the labor and material applied per day can be increased, the effect of per diem in absorbing the indirect allowance will diminish. With a little carelessness or delay in handling foreign cars, then the indirect portion of the allowance may be wholly absorbed in this one item.

Loss of Revenue

During periods of heavy demand for cars, the less time a car spends on the repair track the more time it is available for producing revenue, and its effect upon the net revenue can clearly be shown in the following manner:

Assume that the freight revenue per freight car mile, loaded and empty, is 20 cents, and that the average miles made per car per day is 30. Then such a road would be able to earn on the average a gross freight revenue of $6 per car per day. If its freight operating ratio was 75 per cent, then $1.50 per car per day would represent the net revenue from operation. Clearly, then, for every day a car is held out of service in bad order during periods of demand this would be a proper item to consider in the determination of what should or could be done to avoid such delay.

Switching

I believe it will readily be conceded that the present day cost of a switch engine, including rental and repairs, will vary from $10 to $14 per hour. If it is correct in principle to add a percentage to the direct expense for freight car repairs to cover the overhead and plant facilities, and I believe it to be, the same principle should apply in determining the cost of switching. Regardless of agreement with the principle suggested, take any rate you may see fit and measure it with the service actually performed to determine, if practical, what proportion of the indirect allowance switching may absorb. For the purpose of this illustration, let us use $10 per hour as the cost of a switch engine. Assume the simplest typical case involved in removing just one bad order car from an inbound train or transfer, which we will say consists of 40 cars. On an average 20 cars will need to be handled in cutting out the bad order to be placed upon a temporary hold track, which operation would consume on an average at least five minutes. It would also easily consume an average of five minutes per car to remove a string of cars from the temporary hold track to the repair track and space them a total of at least 10 minutes to put the car on the repair track, and the same amount of time to remove it, or, say, 20 minutes as a minimum. On the basis of $10 per hour, the cost for the four switches involved in cutting out a bad order and placing it on the repair track would be $3.33, or 66.6 per cent of the $5 to apply on the case previously cited, where $15 direct expense was applied in one day. Therefore, in proportion as the amount of labor and material applied can be increased for each time a car is switched to the repair track, the effect of switching expense in absorbing the indirect allowance will diminish.

It should be clearly borne in mind that the estimates of time consumed by a switch engine in setting out a bad order car is purposely intended to conservatively cover the simplest case, and does not cover those cases where, due to accumulations of bad orders, the cars are switched to outlying tracks and later culled over from time to time, the lightest repairs, etc., being selected, the cost for which latter method of handling is of course much greater than the above estimate.

Empty Car Mileage

A conservative estimate of the average out-of-pocket cost of the movement of an empty freight car per mile on the railroads of the United States at the present time would be 5 cents, not including the per diem or mileage payments.

In proportion as the demand for box cars in good physical condition with which to load flour, sugar, grain, etc., increases, with a given number of rough freight box cars circulating upon a road, the empty mileage and switching is bound to increase. A rough freight car may be suitable for loading l.c.l. or merchandise traffic, say to a branch line point where the outbound business is grain. But if such a car is used it must be hauled away empty and a grain car sent in, causing a cross-haul and unnecessary empty mileage.

M.C.B. Rule 120 provides that a foreign car in general wornout condition shall be reported to the owner with an estimate of the cost of making repairs. The owner has but two options, viz., to authorize the repairs, or the destruction of the car wherever it may be located. Nevertheless, many roads, under special agreements between their mechanical departments, are moving such cars home for repairs. Unless such movements are authorized or concurred in by the transportation departments, decidedly uneconomical movements are likely to occur if factors other than the purely mechanical are considered. Before a proper decision can be made as to the economics of a case, the principal factor to be determined is, "Could the car, if repaired where located, be given a load in the direction it would otherwise move empty as a bad order?" If the answer is "Yes," then it is proper to double the mileage the bad order car would make to determine the total unnecessary empty mileage involved.

For example, a Pennsylvania box car at Ogden in bad order, if sent to the owner at Chicago would involve 1,500 empty car miles, and if the excess box car loading were eastbound, it would mean the necessity of moving some other box car empty westbound 1,500 miles, involving 3,000 excess empty car miles as compared with repairing the car at Ogden and loading it to Chicago. At 5 cents per car mile, this would mean an out-of-pocket expense to the carriers involved of at least $150. On the other hand, if a Southern Pacific car located at Chicago were safe to run, but otherwise would be considered a bad order, and the movement of empty box cars were westbound, it would be more economical to all concerned to send such car home and let the owners repair it, there being no excess empty car miles involved, and the owner could probably make the repairs for 20 per cent less than it would cost a foreign road to do so.

Loss and Damage

The A.R.A. Freight Claim Division has recently issued a memorandum indicating that practically 10 per cent of all freight claim payments made during the seven months ending March 31, 1921, aggregating $5,876,056, was paid on account of defective and unfit equipment; and $3,243,806, or 55 per cent, of the total payments on account of defective equipment was for grain, flour and sugar, grain alone amounting to $1,818,664, or 31 per cent.

There are, of course, many factors involved, but suffice it to say that the bad order situation appears to me to be vital, and one which can and should be improved.

When it is necessary to switch a car to a repair track and incur the transportation and per diem expense, regardless of the initials on the car, when practical the required work should be done thoroughly and expeditiously.

In other words, the rules should be made so that the signers of the agreement will observe Rule 1, and coincident therewith I feel sure there will follow reduced cost of freight car repairs and transportation expenses, as well as a reduction in the hire of equipment account.

Discussion

A number of reasons were given in the discussion why foreign freight cars are not better maintained when away from home. One reason mentioned by F. H. Hammill, assistant general manager, Chicago & North Western, was the difference in the design of equipment owned by different railroads which adds to the difficulty of making repairs to foreign cars and makes this work cost more than similar work to the home cars. Mr. Ballantine suggested that a sufficient compensation in the price rules might meet this condition.

C. B. Peck, *Railway Mechanical Engineer*, suggested that while Mr. Ballantine's deductions from his table were no doubt correct, the important point to be determined was whether the present bad order reports or the reports prior to the heavy coal movement were to be considered as more nearly reflecting the true conditions. He presented an analysis showing the gradual increase of bad-order cars requiring heavy repairs from 53 per cent of a total of 175,000 bad-order cars in August, 1918, to 67 per cent of 174,000 bad-order cars on November 1, 1920, just before the beginning of the heavy home movement. These figures indicate a material decrease in the serviceability of equipment during the period shown and disclose an accumulation of repairs not shown by the figures for all bad orders.

J. J. Tatum, superintendent car department, Baltimore & Ohio, sketched the conditions obtaining during the railroad administration which made it necessary to give attention primarily to running gear, draft gear and brakes, leaving the superstructure to receive such repairs as circumstances would permit. He outlined a plan for regional shops to take care of cars of groups of railroads, to be located at the principal gateways where cars are interchanged in large numbers. In reply to a question Mr. Tatum stated that the prices for work done in the regional shops would have to be high enough to pay a profit on the capital required for the establishment of such shops if they are to be established.

Mr. Ballantine showed the benefit of keeping up car repairs by the experiences of the Union Pacific which during the six or eight months covered by the table in his paper put about 60 per cent of its box cars through the shop for heavy repairs. Following the repairs to these cars the mileage between repairs increased to 2,538 as compared with the average of 811 for the United States.

Reclaiming Sheets of Outside Metal Car Roofs

Important Savings in Car Repair Costs Result from Moderate Expenditures for Facilities

As ONE of the results of pooling equipment and deferring maintenance during the period of federal control, owner lines are now having returned to them a great number of box cars requiring extensive repairs to roofs. At the present time one large eastern line has from 10,000

Car With Roof of Reclaimed Sheets

to 15,000 box cars equipped with various makes of metal roofs which are in need of roof repairs. Providing new metal for the roofs of these 10,000 to 15,000 cars would entail an expenditure of from $500,000 to $750,000. To avoid this heavy expense, the road has established plants for reclaiming used roof sheets at 31 points on its system where cars are repaired.

In the great majority of instances, the wear in the original metal sheets was due to poor material supplied during the war period, resulting in leaks occurring at the lower edge of the sheets at the eaves of the car where the sheets overlap the flashing. The plan for reclaiming the sheets involves their removal from the car, cutting off the worn end, reforming and painting.

The roofing sheets, now being reclaimed, originally were

Sheets Before and After Reclaiming

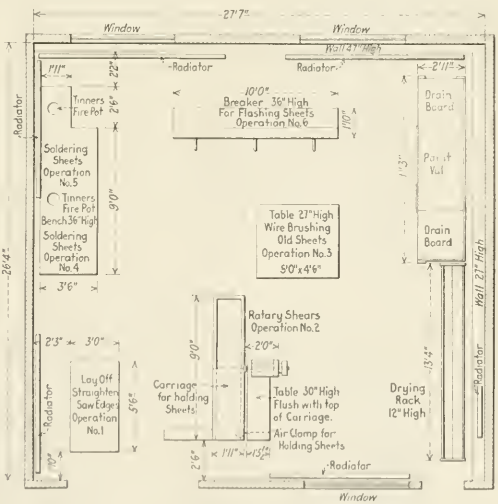
of two lengths, 4 ft. 6⅞ in. and 4 ft. 8⅞ in. Both length sheets were used with 4¼ in. flashing. As reclaimed the 4 ft. 6⅞ in. sheets are cut back to a length of 4 ft. 3 in. and used with 7 in. flashing if the wear in the original permits. Where the wear is greater the sheets are cut back to a length of 4 ft. 0 in. and used with 10 in. flashing. Sheets originally 4 ft. 8⅞ in. long when reclaimed are cut back to 4 ft. 5½ in. for use with 7 in. flashing and to 4 ft. 2½ in. when 10 in. flashing is used.

Roof sheets which are not suitable for use with either the 7 in. flashing or 10 in. flashing are squared and split in the center of the width after all defective metal has been cut off the ends, and are then formed into 7 in. flashing. The 10 in. wide flashing is made from new galvanized iron.

The drawing showing the arrangement of the facilities in

Defective Roof Sheets Formerly Used for Building Purposes or Sold for Scrap

the car roof reclaiming shop illustrates the simple and inexpensive layout and equipment required. The building is of frame construction, 26 ft. 4 in. wide and 27 ft. 7 in. long. The equipment is standard and includes facilities for straightening the sheets, rotary shears for cutting the sheets



Layout of Shop

and the flashing, a table used in connection with the shears for holding the sheets while being cut, a break machine for reforming the ends of the roof sheets and the flashing, a table and wire brushes for cleaning old sheets, tinning and soldering outfits and painting vats and drying racks.

The reclaiming involves six operations; straightening, clipping, cleaning, soldering, reforming and painting. The painting is done by the bath method, and a second coat of paint is applied to the top of the sheets and the flashing after the roof has been rebuilt and applied.

In applying the reclaimed material to the car roofs standard practice, as it obtains with new material, is followed closely. The flashing is nailed to the side facia and a hold-on-clip or cleat is used to hold the flashing. This is nailed to the roof carlines or to the sheathing. Where there is no carline for the nails they are driven through the sheathing and clinched. The flashing has an interlocking seam at each end to prevent leaks.

One of the photographs shows a pile of defective roof sheets. Before the plan for reclamation was perfected these sheets were used for building purposes, covering bridge ties and so on. Many of them were sold as scrap or disposed of in fills along the right-of-way. Another photograph shows piles of roof sheets before and after reclaiming, while a third photograph shows a car roofed with the reclaimed material.

With the facilities described a daily output of sheets and flashing sufficient to provide roofing for five cars is secured at each of the plants. This is done with an expenditure totaling less than $28 per day per plant or, in other words, at a cost slightly in excess of $5 per roof.

Support for Passenger Cars Undergoing Repairs

By Norman McCleod

WHAT might be termed a refinement in the design of a supporting portable trestle for passenger cars while they are undergoing repairs is shown in the accompanying illustration. This device has a number of advantages over the old wooden trestle, the principal one of which is that, being supported on wheels, it can be moved or shifted at will with a minimum amount of labor.

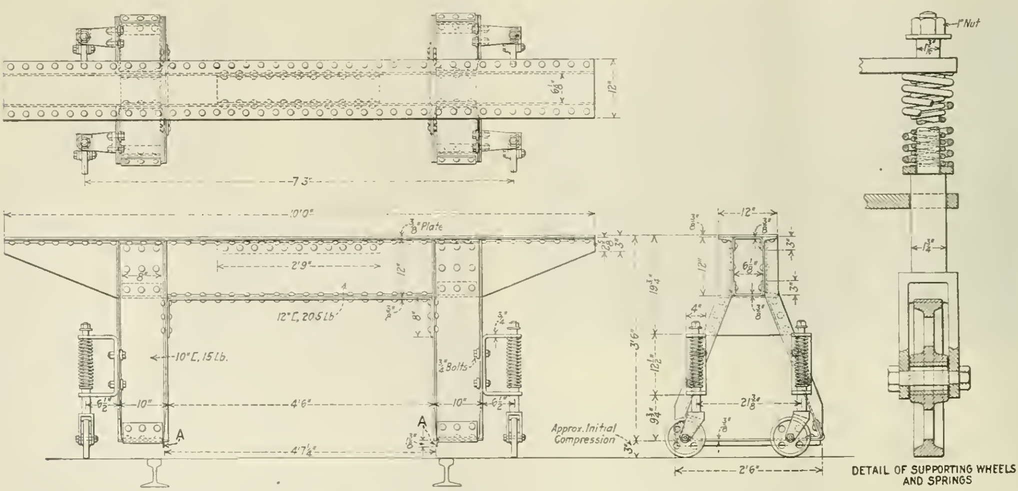
The trestle is built of 10 in., 15 lb., and 12 in., 20½ lb. channels and ⅜ in. steel plate. It is supported on four 8 in. diameter wheels, equipped with roller bearings. The weight of the trestle is more than balanced by four sets of car springs, capable of taking care of about 1,260 lb. each, approximately three inches compression being required to bring the trestle down on the rails.

Provision is made for keeping the trestle in alinement with the track by two projecting flanges, as shown at A, which assume a position adjacent to and just inside the heads of the rails when the weight of the car is placed on the trestle. The details of the wheel, bearing, springs and spindle are shown on a larger scale at the right hand side of the illustration.

The drawings are self-explanatory and the feasibility of the device is apparent. A number of these trestles are in service at the various passenger car repair shops of one of our large railroads and they have proved to be much more durable and satisfactory than any other design used in the past.

RECORD ORE LOADING. What is claimed to be a world's record for loading a cargo of ore was established recently according to the dock office of the Duluth & Iron Range, when the steamer *D. G. Kerr* took on 12,506 tons of iron ore, in sixteen minutes. This office reports that the steamer tied up at the dock at 4:44 p. m., loading and raising the last chute by 5:00 p. m.

IN AMERICA for many years the passenger cars have been made of steel; ours are for the most part still of wood—no doubt that they may burn faster. In America they have automatic couplers, which prevent accidents and save time; in France there are still unhappy human beings who have to lock the cars together one after the other by hand. In America there is not a coach which does not have its two wash rooms, one for women, the other for men; in France a third of the cars have no wash rooms and in those that have them they are kept by ineradicable tradition filthy. In America, in the Pullman cars, which correspond to our first class, each passenger has at his shoulder a small electric light which enables him to read, and a tiny table on which he can work; in France, even in the de luxe cars, it is impossible most of the time to see clearly after dark. In America each coach is furnished with a reservoir of cold water and with paper cups from which to drink; in France, in point of water, there is only that which drops on your head when you go to the wash room. —*Stephane Lauzanne in Le Matin (Paris).*



Convenient Portable Trestle for Passenger Cars

Galewood Yard, Chicago, Milwaukee & St. Paul

The Use of Wood in Freight Car Construction

Is the General Use of All-Steel Construction Justified? The Advantages of Composite Design

By H. S. Sackett
Assistant Purchasing Agent, Chicago, Milwaukee & St. Paul

THE most important feature of transportation in relation to commerce is naturally the freight traffic; thus, in the evolution of steam locomotion the problem always has been the construction of freight cars to meet the requirements of economic operation. From the first type of horse drawn freight car operated on the Baltimore & Ohio, antedating the steam locomotive and moved over timber rails, to the present quasi-standard 100,000-lb. capacity box car designed during the war, wood has maintained its important place because of its inherent suitability for the purpose which has been indisputably established not alone by its service record during the nearly 100 years of railroad history, but ever since merchandise was first transported on sleds; even before the invention of wheels.

A growth from 35 miles of railroad in 1835 to a total of 370,000 miles in 1918, and the development from locomotives of 15½ tons previous to 1850 to the electric "King of the Rails" of 1920 weighing 550,000 lb., and the Santa Fe type weighing over 400,000 lb., are graphic illustrations of progress fully comparable with the unprecedented commercial advance of the United States during the same period.

Developments in Car Construction

Car construction cannot boast of such intense application. Looking back through this phase of railroad history one can hardly escape the impression, that generally speaking, freight cars "just grow'd" like Topsy, at least up to about 20 years ago when the pendulum started on the swing toward the present extreme of super-heavy construction.

In 1867 the Master Car Builders' Association accepted 20 tons as the maximum capacity of box cars. Today the indications are that cars of 100,000 lb. capacity will soon be the standard. These changes naturally made obsolete the older types of equipment as the lighter construction became entirely inadequate to meet the requirements of modern traffic. Thus was developed the quasi-standard type of steel underframe construction as typified by the double-sheathed box car, developed during the past three years.

At the present time, to go beyond this to the all-steel closed-top freight car is hardly good, conservative engineering practice. All-steel cars can, at best, be considered but experimental, as only about ten years of worth-while experience has been had with such equipment and during this period such authentic evidence as is available points to excessive maintenance as compared with composite cars.

Up to this time, furthermore, the steel car has been developed mainly by the railroads which serve the steel districts, and this fact is undoubtedly responsible for their ultra-development by such roads. Likewise, railroads traversing forested regions have held more closely to the wooden or composite cars. The desire to aid in marketing a local product, therefore, has doubtless been a strong factor in the development of the all-steel car.

In this connection too it is of interest to note the recent announcement of the Pullman Company of a return to the composite sleeping car, one of steel understructure with steel skeleton superstructure insulated and finished with wood. This combination makes a safe, strong and comfortable car and one which is certainly superior in all respects to the all-steel type.

In 1918, Z. B. Wilson, of the Southern Railroad, in the Railway Review stated, "Nothing has occurred in the past decade that would justify spending $2,500 for an all-steel box car, while we can build a composite box car with a substantial steel underframe, with superstructure and ends reinforced with steel for $1,250. The writer desires to say * *, that he is very much in favor of composition cars for the following reasons: (1) A greater proportion may be repaired at other than steel car shops; (2) the initial cost is less; (3) the cost of maintenance is less than half of all steel; (4) the sides do not bulge as those of all steel; (5) composite cars can be repaired in half of the time required for the all-steel, thereby materially increasing car efficiency."

However, this controversy is not new. In 1870 the first earnest discussion of the steel car is recorded in the proceedings of the Master Car Builders' Association for that year. About thirty years later we find the fruition of these debates and early studies in the steel center sill, to be followed by the all steel underframe, both of which are justified by experience, but like many reforms that are aimed to achieve perfection over night there seems to be no happy medium and we are now presented with *all steel everything.* There is one consolation in this all-steel craze, that our inbred respect for cattle and hogs, which evidently outweighs consideration for mere human comfort, will prevent the all-steel stock car.

The demands made upon freight carrying facilities have entailed changes in construction to meet new requirements. Among these factors is the high speed with which trains of great tonnage are today moved across the continent. Tractive effort has increased 3,000 per cent and with the increased cost and scarcity of labor has come fly-switching and the hump track. It would be unreasonable to expect the all-wood cars of 20 to 30 tons capacity, weighing between 22,000 lb. and 27,000 lb. and in their prime during the last decade of the nineteenth century, to meet these changed conditions. Efficiency dictates scrapping such equipment and its replacement with modern construction designed to withstand the wear of present traffic. Maintaining obsolete rolling stock is wasteful, and when certain roads spend roughly as high as 35 per cent of the total value of their rolling stock for its maintenance and repair in one year. it is time to establish with positive clarity just how much may be expended for maintenance with safety to financial soundness.

Relative Advantages of the Double and Single Sheathed Box Car

So far, all-steel equipment has not been proved to be the most economical. No attempt is made to prophesy future developments, but with a design adopted which meets all present and future requirements within the range of vision, sound conservation compels the building of the largest number of freight cars for the least money in order to rehabilitate transportation facilities and avoid the serious difficulties and losses occasioned yearly by lack of cars.

However, aside from the matter of expediency and present financial considerations the steel underframe, wood superstructure double-sheathed car (in some cases with metal carlines and steel ends for closed-top cars) presents physical and economic advantages, which quite distinctly identify it as the most suitable for modern conditions. These advantages may be summarized as follows:

(1) It is sufficiently rigid to withstand modern mechanical shock.

(2) It is adaptable to special conditions of lading, climate and traffic, varying with the respective territory involved, without sacrificing the standard interchangeable features of the steel substructure, trucks, draft rigging and appliances.

(3) It may be fully assembled at railroad shops, from materials (such as the lumber for superstructure) often locally available.

(4) Trained labor is more available and less costly, and can be more evenly distributed than were the construction of all steel cars concentrated in the present manufacturing centers, which alone can most economically produce the all steel car.

(5) Repairs can be made more rapidly, at less cost and at any repair yard.

(6) It provides greater protection to a majority of the various classes of lading.

(7) It is more readily suited to interchanges as it meets most effectively the requirements of climatic extremes encountered within the four boundaries of the continent.

(8) The initial cost is less. Although the reproduction value (M. C. B. Rules, 1920) is approximately nine per cent less than that of the all steel car the difference in first cost invested at six per cent compound interest for 20 years, still gives the composite car an advantage of five per cent after deducting such loss, providing maintenance of the all steel car is not greater than that of the steel underframe and wood superstructure car.

(9) The depreciation (M. C. B. Rules, 1920) is the same as for the all steel car, namely three per cent.

(10) Shippers prefer wooden superstructure as packing of lading is more convenient and less costly, because precaution need not be taken against rusted side sheets, bulging ends, condensation from roofs, or leaks of bulk lading occasioned by holes in corroded plates.

(11) It is lighter by upwards of 1,000 lb. and therefore costs less to haul.

Railroad Administration Double-Sheathed 40-Ton Box Car

The single-sheathed, steel superstructure outside frame car must likewise suffer by comparison with the double-sheathed car. Its chief weaknesses are unsightliness after short usage, due to the unavoidable perforating with nail holes of the single thickness of longitudinal siding, as well as the consequent exposure of lading. Where such cars are used for valuable or semi-perishable freight, extra packing is required, and in some instances cars must be sheathed with tarred felt or waterproof paper by shippers; hence, the general unpopularity of this type of car. For such ladings as bricks, paving blocks, castings, etc., it will do unless because of poor loading the heavier pieces go through the side, or break up the siding. In addition, the first cost is greater, and the saving in volume of lumber used is offset by the higher cost of the grade and dimension required.

An average single sheathed car would require about 1,500 board feet of 1¾-in. (rough 2-in.) dressed select, B and better, Southern pine sheathing; the double sheathed car requires about 1,700 board feet, No. 1 common, 13/16-in. lining and 13/16-in. B and better siding. The difference in quoted prices (September 1920) equals a saving of $22.50 a car, which at 6 per cent compound interest during an average life of 20 years would represent $72.15 per car. If applied to 100,000 box cars of the type recently ordered, this would amount to about $7,215,000, enough to add over 2,000 double sheathed cars to the present equipment.

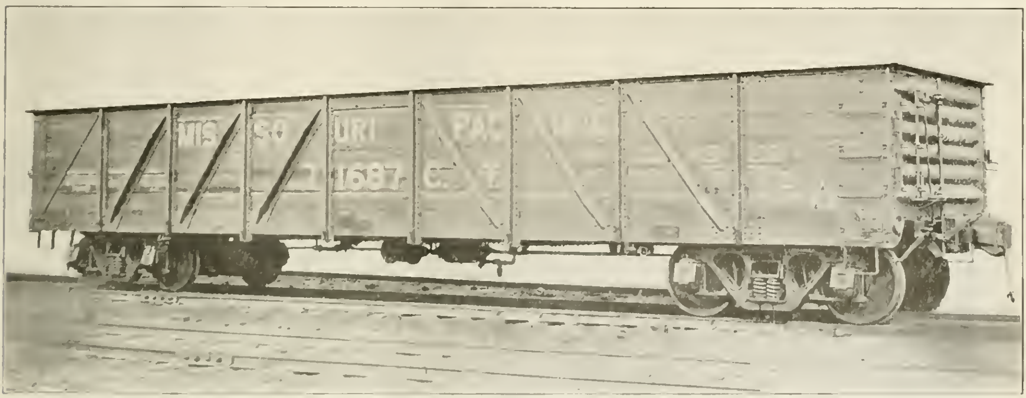
Whether the steel frame superstructure adds sufficient strength to the car, or materially increases its durability is largely guess work—a prophecy of future occurrences which the future alone can answer. At present it has not emerged from the experimental stage. Therefore, the problem is again one of comparative initial cost, and the known service of the wood superstructure against the problematical performance of the steel frame.

The Composite Gondola Car

Our discussion thus leads us to other types of cars, particularly, gondola, flat, stock and refrigerator cars. The latter are by their nature excluded from the possibility of all-steel construction. Gondola, coal and ore cars present different problems, but there is no question that the all-steel gondola still requires considerable development before it can be considered as a successful type. Flat cars are on the wane. Other types, such as tank cars and logging cars, are largely of private ownership and represent a comparatively small percentage of the total freight equipment, and do not materially affect the general question of efficiency in car construction.

Longer experience with all-steel gondola cars, particularly where used in bituminous coal service, indicates that depreciation is greater, maintenance more costly, and that they are consequently less economical than the composite car. In an article already referred to, Z. B. Wilson states that "the Southern Railway is operating a large number of both types (composite and all-steel coal cars) which were built in 1904 and 1905. These cars have been used almost exclusively in transporting coal. Both types are double hopper, and 100,000 lb. capacity. The average cost of repairs to 20 all-steel

Modern Single-Sheathed, Steel Frame and All-Steel Box Cars



Composite Gondola Car

cars was about $666.31 while the average cost on the composite cars was $240.97."

The Railway Mechanical Engineer of May, 1917, quotes the conclusions of William Queenan, assistant superintendent of shops, Chicago, Burlington & Quincy, as follows: "The composite type of car costs less to maintain than the steel gondola. The sides of composite cars do not bulge as do those of the steel car. Records show that while the composite car costs more to repaint than the steel car, it does not require painting as frequently. A large portion of the repairs to composite cars can be taken care of at other than steel car shops. Certain properties of coal cause corrosion to steel but do not affect wood."

In discussing freight car maintenance, L. K. Sillcox, then mechanical engineer of the Illinois Central, in the Railway Mechanical Engineer, October, 1917, stated: "It is simply a question of time until the greater part of a steel car must be replaced; renewals can only be economically and quickly carried out on a large scale for each car for the reason that corrosion is more or less uniform throughout each section of the structure and one part cannot be disturbed without equally effecting the adjacent one. As steel cars advance towards the time of their periodical overhauling many fail in service due to deterioration . . ."

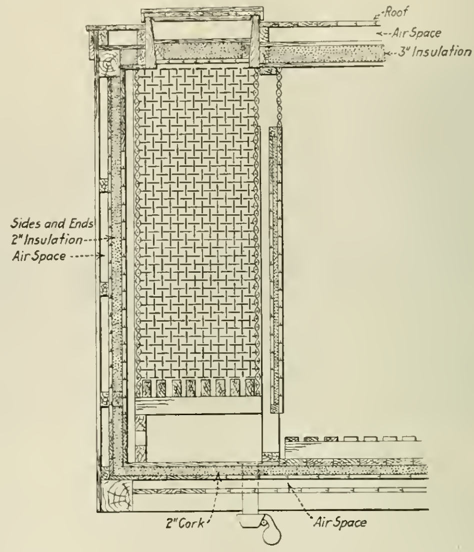
Every road having steel equipment has had to deal with these conditions during the past decade. Even the most enthusiastic steel car men are now contemplating heavier construction and employing specially treated metal to counteract corrosion. The question again forces itself to our attention whether following this costly mirage much further is good practice when composite cars have proved their worth.

Stock Cars

There can be no question that the composite stock car is both the most economical and most suitable. The wood superstructure presents sufficient protection to the lading and also a degree of comfort for the animals. There is the added advantage that all the wood in the superstructure may be thoroughly treated to make it both rot and vermin proof, and this feature permits the selection of lower grades of lumber which naturally adds considerably to the initial difference in cost between the composite type and an all steel car.

The Refrigerator Car

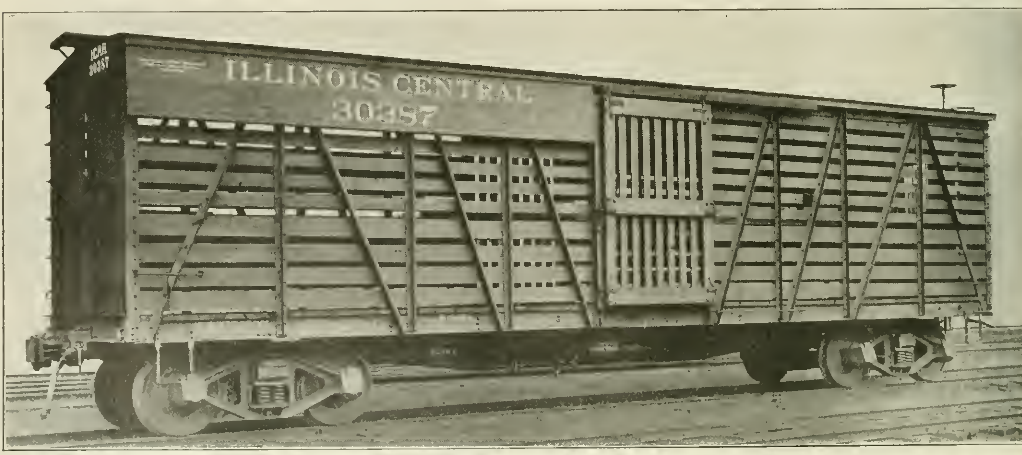
Refrigeration of food products, both in storage and transit, has become the most important element in food distribution. Properly developed and applied, it unquestionably lessens the average cost of food products and provides a normal flow of supplies to the nonproducing urban population, from the reserves accumulated from the surplus of seasonal production. Transporting perishable commodities in perfect condition would contribute greatly in cheapening the most necessary food products. Every dozen of eggs and each pound of meat, butter, fruit or vegetables spoiled in transit naturally



Longitudinal Section of Department of Agriculture Design of Refrigerator Car Insulation

increases the cost in proportion to the decrease in supply, as such loss must be equalized by higher prices for what is left in a salable condition. Therefore, the construction of a refrigerator car is perhaps of greater importance than any other type of car. As insulation is the most important requirement of a refrigerator car it is obvious that the wood body cannot be replaced.

The United States Department of Agriculture has done ad-



Modern Type of Stock Car Construction

SUGGESTIONS FOR LUMBER GRADES AND DIMENSIONS FOR NEW CARS AND REPAIR WORK

Car	Siding: Grade	Siding: Size, inches	Roofing: Grade	Roofing: Size, inches	Lining: Grade	Lining: Size, inches	Decking: Grade	Decking: Size, inches	Framing: Grade	Framing: Size
New Cars										
Box, Double sheathed	B and Better	1 by 4 or 6	B and Better (outside). No. 1 Common (inside).	1 by 4 or 6	No. 1 Common	1 by 4 or 6	No. 1 Common, sq. edge.	2 or 2½ by 6 or 8	No. 1 Common, sq. edge.	As specified.
Box, Single sheathed	B and Better or Select, sap stain, no defect.	1 by 4 or 6	B and Better (outside). No. 1 Common (inside)	1 by 4 or 6			No. 1 Common, sq. edge.	2 or 2½ by 6 or 8	No. 1 Common, sq. edge.	As specified.
Refrigerator	B and Better	1 by 4 or 6	B and Better (outside). No. 1 Common (inside).	1 by 4 or 6; 1 by 4 or 6	B and Better	1 by 4 or 6	No. 1 Common, sq. edge. No. 1 Common, for sub-floor.	2 or 2½ by 6 or 8; 1 by 4 or 6	No. 1 Common, sq. edge.	As specified.
Stock	B and Better		B and Better (outside). No. 1 Common (inside).	1 by 4 or 6; 1 by 4 or 6			All heart or No. 1 Common, treated.	2 or 2½ by 6 or 8	No. 1 Common, sq. edge.	As specified.
Gondola	Sq. edge and sound.	50 per cent full lengths; 50 per cent spliced					Sq. edge and sound.	2 or 2½ by 6 or 8	No. 1 Common, sq. edge.	As specified.
Repair Work										
Box, Double sheathed	No. 1 Common	1 by 4 or 6	B and Better (outside). No. 2 Common (inside)	1 by 4 or 6	No. 2 Common, sound knotted	1 by 4 or 6	No. 1 Common.	2 or 2½ by 6 or 8	No. 1 Common.	As specified.
Box, Single sheathed	No. 1 Common, sap stain, no defect.	2 or 2½ by 6 or 8	B and Better (outside). No. 1 Common (inside)	2 or 2½ by 6 or 8	No. 2 Common, sound knotted	1 by 4 or 6	No. 1 Common.	2 or 2½ by 6 or 8	No. 1 Common.	As specified.
Refrigerator	No. 1 Common	1 by 4 or 6	B and Better (outside). No. 2 Common (inside)	1 by 4 or 6	No. 2 Common, sound knotted	1 by 4 or 6	No. 1 Common.	2 or 2½ by 6 or 8	No. 1 Common.	As specified.
Stock	No. 1 Common		B and Better (outside). No. 2 Common (inside)	1 by 4 or 6			All heart or No. 1 Common, treated.	2 or 2½ by 6 or 8	No. 1 Common.	As specified.
Gondola	Sq. edge and sound	50 per cent full lengths; 50 per cent spliced					Sq. edge and sound.	2 or 2½ by 6 or 8	No. 1 Common.	As specified.

mirable work in its investigations into the subject, covering a period of over 15 years. Its efforts have finally resulted in a so-called standard refrigerator car, as represented by specifications formulated by the recent Railroad Administration. The conclusions arrived at by these exhaustive studies and the desirable features of an efficient refrigerator car were referred to in detail by Dr. M. E. Pennington, connected with the Food Research Laboratory, Bureau of Chemistry, United States Department of Agriculture, in a brochure in which are compiled a number of papers dealing with this subject.

The 4,000 new refrigerator cars recently built and placed in service by the Union Pacific, described in the *Railway Age*, issue of December 31, 1920, follow quite generally the details outlined by Dr. Pennington. In studying the details of construction it is interesting to note that the standard recommended by Dr. Pennington represents, excepting for a few innovations or improvements, practically the all-wood refrigerator car superimposed on the standard steel underframe. Thus we have complete co-ordination of wood and steel, achieving the maximum in efficiency and economy, under present conditions. This thought may well be applied to other equipment, and although there is no parallel in service conditions, there is a distinct analogy in construction costs and maintenance.

Passenger Cars

Passenger equipment if discussed in proper detail is worthy of special treatment, and is largely a question of combining safety with comfort. Careful analytical review of the entire problem indicates that the most economical passenger car for use under present conditions is one of strong steel underframe with steel skeleton superstructure, insulated and finished with wood. It is believed that such construction will give the maximum safety in the present heavy trains as well as a high degree of personal comfort to the passengers.

Greater Economy in Use of Wood

"Familiarity breeds contempt," is an oft repeated truism and possibly this explains the lack of more active interest on the part of car builders in the matter of using wood more economically and securing from it longer service in car construction. Ever since the first freight car—a hundred years ago—wood has been an inseparable and indispensable part of car construction, and because it was plentiful in the past and the best grades readily and cheaply available as was labor for repairs, little or no care has been used to protect it against the natural conditions of deterioration. All failures to this day are classed as mechanical where fully half of the light repairs could be avoided or retarded by employment of practical remedial measures.

On the basis of consumption previous to the war one and one-quarter billion board feet in round numbers were used for car construction annually, or about 3 per cent of the total annual production. This represents an average value of nearly $45,000,000 at normal prices. A saving of about 25 per cent through increased service and decreased repairs would be a goodly item in addition to being real timber conservation.

Thus, in addition to the suggestion that elimination of wood in car construction is neither desirable nor practical, it may be said that lumber may be used more economically by paying closer attention to selection of grades and dimensions which fully answer the purpose but are cheaper, and protection of the lumber against such agencies as decay, insects, checking while in storage, etc. Timber conservation is vital to the nation, and most especially to the railroads, who, because of their prominent position, are obligated to lead in economic movements which are so potent in their beneficial influence. The basic principle of economic utilization—or popularly interpreted, timber conservation—underlies these suggestions of changes in specifications for car lumber which, being sound, bring with them profit in the form of equivalent service at a saving in cost of material and maintenance.

Standardization has proceeded to where there is practically a standard covering grades and dimensions for the various parts of cars, such as siding, lining, roofing, decking, framing, etc. These standards, however, have not taken full cognizance of the frequent difficulties manufacturers encounter in endeavoring to conform their practices accordingly, or their utter inability to do so. The manufacturer of lumber is limited entirely by the manner in which nature provides the raw material, or rather, how the trees grow. Lumber cannot be cast in a mold, nor can it be forged to a drawing. Yellow pine, however, is produced in sufficient variety of grades and sizes to provide perfectly good car lumber quite plentifully if reasonable flexibility is allowed with regard to dimensions.

A large yellow pine mill questioned on the matter replied, "On account of the great number of patterns required by car builders, this mill has never attempted to supply any of this material, as we have found that it required too much special work and too much cutting loss." Loss is waste of material and money, because it must be paid for; its elimination therefore, means economy and conservation.

One of the fundamentals of standardization is to adapt available supplies to the required conditions, thus widening the market of supply by standardizing manufacture and developing economies that effect a reduction in production costs, resulting in stimulating competition and lower prices.

Another manufacturer suggested, "The greatest possible service that could be rendered the car builders and lumber manufacturers would be to adopt a single pattern that would serve for car siding, car lining and car roofing, and then make this pattern in standard lengths; that is to say, all lengths, using what would cut up to best advantage for roofing and siding, and the lengths that would not cut up, on the inside of the car as lining."

Where would the cost of lumber for common building purposes be, and how much greater would be our loss in timber devastation and waste if the present standards had disregarded the availability of the grades and dimensions specified? In drawing specifications for building lumber the dominating factor is to produce the greatest volume of usable stuff at the lowest cost and with the least waste. Reforms are still possible in that field and improvements are frequently accepted.

Specifications for car lumber have changed slightly during the last 50 years, but if the progress were more in line with the conditions manufacturers must contend with in order to supply the lumber to meet some of the most stringent requirements, freight cars might be a little cheaper and at least a greater volume of suitable material would be more generally available. Some builders are more concerned with appearances than with the service to be rendered. A knot in a piece of siding can cause as much comment from a railroad president as a buckled-up steel car.

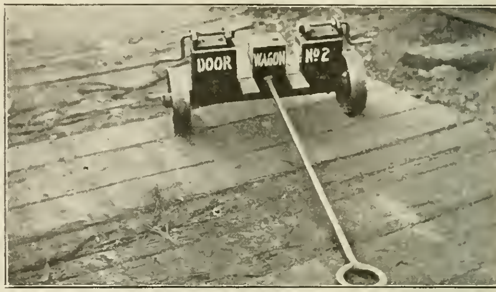
On the other hand, it is equally as important that the railroad engineers be allowed the opportunity of saying what grade and quality of material will be needed to meet their requirements. If the producers and consumers of wood used by the railroads in car construction, therefore, could thus get together on common ground, it is believed standard grades could be developed which would represent a big step of progress toward both conservation and utility—meeting the contingencies of the lumber manufacturer on the one hand and the exacting needs of the railroad engineer, on the other.

The Chicago & North Western will charge the dependents of employees half the regular suburban fare, the new ruling becoming effective January 1. Dependents of employees heretofore have been given passes.

Truck for Transporting Car Doors

By E. A. Murray
Shop Superintendent, Chesapeake and Ohio, Huntington, W. Va.

Doors for box cars are of no great weight, but their size and shape is such that they are awkward to handle and to transport from the shop to the repair tracks. If they are carried in a horizontal position, considerable clear space is required and obstructions may be encountered that will delay their movement or interfere with carrying on other work. In



Truck Alone, Showing Clamps and Handle

addition the labor of handling is a considerable item of expense.

The small truck or wagon shown in the accompanying illustrations has been used for some time and found to be both handy and economical. The truck is light and by its use one man can easily transport two doors at once. The doors are placed on the truck in a balanced vertical position and securely held by clamping screws. The two wheels have broad treads which permit the truck to be pushed with ease

One Man Can Handle Easily One or Two Doors

over comparatively rough surfaces and easily guided in any direction necessary to pass around trestles, ladders, or other obstructions in the passageway even though it may be somewhat narrow. A handle is provided for use when the truck is not loaded. This arrangement is simple, cheaply and easily constructed and should be of use at many freight car repair points.

The Directors of the Chicago, Burlington & Quincy have authorized a pension plan for the employees of that road. Prior to the announcement of the plan, a study is being made of the pension systems of other roads.

Actual and Ideal Boiler Plant Efficiency*

Avoidable Wastes Are Pointed Out, and a Desirable Standard of Boiler Construction and Operation Recommended

By Victor J. Azbe
Consulting Engineer, St. Louis, Mo.

The degree of waste in boiler plants is not generally realized and there is a tendency to judge conditions by a few of the better plants where improvements have been made and whose results are considered as representative of the average run of boiler plants.

Tables 1 and 2 show two boiler tests made under ordinary operating conditions, one on a hand- and one on a stoker-fired boiler. During these tests care was taken that actual operating methods were pursued. The results are very bad but representative of most smaller and some of the larger installations.

Table 3 gives the results of three boiler tests, all made on the same boiler some time apart. The boiler was of the B. & W. type, but poorly set, with a limited combustion chamber of only 0.87 cu. ft. per rated boiler hp. The stoker in use was of the old Jones type.

During Test A the aim was to maintain the same operating conditions as existed before any improvements were made; the result was an efficiency of 56 per cent and boiler rating of 102 per cent. After this first test improvements were begun, without, however, altering the stoker or increasing the combustion space.

After about six months, results were obtained as represented by Test B in Table 2; the efficiency was increased to 68.5 per cent and capacity to 140 per cent of rating. The results were not as yet considered satisfactory and efforts for further improvement were made. In all about 30 boiler tests were run under different conditions and with different fuel and one of the last tests is represented by Test C in Table 3. This last test is very remarkable in several respects, but is correct. In fact, the results are checked by other tests giving equal or even slightly better results.

The remarkable features of the results of this test are as follows:

(1) High boiler efficiency with a relatively inefficient installation and relatively poor coal.

(2) Complete combustion with high volatile coal and a combustion space of only 0.47 cu. ft. per developed boiler hp. or 0.11 cu. ft. per lb. of coal including the space occupied by the coal.

(3) A draft drop through a 16-section, 9-tube (each 16 ft. long) B. & W. boiler of only 0.1 in. at 85 per cent overload.

(4) A flue-gas temperature of 532 deg. Fahr. at 85 per cent overload in spite of the limited combustion space and flame extension to almost the end of the first pass.

(5) An improvement of 39.5 per cent in economy over that of Test A.

(6) An improvement of 81.4 per cent in capacity over that of Test A, in spite of the fact that during the first test maximum boiler rating was aimed at. Other examples could be enumerated of great improvements being made.

Standard of Economy

The writer considers 90 per cent efficiency as the standard of economy attainable under favorable conditions, this 90 per cent representing boiler and economizer without taking auxiliary power into consideration, however. The requirements for this efficiency are rather severe and with 12,000 B.t.u. bituminous coal, 15 per cent excess air would have to be used; flue-gas temperature would have to be no more than 250 deg. Fahr.; combustion complete and no carbon in the ash. These requirements are listed in Table 4.

Table 1—Test on Hand-Fired Boiler Representing Very Uneconomical Conditions

Date of test	Dec. 2, 1920
Type of boiler	B & W
Grate	Shaking
Kind of Coal	Illinois screenings
Steam pressure, gage, lb.	135.6
Temperature of feedwater, deg. Fahr	205.0
Temperature of flue gas, deg. Fahr.	568.4
Draft at back damper, in.	0.48
Draft over the fire, in.	0.24
Carbon dioxide, per cent	5.68
Quality of steam, per cent	98.5
Rated boiler h.p.	150.0
Per cent of rated capacity developed	105.9
Evaporation, equivalent, coal as fired, lb.	4.91
Evaporation, equivalent, coal dry, lb.	5.51
Calorific value of coal, dry basis, B.t.u.	11510
Coal analysis, per cent: Moisture	10.9
Ash	15.8
Volatile matter	35.2
Fixed carbon	38.1
Carbon in ash, per cent	24.4
Heat Balance	**Per cent**
Heat absorbed by the boiler	45.31
Loss due evaporation of moisture in coal	1.31
Loss from vapor of hydrogen combustion	5.41
Loss in dry flue gas	28.21
Loss due to carbon monoxide	4.24
Loss due to combustible in ash	5.40
Loss due to heating of moisture in air	0.30
Loss due to radiation, hydrogen, hydrocarbon, etc	9.22

*From a paper presented at the annual meeting, New York, December 5-9, 1921, of the American Society of Mechanical Engineers.

Table 2—Test on Stoker-Fired Boiler Representing Very Uneconomical Conditions

Date of test	Feb. 23, 1917
Type of boiler	Heine
Type of grate	Detroit
Kind of coal	Pocahontas nut & slack
Steam-pressure, gage, lb	138
Temperature of feedwater, deg. Fahr	152
Temperature of flue gas, deg. Fahr	761
Draft at back damper, in	0.98
Draft over fire, in	0.38
Carbon dioxide, per cent	8.1
Coal burned, lb	14,700
Water evaporated, lb	96,480
Evaporation (actual), lb	6.56
Evaporation (equivalent), lb	7.25
Boiler h.p. developed per hr., lb	386.6
Boiler rating, h.p	328
Per cent of rating developed	118
Heat value of fuel, B.t.u	13,950
Boiler efficiency, per cent	50.4

Table 3—Boiler Tests Representing Improvement of Boiler Performance

Test[1]	A	B	C
Type of boiler		B & W	
Type of stoker		Jones	
Kind of coal		Illinois screenings	
Steam pressure, gage, lb	130	127	129
Temperature of feedwater, deg. Fahr	180.6	187.0	176.8
Temperature of flue gas, deg. Fahr	612	533	532
Draft at back damper, in	0.57	0.34	0.11
Draft on fire, in	0.45	0.24	0.01
Forced-draft pressure, in	3.00	3.52	4.04
Carbon dioxide, per cent	7.6	13.3	14.0
Quality of steam, per cent	0.991	0.991	0.990
Rated boiler h.p	269	269	269
Per cent of rated capacity developed	102	140	185
Evaporation, equivalent, coal as fired, lb	6.14	8.19	8.43
Evaporation, equivalent, coal, dry, lb	6.95	9.05	9.55
Calorific value of coal, dry basis, B.t.u	12,080	12,850	11,864
Coal analysis, per cent: Moisture	11.7	9.9	11.7
Ash	13.4	8.9	12.5
Volatile matter	31.0	32.2	32.5
Fixed carbon	43.9	49.5	43.3
Carbon in ash, per cent	16.7	19.4	17.2
Efficiency of boiler furnace and grate, per cent	56.0	68.5	78.1
Improvement in economy over Test A, per cent	......	22.3	39.5
Increase in capacity over Test A, per cent	......	31.4	81.4

[1]Test A indicates conditions when no effort toward economy was made, while Tests B and C show gradual improvement under an economy campaign. In all three cases maximum possible capacity was striven for.

Table 4—Ideal Boiler and Furnace Performance

Kind of fuel	Bituminous coal
Heat value of fuel, B.t.u. per lb	12,000
Moisture of fuel, per cent	10
Hydrogen in fuel, per cent	3.5
Theoretical air per lb., lb	8.98
Excess air, per cent	15
Actual air per lb., lb	10.33
Flue-gas temperature, deg. Fahr	320
Heat Balance	Per cent
Loss due to dry chimney gas	3.15
Loss due to moisture from H_2O	2.85
Loss due to moisture in coal and air	1.00
Loss due to carbon in ash	1.00
Loss due to incomplete combustion	0.00
Loss due to radiation and conduction	2.00
Total loss	10.00
Boiler efficiency	90.00

This ideal, or 90 per cent boiler and furnace efficiency, has been attained only once, and then by Henry Kreisinger and John Blizard at the Lakeside Station of the Milwaukee Electric Railway & Light Co.

Fuels

With a suitable installation, almost as high an efficiency will be obtained with low- as with high-grade fuels. The obstacle is the tendency toward a greater ashpit loss.

As a rule low-grade fuel should be burned close to the mines and higher-grade fuel transported. Freight and fuel costs should be based on heat value rather than weight.

Combustion

There are several reasons why properly proportioned furnaces with ample combustion space are necessary, the most important being the prevention of escape of unburned gas and formation of soot, the possibility of operating with the least amount of excess air without incomplete combustion, and the prevention of flame entrance among the boiler flues. The last is necessary to obtain low flue-gas temperatures.

Furnace volumes vary from 1 cu. ft. per lb. of coal burned per hr. down to less than 0.1 cu. ft. in some cases. The lower amounts, of course, do not represent the entire combustion space because combustion under such conditions extends among the tubes, at times for a considerable distance, but this is not what is to be desired. The larger amounts are used with powdered fuel and are necessary because the solid particles burning are relatively large and require a larger combustion chamber for their gasification and combustion than is the case when gasification, and to a certain extent mixing with air, takes place on a grate.

The aim is to have the gas completely burned and no flame entering the first tube pass. To accomplish this, more than mere furnace volume is necessary.

Excess Air

The largest preventable loss in boiler plants is that caused by excess air. Determination of this loss by the measure of the CO_2 and flue-gas temperature has achieved considerable popularity. Where such popularity has been attained, the trouble is, however, that quite generally there is satisfaction if the fuel is burned with 100 per cent excess air, and even in well-operated plants no better results are obtained on the average. This is because of the tendency of many an engineer to assume statements as correct without sufficient consideration. With the large combustion chambers coming in vogue nowadays the old assumption that 10 or 12 per cent CO_2 is all that pays becomes obsolete. If we design our furnaces so that flame terminates before gas enters the tubes or soon thereafter and with the boiler heating surface so exposed that the maximum amount of heat is radiated to it, then the standard of good performance is the burning of the fuel with 15 or at the very most 25 per cent of excess air, and the CO_2 maintained should be around 16 per cent.

The point at which excess air enters is very important and should be given greater prominence when boiler-test data are recorded. At present during a test we tend to be primarily concerned with what occurs on the ends; that is, in the furnace and uptake, and few, if any, observations are taken and records made of what occurs between these points. Such items as point of flame termination, relative amount of oxygen, carbon dioxide percentage (which is a true measure of excess air), and temperature drop at various points through the settings, should be carefully recorded and interpreted; then it will be possible to really compare the performance of one boiler with another.

A somewhat overlooked but also very important factor affecting boiler plant economy is "constancy." The percentage of CO_2 may fluctuate during the day from high to low, but if for the whole day a 10 per cent average is taken, it will be found that for a number of reasons the efficiency will not be nearly so good as when 10 per cent of CO_2 is constantly maintained. Therefore the average CO_2 is an improper measure of the loss, but is an indicator of conditions.

Heat Transfer and Flue-Gas Temperature

The temperature of the escaping products of combustion determines fuel loss to a great extent, but what is low and what is high flue-gas temperature? The lack of a suitable measure and standard has in the past prevented proper comparison of results and has also caused a certain lack of incentive for improvement. The writer, in his effort to evolve a measure, has drawn Fig. 1 based on 150 different boiler tests. Each dot represents the average flue-gas temperature at the average rating developed in each test. The space is divided into sections varying from exceptionally good to exceptionally bad results, with the slope of the line following as closely as possible the increase of flue-gas temperature with the increase of boiler output of a number of tests.

To absorb the heat, it is necessary to bring the gas in contact with the heating surface. This some boilers do imperfectly. If the surface is clean everything depends upon gas velocity and distribution. Fig. 2 shows what happens under certain conditions. In the dead spaces temperatures as low as 380 deg. Fahr. were recorded when the flue-gas temperature was 680 deg. Fahr. The gas has the tendency to take the shortest cut, a great deal like a stream of water; in fact, much might be learned from the study of water stream flow which could be applied very profitably to boiler-pass design.

Boiler Capacity

When boiler capacity is increased by the burning of more

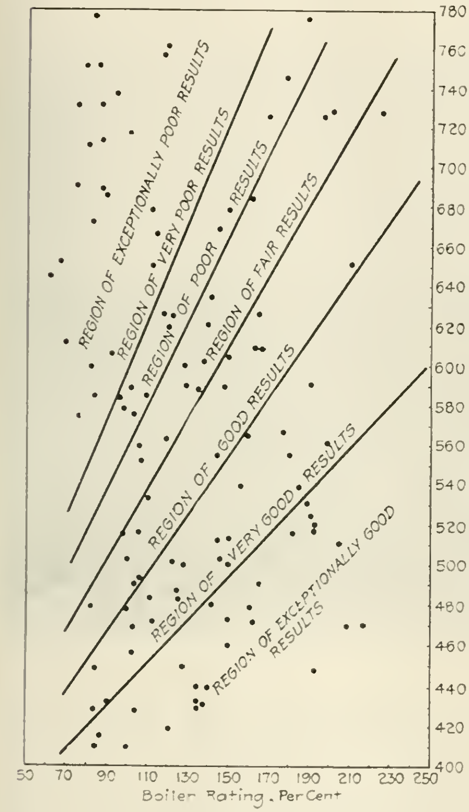


Fig. 1—Flue Gas Temperatures Representative of Good and Bad Results

fuel, the following either does or may occur:

(1) Temperature in combustion chamber increases.

(2) Temperature of gas throughout boiler setting increases.

(3) Temperature difference between water in boiler and gas surrounding tubes and drums increases.

(4) Gas velocity increases.

(5) Heat absorption by radiation increases owing to higher furnace temperature.

(6) Heat absorption by convection increases owing to higher gas velocity and higher temperature difference.

(7) Flue-gas temperature increases.

(8) Dead spaces become more active.

(9) Incomplete combustion increases.

(10) Fuel loss resulting from air in leakage and radiation expressed as a percentage of total decreases.

(11) Excess air decreases.

(12) Fireman's attention usually increases.

(13) Return received from investment increases.

There are several factors in this list that counteract each other, some increasing and others reducing efficiency, but as a balance, within limitations, increased boiler capacity is more economical.

It is the writer's experience that the very large majority of plants possess and operate too many boilers, at times twice as many as necessary. The cry is, "Give us plenty of boilers," and the result is waste in investment and waste in operation.

Since high boiler efficiency at low ratings is more difficult to obtain than at high ratings, it follows that owing to this and also for investment reasons, boilers should be installed designed for high overloads and high and constant efficiency over a considerable capacity range. Especially in plants where the load varies a great deal the boilers should be able

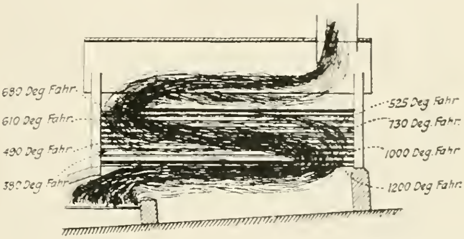


Fig. 2—Unequal Gas Flow Distribution Through a Boiler

to take the peaks; even if these peak loads are somewhat uneconomical they are to be preferred to boilers loafing the greater part of the time. As a rule good boilers, well installed, should be operated at between 150 and 200 per cent of rating, and when a peak is of short duration 300 per cent of rating is permissible. Ratings below 150 per cent should not be permitted except under unavoidable circumstances.

Features of an Ideal Boiler Installation

It may appear to some that the boiler with its appurtenances has been developed to what might be called the limiting point; this, however, is not so. There remains an immense field for experimental research to obtain the necessary data for boiler construction.

The ideal boiler installation should embody the following:

(1) A construction permitting counterflow where flue gas will heat the feedwater which will enter the boiler at as nearly the steam temperature as load fluctuations will permit.

(2) A combustion chamber sufficiently large and effective throughout to prevent the entrance of any flame among the tubes, thus assuring complete combustion, absence of soot, and proper cooling of the gas.

(3) Boiler passes which will be effective throughout without dead spaces where there is no gas flow or only little, and in which the draft drop will be the minimum corresponding to gas velocity. The gas velocity will be the highest permissible by the cost of producing this velocity.

(4) Fuel resistance will be overcome by forced draft.

(5) The relative location of fire bed and boiler-heating surface is to be such that the maximum possible amount of radiant heat will be transmitted to the boiler surface consistent with complete combustion.

(6) Tight boiler walls properly insulated, probably an air-jacketed furnace, the air from which will be injected over the fire bed at high velocity to aid mixing effect or passed through the grate in the ordinary way.

(7) A stoker permitting combustion with no more than 15 to 25 per cent excess air, no more than 1.2 per cent unburned carbon in ashpit, no deposit of slag on the tubes and these conditions maintained at low and high ratings.

(8) Scale deposit prevented by specially constructed self-cleaning boiler, external chemical treatment of feedwater, use of distilled makeup water, filtering of the water in the boiler by recirculation or by a combination of these methods.

Selection of Railroad Shop Machine Tools

A Description of Types Best Adapted to the Principal Machine Operations; Importance of Grinders Stressed

By M. H. Williams

IN the near future it is to be hoped that financial conditions will enable the railways to purchase needed additional machine tools. As the larger railway repair shops are developing quantity manufacturing methods, it follows that the most modern, productive machines should be carefully considered in order to ascertain if they will be a profitable investment. Below are mentioned a number of machines commonly used in manufacturing plants and also in a few railway shops where their installation has resulted in greater production, reduced cost of machining, better finish, or a combination of all three advantages.

It will be noted when going over the lists of machines that many are more or less strangers in railway shops and at first glance they may appear too far advanced for the work required. However, in railway shops where a modern, semi-special machine is installed the work will in time grow up to the machine. That is, new uses are continually found for machines having great productive capacity and it is surprising, after installing a new class of machine such as a grinder, milling machine, or automatic, to note how soon new uses are found for these machines and how the work will pile up around them; also how soon additional machines will be asked for owing to the transfer of work from obsolete types.

Plain Knee-Type Milling Machines

No attempt will be made to explain in detail the machines referred to in this article, but it is hoped to outline their

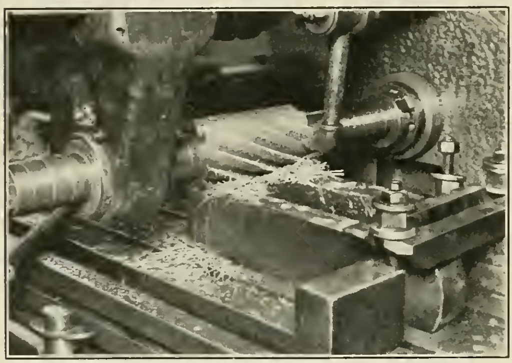


Fig. 1—Modern Plain Knee Type Miller "Producing" a Valve Motion Lever

advantages and respective fields of usefulness. The large, plain, knee-type milling machine is one of the tools that should receive first consideration and along with it the question of fixtures for holding various articles on the machine when milling. With the No. 5 horizontal machine (Fig. 1), using coarse-tooth, high-speed steel cutters, parts such as pedestal shoes, rod wedges, valve gear levers, etc., are readily milled with a feed of 3 to 12 in. per min., the rate of feed being principally a question of how securely a part can be held on the machine table or in the fixture. As far as the cutters are concerned the later designs will generally stand all that the holding devices will. As an illustration, pedestal wedges 18 in. long by 4 to 8 in. wide are milled in three minutes per side. Adding to this 5 min. per side to place in and remove from the fixture, the total time for the two sides is 16 min. When milling the edges, four wedges are set up at one time and milled at the same rate of feed. This makes the time to mill the two edges and clamp 4 min., or a total of 20 min. per wedge. This time is often reduced where a fixture holding two wedges, one after the other, is used.

The flat surfaces of valve gear levers are readily milled with ordinary cutters. The different fillets can be made readily by the use of cutters of the same diameter as the

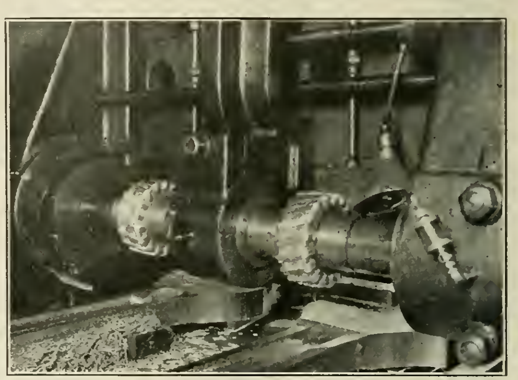


Fig. 2—Powerful Slab Milling Machine Used for Channeling Rods

fillet, the result being that the entire outside surfaces of the levers are finished from rough forgings to the finished sizes on this machine. In addition, the insides of the jaws can be milled from the solid forging by the use of small diameter, steep pitch, coarse tooth, milling cutters. Levers can be finished using a 3-in. feed on the plain flat surfaces and a ¾-in. feed when forming the insides of jaws. Forming the fillets on a milling machine will show considerable advantages over previous planer and slotter methods. The surfaces left by the milling cutters are usually smooth enough to meet all requirements for work on freight locomotives and with a small amount of grinding will meet the requirements for locomotives in passenger service. It can be said without fear of contradiction that a valve rod should never go on a planer, shaper or slotter.

When milling rod keys it is primarily a question of the time taken to clamp and remove the parts from the machine. With proper fixtures for holding, these can readily be milled at the rate of 3 to 6 in. per min. As a result the time per face will be from 2 to 4 min.

The above mentioned uses for this class of machine are only a small proportion of what will develop after their installation. One point should be borne in mind; a modern milling cutter in a heavy, rigid machine will as a general rule mill a surface sufficiently flat and true in one cut to meet the requirements for railway work. Whether the surface be wide or narrow makes but little difference as far as the rate of feed is concerned.

With the plain knee-type milling machine the output is governed largely by the type of holding fixtures used. Under most conditions the time required for loading and unloading articles is actually greater than that required for the milling. Therefore, the more suitable and handy the fixtures, the greater the output and correspondingly the fewer milling machines required. It is economical to provide special holding fixtures for the articles more frequently required. The manufacturers of milling machines are always ready to help out on the designs of these fixtures; therefore, when considering the purchase of a machine, it is well to obtain the benefit of their service department by sending prints of what is required to the machine builder.

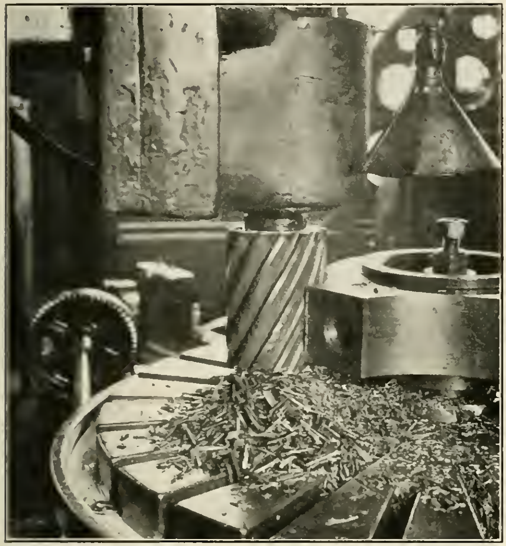


Fig. 3 Heavy Vertical Miller and One of Its Common Uses

Slab and Large Vertical Millers

The flat surfaces of main rods and side rods should in all cases be milled in preference to planing. With slab milling machines of the larger type such as the 48 in. by 48 in. by 16 ft., two main or side rods can be milled on their flat surfaces at one time. From four to eight may be milled on the sides at one time, or two rods can be fluted at one time (Fig. 2). These rods are readily milled when feeding 1 to 3 in. per min. In addition to machining the flat surfaces the rods are milled around the bosses to required shapes and sizes.

A milling machine for the above purpose should not be a light toy but a powerful machine, strong enough to work milling cutters to their limit and under favorable conditions of heavy loading consume 80 hp. To set up rods on this machine takes no longer than on a planer; in fact, with a machine bed of ample length, one set of rods is often set up on one half of the bed while milling on the other half, thus reducing the idle time below that possible on a planer. The milling machine has the advantage that the straight, flat surfaces and also the bosses or fillets can be finished at one set up; also, the surfaces are generally smoother than when planed. The time required is about 50 per cent less when milling as compared with planing.

For milling the radius around the rod bore and forming fillets, the larger vertical milling machine (Fig. 3) is used. With machines of this type one large or two small rods are readily machined at one time at feeds of ½ to 1 in. per min., depending largely on the amount of metal left on the forging. This machine is also used for milling the edges of links and link blocks and much other miscellaneous work; also surfaces that are difficult to mill on the slab millers. It can generally be said that the ends of two rods can be milled in the time taken to slot one rod.

Vertical Knee-Type Milling Machines

The jaws of main rods or straps for holding the front and rear brasses are readily milled on the large vertical type milling machine (Fig. 4). For this work the open end jaws are milled by feeding the milling cutter directly into the solid forging cutting on one side of the jaw, then going across the end of the jaw and finally back on the opposite side, thus removing the block. After this, the surfaces are gone over with the same cutter for the finishing and sizing operations. For closed jaws such as are common in many main rods a clearance hole is drilled for entering the milling cutter, after which the jaw is roughed and finished as above described. This method of machining eliminates drilling, sawing and slotting for removing the central block of metal and makes it possible to finish these jaws in one set up on the machine, to the correct size and with a smoother finish than is obtained on the slotter. Plowing into a rod with a milling cutter does not present any difficulties where the coarse tooth, high spiral cutter is used, the cutter being well supported at the lower end. This form of cutter, throwing out chips from the slot, prevents clogging as is the case with cutters of the ordinary form.

In order to operate milling machines to their fullest capacity it is necessary to keep the milling cutters sharp, so cutter grinders (Fig. 5) should be installed in tool rooms for the uniformly correct grinding of all milling cutters.

There is an important question in milling versus filing rod brasses. The work of fitting main rod brasses to rods probably will be ever with us; these brasses are getting larger and larger and the filing is becoming more difficult from day to day. The work of filing brasses can be eliminated by the use of the plain knee-type milling machine and proper fixtures for holding the brasses. With these, the brasses are milled to the correct size to fit the rods, a comparatively simple operation that does not require unusual workmanship.

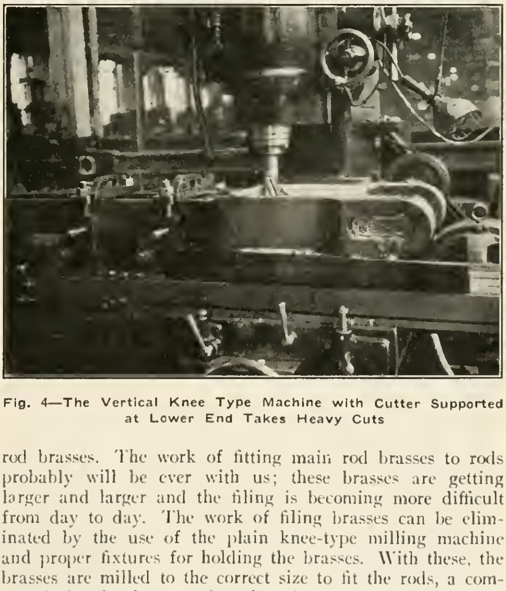


Fig. 4—The Vertical Knee Type Machine with Cutter Supported at Lower End Takes Heavy Cuts

Increased Importance of Grinding Machines

If milling machines are essential to efficient shop operation so also are grinders. In the railway shop of the future every smooth or bearing surface that can be reached by a grinding wheel will be finished by grinding, otherwise the maximum economy in machine operations will not be realized. Today it is the common practice in most manufacturing plants to finish all possible surfaces in this manner and this practice will sooner or later be followed in every railway shop. Many car and locomotive parts can be roughed out on heavy production machines but the use of the grinding process for finishing operations possesses advantages over any other method. Smooth finish, accurate sizes and rapid machining are features of the work done on modern grinding machines. It may be said that files and emery paper should be eliminated as a means of securing highly finished surfaces.

Plain Cylindrical Grinders

The locomotive piston rod of the future will be blanked out about 1/32 in. large by taking the coarsest feed the lathe will stand. The rod will then be transferred to a grinder and finished on both the straight and taper surfaces. This will result in a finish more uniform than filing and at a reduced cost. Valve rods will be treated in a similar manner. Crosshead pins and crank pins will be blanked out on turret lathes or automatic chucking machines and finished by grinding. Knuckle pins and valve motion pins and bushings

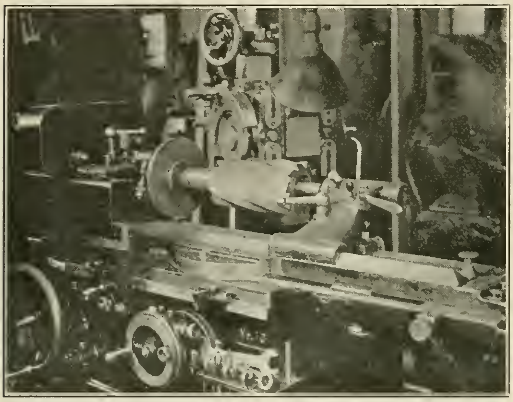


Fig. 5—The Universal Cutter Grinder—An Essential Shop Tool

will be blanked out on automatic machines, ground to a semi-finished state and finally finished to the required size on grinding machines at the time of making repairs to the locomotives. Locomotive and car axles will be roughed out on lathes and ground (Fig. 6) to the finished sizes as in making piston rods. In fact every bearing surface coming within the range of plain cylindrical grinders will be finished on these machines.

The plain cylindrical grinder of the future will be a hog for work and, as a result, surfaces will be finished quickly. The smallest grinder for railway work, namely, the 10 by 36 in. size, has sufficient strength and rigidity to consume at least 15 hp. This size is used for grinding smaller articles such as valve motion pins and bushings, side rod knuckle pins and bushings, crosshead pins, etc. For larger work such as piston rods, axles, large crank pins, etc., these machines should be about 20 by 120 in. and consume 40 hp. Piston rod grinding machines have been installed in several railway shops and generally proved the value of grinding as compared to other methods of finishing. With up-to-date machines, the diameter of rods can be reduced 0.002 in. at each pass of the wheel and with a feed of 1½ in. per revolution of the rod. This serves as a basis for calculating the possibilities of grinding.

Moreover, it is to be hoped that some day the grinder manufacturers will bring out a machine to grind the journals of locomotive axles with the wheels mounted, this method to be substituted for the present practice of turning and burnishing. There is a demand for a machine of this nature owing to the superior finish, more accurate work, and the fact that the diameter of the axle will be reduced a minimum amount.

Surface Grinding Machines

The work of refinishing flat surfaces such as the sides of main rods where worn at the jaws, the surfaces of new rods

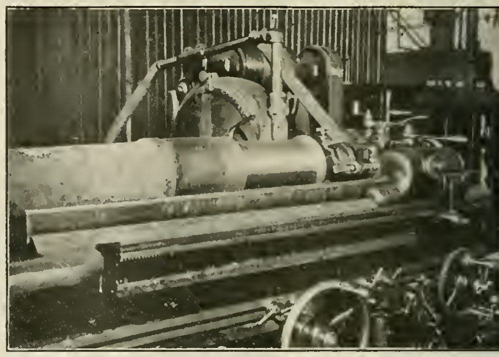


Fig. 6—High Power Cylindrical Grinder Truing a Trailer Axle

where a smooth surface is required, surfaces of guide bars, the sides of links and link blocks, sides of large washers used on side rods made from boiler steel and finished on their flat side, will be finished on surface grinders (Fig. 7), the work being held by magnetic chucks in order to reduce the time of set up. These grinders are now available, of heavy construction, requiring about 40 hp. to run and as a result the time required for setting up and finishing a surface is small when compared with planing, filing and polishing with

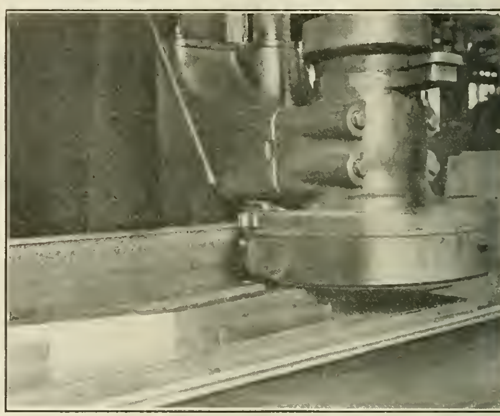


Fig. 7—Surface Grinder, Equipped with Magnetic Chuck Finishing a Link.

emery paper. It is surprising to note the number of car and locomotive parts with flat surfaces that can be ground to good advantage; therefore, the surface grinder is one of the machines that should receive more careful attention in the future than it has been given in the past.

Planetary and Chucking Internal Grinders

The planetary internal grinder (Fig. 8) is almost indispensable in railway shops, being used for truing the holes for bushings in valve motion levers and side rods, the bores for pins in link blocks, truing brass bushings used in air brake triple valves, feed valves and similar articles, regrinding air pump cylinders, valve chamber bushings, etc. With this class of machine the bore of levers, rods and other articles can be ground practically true in a fraction of the time required for boring, at the same time producing much smoother work. This machine not only becomes a money saver but also results in superior work. The automobile companies have set a pace for doing work on this machine that the railways should endeavor to follow.

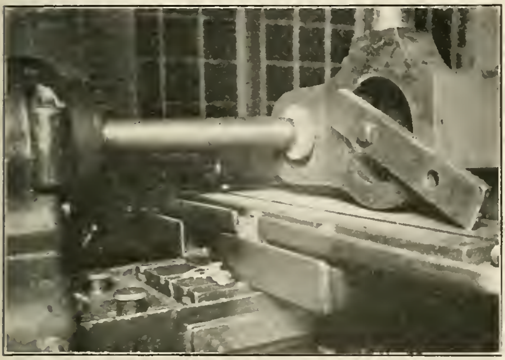


Fig. 8—No Machine Equals the Planetary Internal Grinder for Truing Holes

The chucking grinder is used to a limited extent in railway shops and extensively by manufacturing concerns. Where used it has proven of great value and should receive careful consideration. This machine is used for grinding the bores of knuckle and valve motion bushings and other articles where a true and accurate internal bearing is necessary. It can not be considered a luxury but is a money saver purely from the manufacturing point of view, owing to the fact that when blanking out articles, less time is consumed. It is not necessary to maintain close sizes which results in a greater output of automatic or turret lathes, the general scheme where these machines have been installed being to blank out the articles fairly close to size and then grind the bearing surfaces to exact gage sizes. This results in more accurate work, and in addition has the advantage that casehardened bushings can be ground true and the warping due to casehardening eliminated. This country is noted the world over for the interchangeability of parts going to make up completed machines, and this interchangeability has been brought about largely owing to the use of grinding machines. If the manufacturers that are in the business to make money find grinding a paying proposition the process must possess merits that railway men cannot afford to ignore.

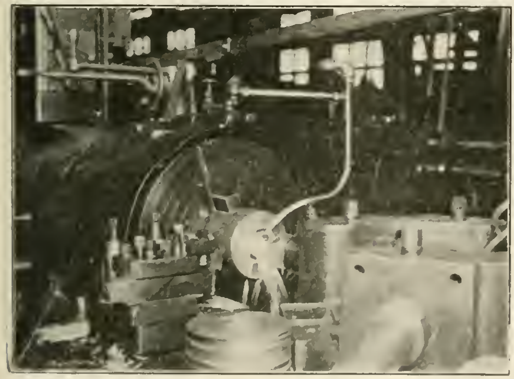


Fig. 9—Powerful Turret Lathe Machining Crank Pin Collars

Use of Heavy Turret Lathes

The large turret lathes (Fig. 9) are desirable machines for railway shops as they machine castings and forgings too heavy for the automatics much more quickly than can be done on regular lathes.

In order to obtain the full output from turret lathes, it is necessary to equip them with suitable fixtures such as box tools, bar turners, dies, etc. By the use of these fixtures it is often possible to arrange the work so that two or more tools are cutting at one time and as a result the rate of output is greatly increased. The makers of turret lathes generally maintain a service department and will gladly supply data and drawings for tooling for any job desired, thus enabling railroad shops to install an up-to-date outfit at the start and avoid a lot of expensive experimenting on small tools and delays to machines. In other words, it pays to pay the other fellow for what he has designed and not pay the local force for what the other fellow can do better and cheaper.

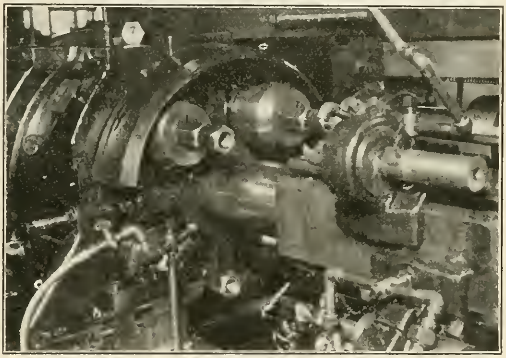


Fig. 10—Modern Automatic, Unequalled for Production of Duplicate Parts

Automatic Screw Machines

The automatic screw machine (Fig. 10) and automatic chucking machines have proved their value in railway shops, the smaller screw machines being used for articles required in moderate quantities such as are made from bar stock and the chucking machines being used principally for finishing castings and forgings. As a general proposition it may be said that one man on an automatic will produce as many articles per day as three men on center lathes, or the hand-operated turret lathe. When considering the cost of machine tool equipment per unit article required, the automatics are in most cases the cheaper, and should be selected wherever there is a reasonable possibility of keeping them busy.

In some railway shops practically all valve motion bushings and pins are made on automatic screw machines from bar stock at a cost very much less than when made on other machines. The chucking machines are used for machining forgings and castings such as knuckle pins and bushings, crosshead pins, air pump piston heads, globe valves, or in fact any article within the capacity of the larger machines.

Bending Center Suspension Brackets

By Wesley J. Wiggin

Asst. Blacksmith Foreman, Boston & Maine, Billerica Shops, Mass.

A former for bending center suspension brackets is shown in the illustration and has demonstrated its value in the quantity production of these parts. The brackets are made of spring steel on the device shown in Fig. 1, the sequence of operation and former details being shown in Fig. 2.

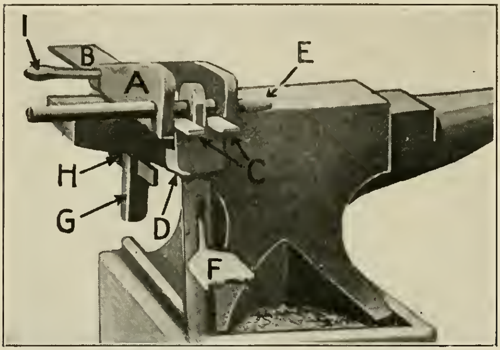


Fig. 1—Former and Bracket Before Bending

The first operation is to punch the two holes and slot on an 18-in. double punch and shear; the bracket after this operation being shown in the upper left corner of Fig. 2.

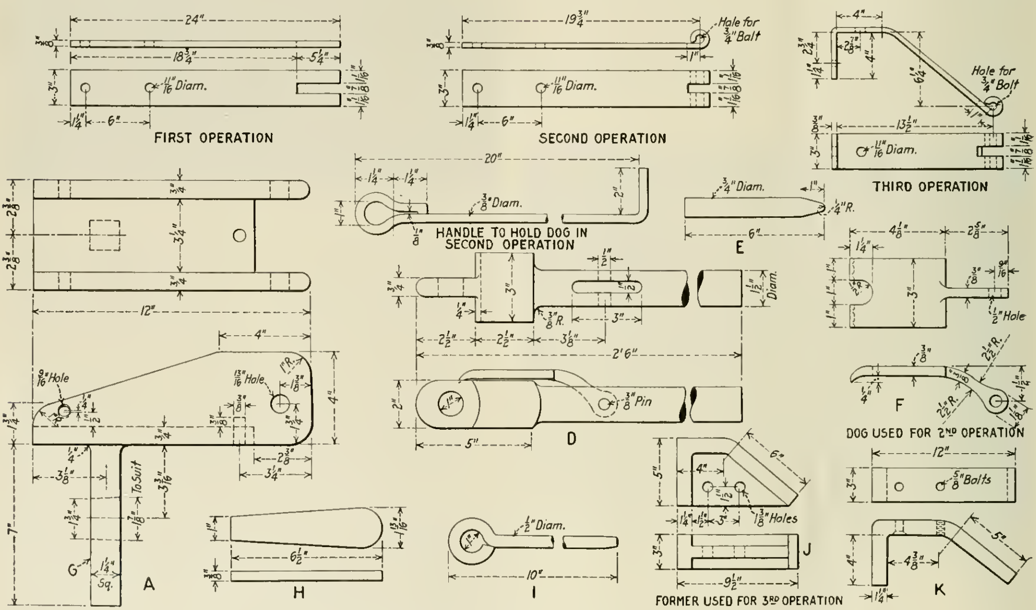


Fig. 2—Operations and Details of Former for Bending Center Suspension Brackets

The second operation consists of forming the eyes and the third, making a double bend to form the finished bracket. Referring to Fig. 1, a view is given of the bracket and former at the beginning of the second operation. The former *A* is attached firmly to the anvil by means of projecting part *G* and taper key *H*. Bracket *B* is inserted in the former with ends *C* projecting beyond the swinging arm *D* which is pivoted on pin *E*. It is evident that the revolution of *D* will bend ends *C* around the ¾-in. pin *E*, forming the eyes of the bracket. The dog *F* is used in the latter part of the second operation to insure ends *C* fitting accurately around the pin *E*.

During the third operation both bends are made in the bracket with one heat by means of formers *J* and *K*, former *J* being fastened in *A* by means of pin *I* (Fig. 1). The pin hole in *J* is located so as to bring the bends at the proper points and it will be noted that the two holes enable two different sized brackets to be made. The two bends in the bracket are made simultaneously between formers *J* and *K*, using light blows of a sledge hammer and thus the bracket is completed ready for service. Any number of brackets, all alike as to relative location of ¾-in. bolts, holes and bends, can be made with this device and with a considerable saving in time over what would be required to do the work without it.

Polishing Tap and Reamer Flutes*

Flutes of reamers, taps, and other similar small tools are not usually polished in regular production work, but are only ground with solid wheels. For that operation Norton Alundum wheels, 2 in. to 6 in. in diameter by ¼ in. to ½ in. thick, grains 60 or 80, grades O to Q, have been found satisfactory.

However, some manufacturers do polish the flutes of taps and reamers; and for that work a felt or leather wheel is generally used, unless the work is extra large, when a canvas wheel is better, since it will hold the abrasive better and give greater production. On the smaller sizes a leather wheel is considered best from the cutting standpoint, while it is as good as other kinds for finish. These are made from

*From Grits and Grinds.

good quality of oak tan leather. Such wheels should be approximately 6 in. or 8 in. in diameter by ¼ in. or ½ in. thick.

Care should be taken to see that the polishing wheel is true and if necessary it should be turned true before setting up with grain. When this is done a sizing of good glue should be applied and left about two hours to dry. Then two coats of glue and abrasive are put on and left to dry over night. Before using, the grain on the sides of the wheel should be dressed off with a piece of broken grinding wheel, so that it cannot cut the edges of the work being polished.

The sizes of wheels and also the grain to use depend largely upon the sizes of the work. For the large work grain 60 or 80 is good, while for smaller sizes about 120 or 150 is satisfactory. If a still better finish is required, grain 200 with Tripoli or oil can be used.

This work is all done free-hand and is considered quite difficult. It sometimes takes even as long as a year to train a man so he will make an efficient polisher of this class of work.

Standards of Railroad Shop Welding Practice*

General Rules Together with Typical Examples of Welding and Building Up Worn Parts Are Included

By G. M. Calmbach
Welding Engineer

In making heavy frame welds with gas it is essential that the parts be carefully cleaned and prepared for welding by cutting the ends to the proper angle and making necessary allowance for contraction in cooling. It is also wise, wherever space permits, to build up the weld a certain proportion larger than the original cross section in order to provide additional strength.

The standard method of cutting, welding and reinforcing bolsters, truck side and engine frames, and all other steel, iron, or cast steel from ¾ in. to 8 in. in thickness is shown in Fig. 1 and the accompanying tables. The amount of reinforcement provided is a certain proportion of the cross section decreasing in amount as the size of the section increases. It will also be noted from the tables that the angle to which the broken parts are cut or Ved varies from 45 deg. to 55 deg., all sections over two inches thick being Ved and welded from both sides.

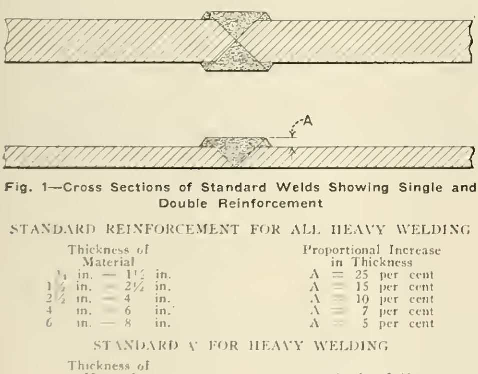


Fig. 1—Cross Sections of Standard Welds Showing Single and Double Reinforcement

STANDARD REINFORCEMENT FOR ALL HEAVY WELDING

Thickness of Material	Proportional Increase in Thickness
¾ in. — 1½ in.	A = 25 per cent
1½ in. — 2½ in.	A = 15 per cent
2½ in. — 4 in.	A = 10 per cent
4 in. — 6 in.	A = 7 per cent
6 in. — 8 in.	A = 5 per cent

STANDARD V FOR HEAVY WELDING

Thickness of Material	Angle of V
¾ in. — 1½ in.	One side — 45 deg.
1 in. — 2 in.	One side — 55 deg.
1 in. — 2 in.	Both sides — 45 deg.
2 in. — 3 in.	One side — 50 deg.
2 in. — 3 in.	Both sides — 55 deg.
3 in. — 4 in.	Both sides — 55 deg.
4 in. — 5 in.	Both sides — 55 deg.
5 in. — 6 in.	Both sides — 55 deg.
6 in. — 8 in.	Both sides — 55 deg.

*The second of two articles on railroad shop welding practice by this author. The first article appeared on page 772 of the December *Railway Mechanical Engineer*.

Preparation for Frame Welding

As in the usual practice the frame to be welded is lined up, trammed and checked with the opposite side as shown in Fig. 2. The weight of the engine is taken off the frame and jacks placed under the jaws on either side of the weld. Then tram over the break, locating permanent points by which the expansion will be governed. Referring to Fig. 2, the frame should be cut out from both sides to the angle shown, all surfaces being chipped and cleaned preparatory to welding. It is necessary to spread the frame a suitable amount to allow for contraction in cooling, this allowance for contraction varying slightly in amount depending upon the location of the break. Referring to Fig 2, when breaks occur at points marked *A*, ¼ in. should be allowed for contraction. At points *B* 3/16 in. is allowed. Whenever welds are to be made in any part of the jaw the binder should be in place if possible. A ⅜ in. plate should be tacked to the lower side of the frame on which a foundation can be made to start the weld. This plate extends out on both sides of the frame the thickness of the reinforcement and is welded firmly to the frame at all points of contact including the edges. This plate forms a base on which to start the weld.

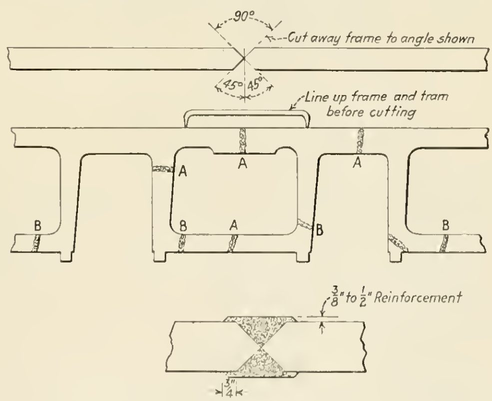


Fig. 2—Location of Common Frame Breaks and Method of Welding with Gas

Two operators should be employed, one on each side of the frame. After the weld reaches the thickness of two inches it should be hammered, this hammering to continue at intervals until the weld is finished. It is important that at no time during the process of the weld any part should be less than red hot. That is to say, the operator should keep the finished part of the weld red hot at all times and when the weld is finished the entire weld should be brought up to an even heat before jacks are removed. This will relieve any internal stress and decrease the possibility of future breaks.

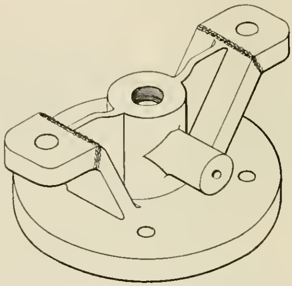


Fig. 3—Air Signal Valve Casting Repaired by Gas Welding

For the amount of reinforcement to be applied reference should be made to Fig. 1 and the accompanying tables.

Miscellaneous Welding and Building Up Jobs

The possible uses of both gas and electric welding in railroad shops are too numerous to mention and both processes

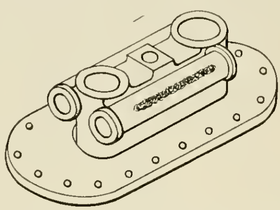


Fig. 4—Air Compressor Steam Head Reclaimed by Gas Welding

have been greatly extended during the past few years, saving large sums of money annually to the railroads. The important point to be remembered, however, is that either welding process costs money and if the locomotive or car part being repaired or reclaimed is small and has a first cost less than the cost of gas or electricity and labor used, it is obviously poor economy to weld it.

For the air signal valve casting, as shown in Fig. 3, how-

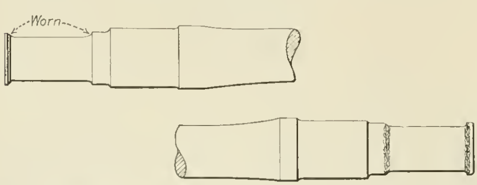


Fig. 5—Building Up Worn Axle Collars; Electric Welding

ever, the cost of labor and gas used in welding on the broken lugs would be considerably less than the cost of a new casting, and it is therefore good economy to make the repair by welding. The castings after being welded by competent operators will be just as good as new.

An interesting example of what can be accomplished with gas welding is shown in Fig. 4. The steam head of the New York air compressor is located at the bottom and, without proper care in draining during the cold weather, will often become cracked through the wall to the exhaust passage as

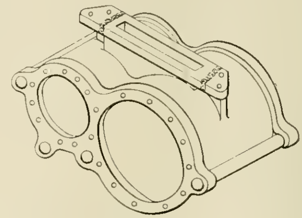


Fig. 6—Air Cylinder Lugs Replaced by Gas Welding

shown in Fig. 4. This steam head is quite an expensive casting with a more or less intricate system of coring in which it was found necessary to maintain walls of equal thickness. The problem in getting a successful weld on this casting is to

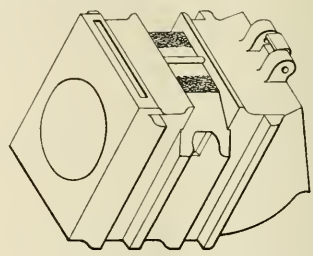


Fig. 7—Building Up Worn Journal Box; Gas Welding Used

provide for contraction and this can be accomplished only by the careful and thorough pre-heating of the steam head after which the crack can be welded with gas. The entire weld and adjoining walls of the casting should be brought to a

Fig. 8—Building Up Brake Shaft Ends; Electric Welding Preferred

uniform temperature and allowed to cool slowly to prevent internal strain and a subsequent crack which will be worse than the first.

Building Up Worn Parts

Among the possible uses of welding processes perhaps none is more important than the building up of worn parts, in many cases making them as good as new for further use. The example shown in Fig. 5 is a worn axle collar before and after being built up by electric welding. After the welding has been completed it is necessary to mount the axle in a lathe and remove excess metal deposited on the collar, leaving a smooth fillet of the original dimensions.

Another example of welding broken lugs is given in Fig. 6 in which both lugs have been broken from an air compressor cylinder, either through a wreck or accidental dropping or mishandling on the floor. The common method of repairing a cylinder with broken lugs is to have new lugs forged of wrought iron or axle steel in the forge shop, fitted to the

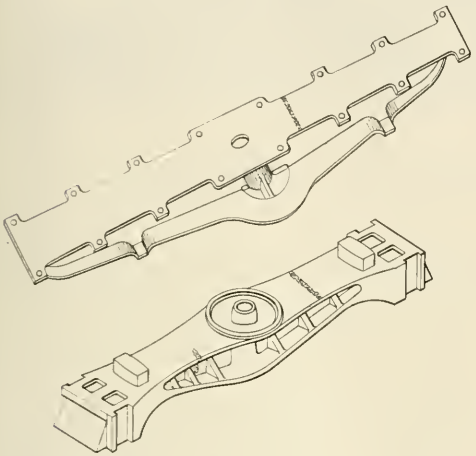


Fig. 9—Steel Car Bolster Effectively Repaired by Gas Welding

cylinder which has been properly machined, and secured in place by three or more bolts through the extended sides of the lug and the cylinder. It is obvious that in both cost and length of time required to make a repair, welding is much to be preferred over the mechanical process of applying new lugs.

The method of building up a worn journal box and the ends of an engine brake beam are illustrated in Figs. 7 and 8 respectively. Both of these parts can be built up and made

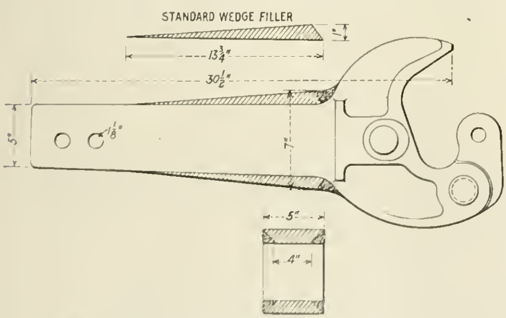


Fig. 10 The Addition of Wedge Fillers Changes 5 In. by 5 In. Coupler Shank to 5 In. by 7 In.; Gas or Electric

as good as new in a very short time and at a slight cost. In the case of the journal box it is advisable to use gas for building up but with the brake beam the electric method would be better. In case gas is used to build up the worn brake beam ends, great care must be exercised not to overheat the ends and the entire beam should be carefully annealed before being machined and put back into service. Otherwise there is a good chance of a train delay due to dropping the brake beam.

The possibilities of welding are also illustrated in Fig. 9 showing heavy steel car bolsters which have become cracked at two points in service and would have to be scrapped were it not for the possible use of the gas welding process in repairing the cracks. As in the case of all complicated castings subjected to tension it is impossible to weld one section and have it cool off without causing internal stress. For this reason due allowance must be made for contraction in cooling and the careful annealing of all parts after welding is necessary to insure a permanent weld.

Another interesting example of welding is shown in Fig. 10 in which a 5 in. by 5 in. coupler shank is changed to a 5 by 7 by the addition of a standard wedge filler held in place by either electric or gas welding as shown in the illustration. One end and both sides of the filler are undercut as shown in the cross sectional view, the undercut space being filled in with welding material, thus holding the wedge filler firmly to the coupler shank. The preceding are but a few of the many interesting examples of welding work performed in modern railroad shops.

What Does the Workman Want?

At the present time there is a great deal of discussion of industrial unrest, and dissatisfaction among the workers is one of the most important problems of shop management. It is seldom that the fundamentals of the problem of overcoming the present situation are so clearly and concisely stated as in the following, which is taken from an address by John Calder, manager industrial relations, Swift & Co., at the convention of the Iowa Manufacturers' Association.

What does the workman want? We know specifically what some people do not wish him to have and what other people insist that he should desire, but let us scrutinize closely what the workman himself really wants. Let us put it very briefly and ask and answer these four questions:

1—What is it?
2—What causes it?
3—What of it?
4—What are we going to do about it?

What Is It? Just five things:

(a) A Steady job.
(b) Adequate real wages.
(c) A good foreman.
(d) A voice in settling his own conditions.
(e) A chance to rise on his merits.

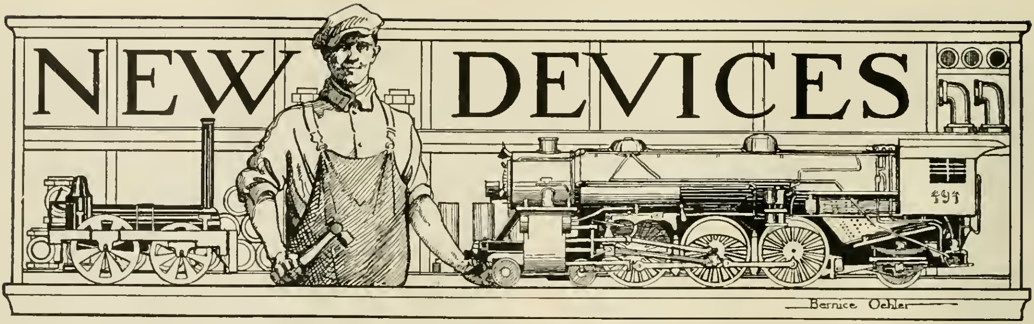
What Causes It? The nightmare of unemployment, the standard of living and the unintelligent and unwise handling of workmen individually and in small groups by supervisors who lack tact and enlightenment and sympathy.

What of It? Unrest! Industrial wars and rumors of wars. A state of mind which is fertile soil for the man, often not a workman, who wishes to capitalize the worker's feelings for quite different and subversive purposes.

Men are moved much more by their feelings than by their thoughts. When intelligence, emotions and disposition—the three motive powers of human beings—are appealed to in people lacking necessary information, the fact that your appeal is based on truth has very little to do with the result of those in an exasperated state of mind. What of it? Low production; low morals; little co-operation; readiness to change our social and economic system for others which give no guarantee of betterment.

What Are We Going to Do About It? Educate! Educate whom? The employer, the superintendents and the foremen, the employees and the public in the art of co-operating harmoniously in "getting a living."

Educate how? By suitable literature, talks, personal contacts and open forums of supervisors and employees, where a chance to talk back is afforded and where there is an opportunity to air ignorance and knowledge, truth and untruth.



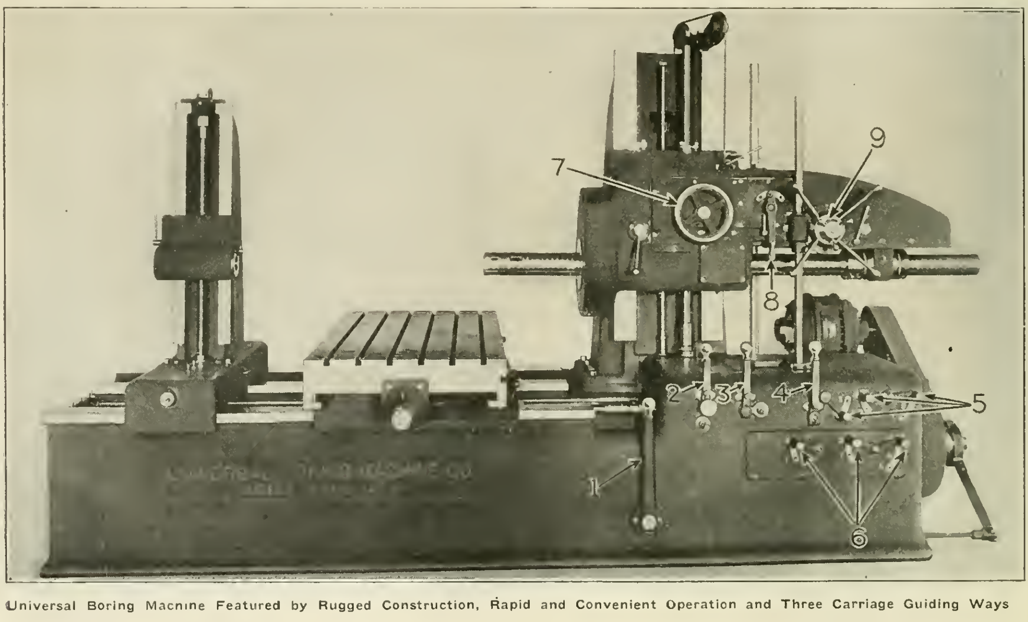
Tri-Way Universal Horizontal Boring Machine

THERE are several distinguishing features about the horizontal boring machine illustrated, which has been developed and placed on the market recently by the Universal Boring Machine Company, Hudson, Mass. One of these features, said to be original, is the use of three flat ways in the front, center and back of the machine to furnish guiding surfaces and support the unusually long carriage. This arrangement practically eliminates table overhang and provides for the boring of holes in the extremities of large, heavy castings. The first boring machine of the three-way, or tri-way, type was completed in 1919 but many improvements in design and construction have since been made and incorporated in the new machine, which is a large size particularly adapted for railroad shop and other heavy work.

The bed of the machine is rectangular in shape, being thoroughly ribbed and braced to prevent springing if it should happen to be placed on a poor foundation. A coolant system is provided and the top of the bed slopes to the head end, allowing the coolant to run down into a settling chamber at the end of the bed. From the settling chamber the coolant overflows into another chamber from which it is pumped through suitable piping to the work. The bed has also been designed to receive an electric motor without the use of an overhanging bracket. Chip chutes from which chips can be removed are provided at the back of the bed.

The rear post is a new and heavier design but requires no special description. Compensating nuts for taking up wear in the elevating screw are shown at the upper end of the screw. The carriage and table are practically the same as in the Nos. 3-A and 3½ Universal boring machines, except for being heavier and designed to take care of the coolant without piping. The head post has been designed in proportion to the rest of the machine with wide bearing surfaces for the head, an arrangement which assures both strength and accuracy.

The head is similar to previous models but is provided with a reversing lever for the boring bar, slow hand feed for the boring bar, and a lever for throwing in the higher boring bar speeds. The speed and feed change gears are arranged in geometrical progression and located in two trays, the lower



Universal Boring Macnine Featured by Rugged Construction, Rapid and Convenient Operation and Three Carriage Guiding Ways tray being filled with oil, and gears in the upper tray being lubricated by slash and oil vapor. Both the speed and feed boxes are operated on the same principle. Levers for shifting speeds and feeds and for operating them are within easy reach of the operator's right hand, all being within a radius of 28 in. Automatic stops and rapid power traverse are provided in all directions. All levers have ball handles and are both easy and comfortable to operate.

Referring to the illustration, lever *1* operates a friction clutch for starting and stopping the main driving shaft. Selective feed lever *2* is provided for throwing in whichever feed the operator desires whether the table cross feed, carriage feed on the bed or vertical feed of the head on the post. When one of the feeds is selected the others are automatically locked out. All feeds and also the rapid traverse for all feeds are thrown in by lever *3*, feeds being reversed by means of lever *4*. Three levers *5* and three levers *6* are provided for changing all feeds and speeds respectively. The handwheel *7* gives fine hand feeds for the boring bar. Lever *8* reverses and sprocket wheel *9* provides rapid hand feed for the boring bar.

The main boring bar of this machine is 4 or 4½ in. in diameter, a No. 6 Morse taper hole being provided in the end. The automatic boring bar travel is 30 in. which may be increased to 60 in. by resetting. The table is 30 in. by 63 in. or 36 in. by 75 in., being provided with power cross feeds of 48 in. or 60 in. respectively. The longitudinal feed of the carriage is dependant on the length of bed and width of table selected. Power vertical feed of 30 in. to the head is provided. The maximum distance from the table to the center of the bar is 30 in. and the greatest distance from the faceplate to the outer support is 72 in., 108 in. or 120 in. Twenty-four spindle speeds are provided ranging from 7 to 285 r.p.m. Twelve feeds in either direction can be obtained, the milling feed varying from ¼ to 5⅝ in. per min. and the boring feeds from 1 in. to 2 13/16 in. per min. An 18-in. by 4-in. driving pulley is required on the friction clutch, the pulley to operate at a speed of 230 r.p.m. The floor space occupied by the machine is 45¼ in. by 145¾ in., its shipping weight crated being about 2,200 lb.

One 3-in. plain extension boring bar 50 in. long with a No. 6 Morse taper hole at one end is provided as regular equipment; also four drill sleeves with necessary cranks and wrenches. Special sizes of beds and tables including a 30 or 36-in. rotary table, also an auxiliary table 72 in. long by 8 in. wide with one T-slot, can be provided. Motor equipment with motor base, sprockets and chain also are furnished to order as special equipment. The machine is constructed with a junction overload clutch on all feeds. This is adjusted to take the maximum cut of the machine. Beyond that point it will give, thus safeguarding against any accidental breaking of the parts of the machine.

Dual Flow Steam-Driven Air Compressor

The steam end of the Dual Flow steam driven air compressor recently developed by the Chicago Pneumatic Tool Company, New York City, is said to be entirely new and distinctive, yet based upon principles which have already proven their soundness and superiority in steam engine practice. The foremost feature of this machine, illustrated in Fig. 1, is the steam cylinder which is so designed and constructed that initial condensation is almost entirely eliminated, resulting in a great saving in steam power.

Initial condensation is one of the greatest preventable losses in steam engines of the old counterflow or compound type; it is caused by the cooling of the cylinder walls and head by the comparatively cool exhaust steam as it washes over them in leaving the cylinder through the same port by which it entered. In the Dual Flow cylinder, the exhaust steam does not wash back over the cylinder walls and head, but leaves through a port in the center of the cylinder. Thus the interior surfaces of the cylinder walls and head remain at very nearly the same temperature as the entering steam and initial condensation is reduced to the absolute minimum.

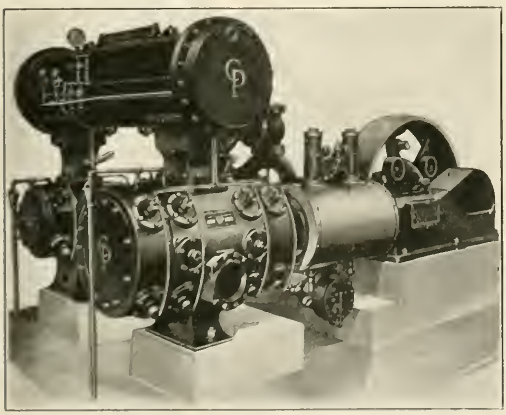


Fig. 1—General View of Dual Flow Air Compressor

The exhaust port is uncovered by the piston when the latter has traveled about half its stroke. The exhaust is controlled, however, by a patented, steam-tight poppet valve, which opens when the piston is near the end of its stroke and closes again (if the machine is running non-condensing) when the piston covers the port on the return stroke. When running condensing, the valve closes early in the return stroke.

The Dual Flow cylinder was designed to have several advantages over unaflow types. In the first place, a material saving in steam consumption when running non-condensing is claimed. Since the piston of a unaflow engine covers the exhaust port at the start of the return stroke, some provision must be made for preventing excessive compression. This usually takes the form of large clearance spaces. If there is any back pressure, there must be still greater clearance. Compression in the Dual Flow cylinder on the other hand does not begin until the piston has traveled half the return stroke. The result can be plainly seen by referring to Fig. 2 *B*, in which the diagram *A* of a Dual Flow cylinder is superimposed upon that of a large clearance unaflow machine.

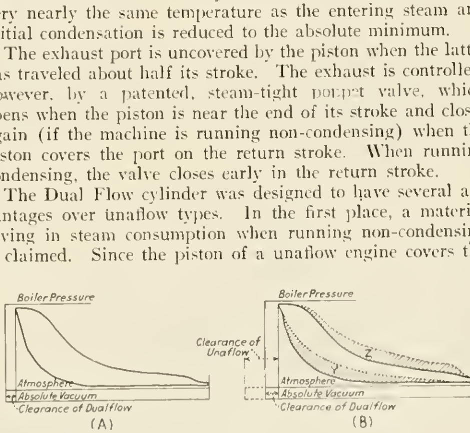


Fig. 2—Comparison of Unaflow and Dual Flow Indicator Diagrams

First, the area *Y* is lost by the unaflow machine, owing to early compression. It must be offset by the area *Z* which means the addition of more steam, later cut-off, higher release and less expansion.

Second, the Dual Flow design permits of a shorter cylinder and much shorter piston, hence the weight of the reciprocating parts is considerably less.

Third, there is less friction and the cylinder can be more easily lubricated.

A section of the cylinder, showing its construction, is given in Fig. 3. Valve leakage probably causes a greater steam loss than any other single factor. Especially is this true of installations where superheated, high-pressure steam is used; in fact, the faults common in most of the valves now used, such as leakage, excessive clearance, necessity of valve lubrication, etc., have partly offset the advantage to be derived from the use of superheated steam. Too much attention, therefore, cannot be given to the type of valve used.

A solution of the valve problem has been sought in the case of the Dual Flow steam driven air compressor by the adoption of the Skinner steam-tight, double-seat poppet valve for both admission and exhaust. This valve is said to remain steam tight indefinitely and seat perfectly, regardless of the pressure or temperature under which the cylinder is operated. It has been known to keep steam tight, with one grinding, with 159 lb. pressure and 150 deg. F. superheat and also with saturated steam at 100 lb. pressure. No lubrication is required.

Inequalities of expansion of the metals forming the valve and seat due to different co-efficients of expansion, are compensated for and no side thrust is imposed upon the stem by the lifting mechanism.

The governor is mounted in the flywheel and operated by centrifugal force and inertia. The governor arm is connected to the steam valve eccentric and by changing the throw of the latter it changes the point of the cut-off of the steam entering the cylinder. This method is obviously superior to the old scheme of merely throttling the steam. It is apparent that variations in speed may be made by adding or removing weights.

Unlike the old counterflow engines, which were regulated economically by slowing down during the unloaded periods of the compressor, the Dual Flow is a constant speed machine and shows the best steam economy when operating at its greatest speed. Regulation is therefore effected by two-step capacity control. Two differential unloaders connect with the inlet valves and reduce the capacity of the compressor in two steps. One unloader holds open the inlet valves on the crank end of one cylinder and the head end of the other. The second unloader holds open the inlet valves at the opposite ends. This is one of the simplest, most positive and most efficient methods of regulation known. The air valves are of the Simplate, independent disc type.

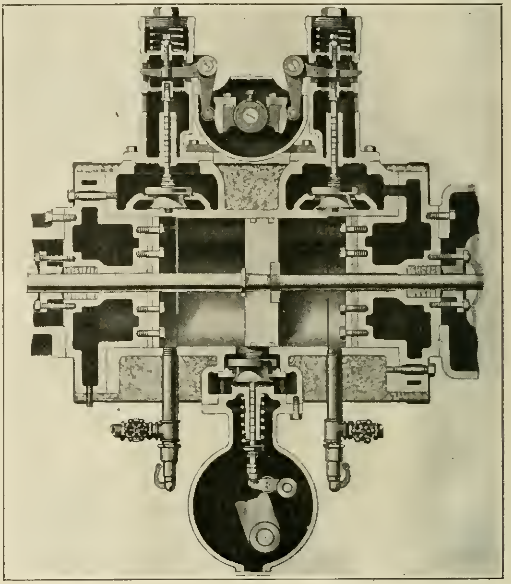
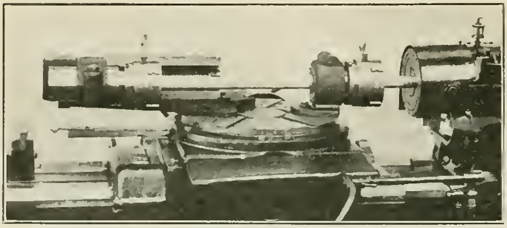


Fig. 3—Cross Section of Dual Flow Steam Cylinder

Staybolt Equipment for Flat Turret Lathes

THE advantages of the staybolt equipment developed recently by the Acme Machine Tool Company, Cincinnati, Ohio, for use on flat turret lathes are readily apparent, the principal object of this equipment being to produce accurate threads of the same concentricity and lead on both ends of staybolts. It is essential to have both die heads cutting simultaneously so that the leads will correspond exactly with that of the master stay bolt tap. The rear die-head is made adjustable, as shown in the illustration, so that any length of bolt within the range of the machine can be handled.



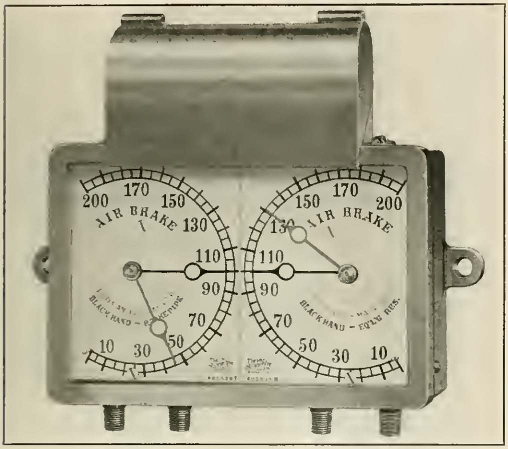
Staybolt Thread Cutting Equipment for Use on Cincinnati Acme Flat Turret Lathes

In operation the staybolt is first turned complete with a multiple cutter box tool provided with an adjustable tool for recessing the blank space between threaded ends. (This box tool is not shown in the illustration which gives a rear view of the thread cutting equipment.) After the staybolt has been turned the die heads are brought into position as shown. The front tool holder carries one die head while a special adjustable holder carries the rear die head. A micrometer collar is provided on the screw for accurate adjustment so that both die heads have the same relative lead.

Regular staybolt equipment can be provided for the 2½ in. by 26 in. Cincinnati Acme flat turret lathe to thread staybolts 1¼ in. in diameter by 14 to 24 in. long. On the Universal or 3¼ in. by 36 in. flat turret lathe, bolts up to 1½ in. in diameter can be threaded and lengths from 14 to 25 in. long. With special turners, work from 8 in. to 14 in. long can be accommodated in one chucking. Work less than 8 in. long can be threaded before releasing. A special slide arrangement can be provided on the 3¼ by 36 in. and the No. 3 universal flat turret lathes to thread the following lengths: No. 3 Universal, 25 in. to 42 in.; 3¼ in. by 36 in. flat turret lathe, 25 to 34 in., with diameters as mentioned above.

Quadruplex Locomotive Air Brake Gages

THE Ashton Valve Company, Boston, Mass., has made an innovation in gage design in the combination of two duplex air gages in one body as illustrated. These gages, known as quadruplex gages, are made in the 3½ or 5-in. sizes ordinarily used on locomotives and can be provided with or without the electric light attachment shown in the upper part of the illustration. The advantages of the new construction include uniformity of dial size, economy of space, centralized location of both gages with indicating hands near together and fixed location of the zero readings. Consequently the engineer, by concentrating his vision particularly on the brake pipe and equalizing reservoir pressure hands may regulate more uniformly and accurately brake application and thus secure smooth handling of the train.



Ashton Five-In. Dial Quadruplex Locomotive Air Brake Gage

The illumination of the dials is accomplished by the special enclosed electric light attachment, which prevents diffusion of the light rays over other sections of the cab and thus in no way interferes with the engineman's vision. The electric attachment is designed for a standard cab lamp, 16 watts, 34 volts, having standard receptacles with lamp grips as adopted by the A. R. A., Mechanical Section, in 1920. Gage dials are graduated to 150 or 200 lb. as specified, but are marked as illustrated unless otherwise ordered.

The gage case, being oblong, will facilitate installation in a vertical position and establish a uniform location of zero marks, a condition which is more or less difficult to determine with round case gages. No difficulty will be found in connecting the original copper gage pipes to the fittings on the new gage.

The movements and interior construction of the gages are similar to those used on the Ashton Duplex air brake gages and involve no complications in repairs. The quadruplex air gages are so constructed that one gage may be tested, adjusted or repaired without interfering with the others. The 5-in. gage, without electric light attachment, is called No. 62-Q and with the attachment No. 62-Q-E.

Die Sinking Machine for Work on Large Dies

A DIE SINKING machine incorporating unique features, particularly adapting it to handle large dies, has been placed on the market by the Pratt & Whitney Company, Hartford, Conn. By means of Bayrer's compensating arms, a die weighing four tons may be suspended by elevating screws, placed in position on the table and easily swiveled, tilted or turned on edge by the operator. The hand feeds are thereby rendered sensitive to light cuts and the die may be fed over to extreme limits for cutting gates without the slightest cramp.

The compensating arms can be folded back and latched against the sides of the column. Hinge shafts for the arms are attached to the column with pins through massive ears. The arms are carried on roller bearings supplemented by ball bearings. They are, therefore, sensitive to any movement imposed on the die.

Fig. 1 shows a front view of the machine with the arms extended supporting a die which is swiveled on the table and moved into position for a cut near the end of the die. Both of the outer carrying arms are provided with balance beams and adjustable weights by which the load of the die can be approximately balanced and relieved from the table. Crabs attached to the end of the die provide trunnions by which the die is supported and on these trunnions it may be readily tipped on its side for edge cuts. When the die is being tipped on its side the table is dropped clear of the die, the arms sustaining the entire load.

The machine is of the knee type, permitting proper elevation of dies of various thicknesses to bring the cut to a convenient level for the operator. To this end the range of the knee travel is kept exceptionally low down and platforms are unnecessary. The cutter spindle is mounted in a counterweighted vertical head provided with hand feed with a graduated dial. A rapid traverse for the quick adjustment of the head is provided. Power to the cutter spindle is transmitted through a quarter turn belt from the gear box in the rear of the machine. All changes of speeds and feeds are made by levers in front of the machine convenient for the operator.

Pratt & Whitney Die Sinking Machine

Hand and power feeds are furnished for both the longitudinal and cross feeds of the table. In addition a rapid power traverse is provided for all movements of the table, including elevating and depressing. The mechanism driving the power movements operates through a friction to prevent injury to parts in case of over-running. A cherrying attachment is readily applied to the cutter head, drive being effected through gearing to the nose of the cutter spindle. When not in use the cherrying attachment is swung back out of the way and does not interfere with the use of the machine. The machine is equipped for either a constant speed drive direct from a line shaft or from a motor mounted on the machine. It is also made with and without the die-carrying arms.

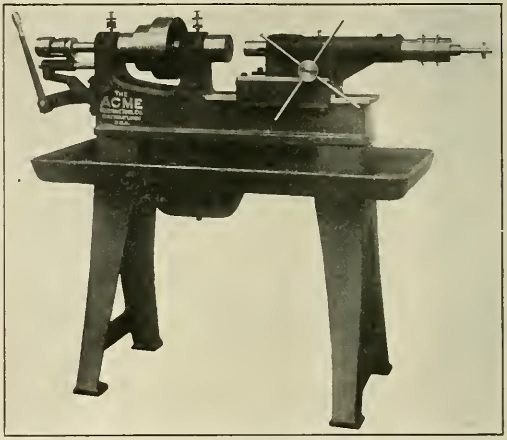
The table top dimensions are 22 in. by 48 in.; the table longitudinal feed, 48 in.; table cross feed, 17 in.; table vertical feed, 15 in.; cutter head vertical feed, 12 in.; spindle speeds (12), varying from 27 to 79 r.p.m.; table power feeds (9), from 9/16 in. to 10 in. per min.; table rapid traverse, 42 in. per min.; floor space parallel to table, 10 ft.; height of machine, 9 ft and weight, approximately 16,000 lb.

Horizontal High Speed Drilling Machine

ESPECIALLY adapted to the drilling of small, deep holes, a horizontal high speed drilling machine has been developed recently by the Acme Machine Tool Company, Cincinnati, Ohio, and added to this company's line of turret machinery. The design of the machine generally is similar to that of a hand-screw machine in that the spindle and chuck operations are identical. The work is held in the automatic chuck, which is opened and closed by means of the chuck lever, located at the front head end of the bed.

The high speed drill spindle which takes the place of the standard turret is provided with a No. 1 Morse taper at the front end for holding the drill chuck. This drill spindle is driven from a pulley on the countershaft and connected by a belt to a flanged pulley on the spindle. Both spindle and pulley are provided with ball bearings, the bearings for the pulley being mounted on a separate stationary sleeve, through which the drill spindle passes. This relieves the drill spindle proper from all belt pull and allows it to be operated easily and quickly. The spindle is mounted in a seperate sleeve provided with racks into which meshes the gear on the turnstile shaft. The turnstile handle moves this spindle backward and forward and the stop collar on the end of the spindle acts as a stop gage when the drill has reached the depth desired.

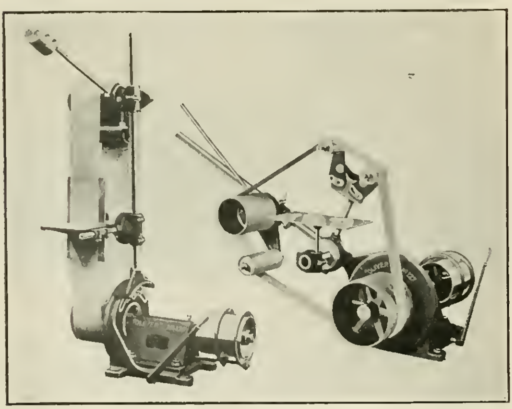
The spindle is mounted in a casting block which in turn is mounted on the turret slide saddle, and this arrangement permits locating for long or short pieces, as may be desired. The drill spindle is ordinarily run at approximately 3,000 r.p.m. and this speed, together with the machine spindle speed of 500 gives a combined drilling speed of 3,500 r.p.m.



Acme Horizontal High Speed Drilling Machine

Variety Belt Sanding and Polishing Machine

A VARIETY belt sander has been developed by the Oliver Machinery Company, Grand Rapids, Mich., designed for the rapid sanding and polishing of all kinds of small irregular shapes, edge work and flat surfaces; also for polishing metal surfaces. It can be used in wood working and pattern shops, or wherever a finishing and polishing machine is required. Features which are claimed for the machine include rapid production, ease of setting up work and maximum convenience and safety to the operator in performing his duties.


Variety Belt Sanding Machine for Rapid Sanding and Polishing

The main drive pulley is mounted on a countershaft, located on a substantial base, with a frame swinging about the center line of the countershaft and carrying a support arm. On this support arm are carried two clamp brackets, one of which supports the main idler pulley and the tension idler. The other supports the table and backing plate or any forms or flexible pads desired.

The machine will take belts up to 10 in. wide and 14 ft. long. The 10 in. by 12 in. edging table tilts to any angle up or down to 30 deg., can be adjusted in or out, and has drilled holes for attaching wood tops or forms. The backing plate is 10 in. wide and can be adjusted in and out to suitable tension on the belt; it has drilled holes for attaching flexible pads.

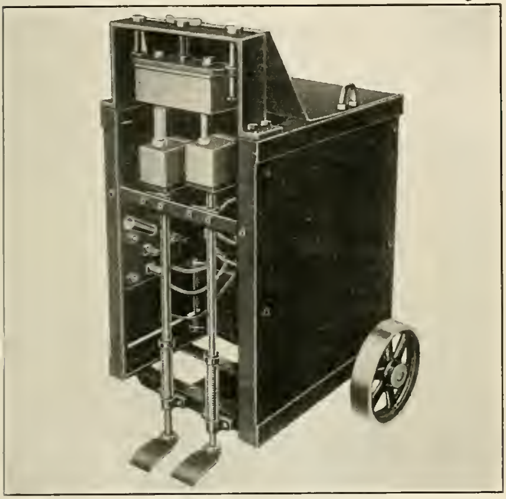
The main idler runs in ball bearings and is adjustable up or down the whole length of the idler arm to take care of various lengths of belts. The tension idler is of the ball bearing type, fulcrums in the center line of the main idler and is balanced by weights to give the right tension to the belt. Both the main and tension idler pulleys are faced with leather.

The fork idler of this attachment, mounted on the machine in place of the regular table, is used for doing oval sanding, such as oval frames and all irregular shapes. The fork idler, rigid in construction, carries two aluminum idlers which run in ball bearings and are adjustable to the work.

The height of the machine is 80 in. over all and about 4 by 8 ft. of floor space is required. A 2-h.p. motor, running at about 900 r.p.m. is required when direct connected to the lower drive pulley.

Portable Electric Rivet Heating Devices

The increased popularity of rivet heating devices using electrical energy is everywhere in evidence and based on several important advantages. In convenience of operation, cleanliness and ready movement from place to place, the electric rivet heater surpasses any other type made.



United States Electric Rivet Heater Heats Rivets from 3/8 In. to 1½ In. in Diameter in Lengths up to 6 In. without Adjustment

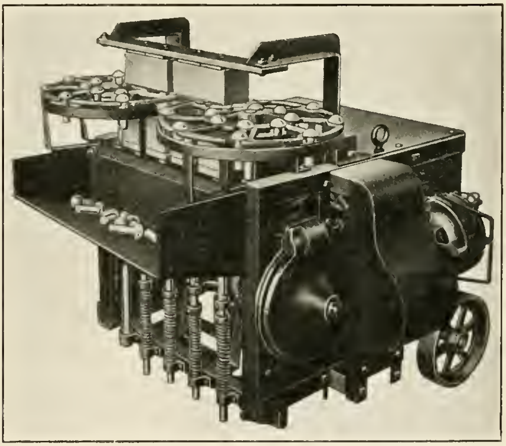
Hot rivets are provided in a few seconds and being heated from the inside, rivets are free of scale, have a uniform temperature throughout and there is a minimum number of lost and burnt rivets. On account of the fact that current is used only when rivets are being heated, the machines lose little heat by radiation and are comfortable to work around.

The rivet heater, illustrated in Fig. 1, was designed recently by the United States Electric Company, New London, Conn., and embodies the advantages mentioned above. It was built to meet the requirements of structural steel builders, boilermakers, car manufacturers and in fact any one who uses hot rivets from ¼ in. to 1½ in. in diameter by 6 in. long. The time for heating a rivet of the largest size is about 30 seconds.

The device is built in three types A, B and C with electrodes arranged to heat two, four or six rivets at one time. The large type C machine can heat twelve pin rivets per minute, which is as fast as they will ordinarily be required. Ten, 15 and 20 kw., respectively, is the power consumption of the machines, depending upon the diameter of rivets to be heated.

A pan is supplied with the heater when it is desired to hold a quantity of rivets in front of the operator or heater, and the rivets are easily placed by hand in the electrodes and removed with the tongs when heated. The operation is simple. The control switch being set for the size of rivets to be heated, the operator presses down on the foot lever and places a rivet between the electrodes until the desired heat is obtained. By heating in series after the first two rivets are heated, there is always a hot rivet ready for the riveter, and the operator always can control the current by removing one rivet, eliminating the pulling of a switch. The switch will be supplied if specified so that it will not be necessary to remove the rivet. The machine operates on 60 cycles and 220, 440 or 550 volts, single phase.

The automatic rivet heater, illustrated in Fig. 2, is built to heat rivets when making long runs on one size of rivet, heating as high as 12-¾ in. by 2½ in. rivets per minute. The machine is equipped with a control switch, the disks being arranged to hold any size rivet and accommodating 32 at one loading. The electrodes can be adjusted for any length of rivet up to five inches long and timed to give the desired heat in the rivet.



Automatic Electric Rivet Heater for Use When Making Long Runs on One Size of Rivet

New Mezzo Steel Developed for Drills

A steel of moderate cost and between carbon and high speed steel in cutting ability has been produced recently by the Cleveland Twist Drill Company, Cleveland, Ohio, and called Mezzo steel. This new steel is said to possess unusual qualities as the result of introducing a certain combination of alloys and giving a special heat treatment. It is well understood that a large number of shops are not equipped with sufficiently modern, powerful machines to get maximum results from high speed drills. They are forced to reduce the speed of the drills, and if rigidity is lacking, also the feed, this reduction resulting in much less work per hour. For maximum efficiency and strength, high speed drills must be run fast enough to keep them fairly hot, and if the equipment will not allow this, a reduced speed nearly always results in breakage, which is costly. Costly breakage forces many shops with improper equipment to go back to carbon steel tools and this results in a greatly reduced productive capacity.

It is evident that a great saving in expense can be made and maximum production obtained in the above cases by the use of a drill which sells at a moderate price and which will stand up under speeds and feeds considerably above those possible with carbon drills. Mezzo drills are recommended for drilling cast iron at greater speeds and feeds than can be used for carbon drills. In drilling machine steels and the softer alloy steels, Mezzo drills are said to be excellent, performing at much higher rates of speed and feed than those made of carbon steel. They are not, however, recommended for use in extremely hard materials. For this purpose high speed drills still outclass anything developed and their comparatively high initial cost is more than offset by the greater production.

The accompanying table of data from Mezzo drill tests is said to represent good general practice and should be compared with an average peripheral speed for carbon drills of about 35 ft. per min. in cast iron or machinery steel, with .010 in. feed per rev. It will be seen that the new drills produced holes at over three or four times the normal rate of carbon drills. Mezzo drills are furnished in sizes from 9/16 in. to 2 in. inclusive and are carried in stock for prompt deliveries in any standard size.

Table of Comparative Drill Tests

Size Drill	Material	R.P.M.	Feed Per Rev.	Peripheral Speed, Ft. Per Min.	Inches Drilled	
					Mezzo	Carbon
5/8	3 in. C. I.	356	.031 in.	60	60*	5
5/8	4 in. M. S.	356	.024 in.	60	32*	1/2
3/4	4 in. M. S.	294	.024 in.	58	10 1/2	1/4
3/4	4 in. M. S.	225	.020 in.	50	32 1/4	1/2
3/4	3 in. C. I.	294	.020 in.	58	30*	1
15/16	4 in. M. S.	225	.024 in.	55	8	1/2
15/16	3 in. C. I.	294	.032 in.	75	30*	2 1/2
1	4 in. M. S.	225	.015 in.	60	21	1 1/2
1	3 in. C. I.	225	.020 in.	60	25	1
1 1/4	4 in. M. S.	180	.016 in.	59	24	4
1 3/8	4 in. M. S.	144	.020 in.	51	12	1 1/2
1 5/8	4 in. M. S.	144	.032 in.	61	30*	2 3/4
2	4 in. M. S.	106	.015 in.	55	32*	3 1/4

Note—3 in. C. I. means a cast iron billet 3 in. thick.
4 in. M. S. means a machinery steel billet 4 in. thick.
*means test stopped, drill still in good condition.

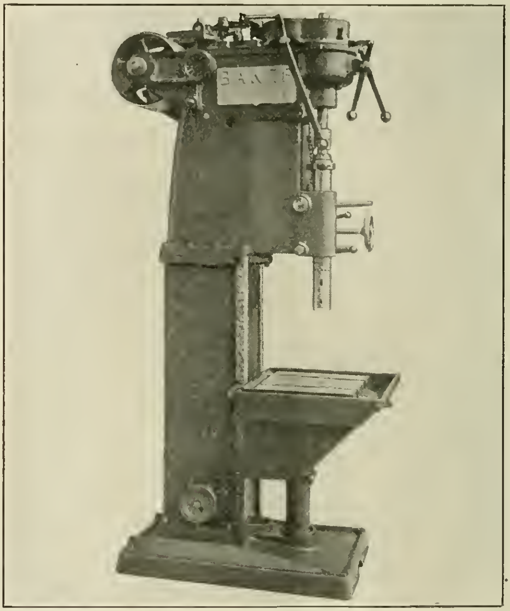
Single Purpose and Quick Change Drill

The drill, shown in the illustration, is a single purpose machine intended for medium duty boring and drilling work and arranged to be provided with a quick change speed box if desired at small expense. As a single purpose machine, speed changes are made by transposing gears, but should the customer desire a quick change of speed, a speed box can be installed giving four changes with one set of slip gears in the same position. This arrangement provides practically an unlimited number of combinations. The feed train is handled in the same manner, both single purpose and quick change.

Another innovation is the mounting of the tight and loose pulleys at the back of the frame, the shaft being supported by lugs cast upon the machine itself. This not only insures greater rigidity but also gives the opportunity of placing these machines in gangs at unusually close center distances, which is desirable where the work is of such a nature that one operator can handle two, three or possibly four spindles at one time. This machine is made by the Baker Bros., Toledo, Ohio, and is designed to handle drilling operations from 3/8 in. up to 1 1/2 in. maximum diameter. It has a proportionate capacity for boring and facing operations and yet is easily and quickly handled as a light sensitive drill. When used as a single purpose machine it is fitted with exactly the proper speeds and feeds, there being no unnecessary gears and shafts running idle and wearing as well as lowering the efficiency of the machine.

The distance from the center of the spindle to the column face is 11 in. and from the end of the spindle to the table is 29 in. The length of feed is 12 in.; vertical adjustment of table, 18 in. The table when furnished plain is 15 in. by 16 in. When fitted up as a single purpose machine, speeds of 144, 226, 300 and 468 r.p.m. are provided. When fitted up as a quick change machine, 16 speed changes from 39 to 632 r. p. m. are available. The feeds on the single purpose machine are .008 and .025 in. per revolution. The feeds on the quick change machine are 10 in number, varying from .008 to .094 in. per revolution. The pulley speed is 600 r.p.m. The standard speeds and feeds listed above are comprehensive and cover the average requirements, but if other combinations are desired they can be furnished.

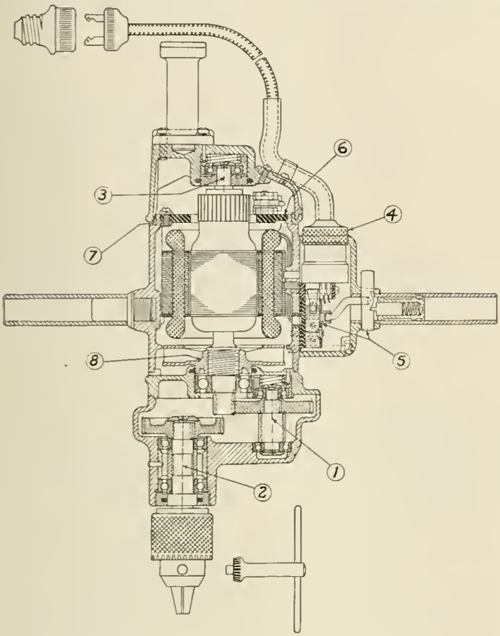
This machine may be arranged for driving with an individual motor when desired. For this arrangement the machine is furnished with the base extended in the rear to which the motor is bolted. This makes the machine and its motor self-contained, which is especially desirable if it is at any time necessary to move the machine. Motor speeds should preferably be 1,200 r.p.m. though it may run at any speed. A tapping reverse, supporting bracket for heavy boring operations, positive depth feed, or multiple depth stop can be furnished as special equipment.



Baker No. 121 Medium Duty Drilling and Boring Machine

Rugged Portable Universal Motor Drill

PERHAPS the most important feature of the portable electric drill, illustrated, which was recently placed on the market by the Hisey-Wolf Machine Company, Cincinnati, Ohio, is its rugged design throughout. This new drill is known as the Super-universal motor drill, being built in 3/8 in. and 1/2 in. sizes. Approved construction features are included, and the motor, also made by the Hisey-Wolf Machine Company, is of modern design, provided with ball bearings throughout.



Hisey-Wolf Portable Electric Motor Drill of Improved Design

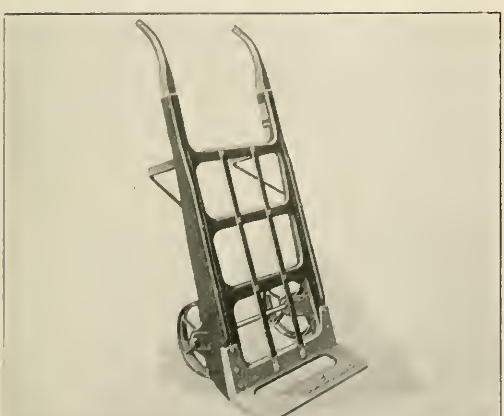
Referring to the illustration, all revolving spindles, *1*, *2* and *3*, are fitted with ball bearings securely fastened, thereby eliminating slipping. To eliminate all strains common with permanently fixed bearings spring tension is provided, a feature which automatically permits expansion and contraction of the shafts without distortion. In addition, free and uniform traction of the balls tends to add greatly to the life of all parts.

The quick cable connector *4* is an important feature. This external connector permits cable repairs and renewals to be made without dismantling the machine, thereby preventing much inconvenience and loss of time. The patented switch *5* is furnished as standard equipment and while externally mounted, is protected with a removable switch handle cover. The brush holder yoke *6* is made of bakelite, which is not affected by oil, moisture or atmospheric conditions and therefore will not warp or change in form. The complete yoke is adjustable and the motor brushes can be adjusted from outside without dismantling the machine. Forced ventilation is applied scientifically. The vent openings *7* at the handle end of the machine are so designed that all the cool incoming air must pass over the commutator and brushes before being drawn through the motor and expelled. The design and mounting of fan *8* prevents the lubricating grease in the gear head from working into the motor parts.

It is claimed for the new machine that its mechanical parts are so proportioned as to meet the most severe service requirements and that the drill has an unusually low operating cost (current consumption) compared to drilling capacity.

Hand Truck Designed for Heavy Service

A HEAVY service hand truck, shown in the illustration, has been developed by the Sharon Pressed Steel Company, Sharon, Pa. It is featured by large, easy-running wheels and rugged construction, being designed to withstand the rough usage usually given this form of truck in actual service. The truck is known as the Bluenose, a name taken from the distinctive steel blue color of the nose. The truck frame is made of a single piece of 1/8 in. hot-rolled, open hearth steel, pressed into the shape shown and provided with reinforcing beads and flanges at points subject to extra heavy stress. The wheel lugs, an integral part of the frame, are stiffened by one-half inch beading pressed in place.


Sharon Hand Truck Made With One-piece Pressed Steel Frame

The nose of the truck is pressed from 1/4 in. steel with heavy flanges at the corners to prevent springing when lifting a load. The footings are of pressed steel, sufficiently heavy and well braced to withstand double the rated load of the truck. It will be noted from the illustration that the wheels are housed within the frame, so that the axle is supported in lugs at four points instead of two as is the usual construction. The Bluenose truck is furnished with malleable iron wheels with either plain or roller bearings, or with cushion wheels of approved type. Handles for the truck are of oak, steamed and bent, being held by lag screws and easily replaced should one become broken accidentally. Straight handles can be provided if desired, the nose of the truck may be made square or round, crossbars straight or depressed, or handles long or short. The Bluenose is made in two sizes, 54 in. long by 18 1/2 in. at the nose, weighing 65 lb.; and 64 in. long by 23 1/2 in. at the nose, weighing 120 lb.

GENERAL NEWS

Six electric locomotives left for foreign markets during October. Five of these valued at $228,345, went to Brazil for the new electrification equipment being installed there; one, invoiced at $8,500, went to British South Africa.—Bureau of Foreign and Domestic Commerce.

The Arcola hot water apparatus is to be used to heat the 23 passenger cars of the Piedmont & Northern, an electric road 127 miles long, in North Carolina and South Carolina. Anthracite coal will be used. Hitherto the cars of this line have been heated by electricity.

The Interstate Commerce Commission has issued its ninth quarterly summary of accident investigations made by the Bureau of Safety, covering the reports completed in the three months ending with September, 1921. This pamphlet, 32 pages, covers 17 accidents—seven collisions and 10 derailments.

According to the annual railway accident reports of roads in Great Britain during the 20 years, 1901 to 1920 inclusive, 99 cases of bursting of boilers or tubes of locomotives occurred in that period, resulting in seven railway employees being killed and 111 injured. According to The Engineer from which these figures are taken, the reports do not distinguish between explosions of boilers and explosions of tubes but as in all but six cases employees were injured, the consequences were apparently serious on each occasion.

Serbia to Receive German Locomotives

The kingdom of the Serbs, Croats and Slovenes will receive on account of reparation 50 locomotives and 2,500 freight cars from Germany.

Stinnes a Locomotive Builder

It is reported that the factories purchased by Hugo Stinnes in Rumania have begun the construction of 2,000 locomotives for the Russian Soviet Government.

Austrian Cars Allotted to Italy

The conference of the states of the former Austro-Hungarian Monarchy at Cortorose has decided that 2,000 Austrian cars are to be transferred to the Italian State Railway Administration.

Rumania to Build Rolling Stock

The Societe Franco-Roumaine du Materiel du Chemin de Fer has been formed in Bucharest for the construction of railway rolling stock. On the other hand, the Rumanian State Railway Administration has ordered 150 locomotives and 1,500 freight cars from Germany.

Surplus Serviceable Cars

According to the weekly reports of the Car Service Division of the American Railway Association, there were large increases in the freight car surplus during the weeks ended November 15, 23, 30 and December 8. During these periods the totals were 140,189, 213,523, 282,962 and 368,042, respectively.

Bad Order Cars

The reports of the Car Service Division of the American Railway Association showed 333,616 freight cars in need of repairs on November 15, or 14.4 per cent of the cars on line, as compared with 345,801, or 15 per cent on November 1. This represents a reduction of 11,585 cars. A decrease was also noted for the period ended December 1, the total reported being 320,292 cars, or 14 per cent.

Swedish Turbine Locomotive

Advices from Stockholm state that the Ljungstroems Steam Turbine Company's turbo-condenser locomotive was successfully tested on October 22. A speed of 90 kilometers (56 miles) per hour was attained, a heavy train being pulled. The new locomotive is said to effect a saving of 50 per cent in fuel as compared with the ordinary steam locomotive.

C. M. & St. P. Officers Fined

H. E. Byram, president of the Chicago, Milwaukee & St. Paul and three other officers were fined one hundred dollars on November 8 on each of 25 charges brought by employes who claimed that their wages were docked when they left work in order to vote. The officers were granted sixty days to file a bill of exception and make an appeal. The execution of the fine will be postponed pending the outcome of the appeal.

Electrification of Hungarian State Railways

The Hungarian State Railway Administration has decided to electrify 870 miles of line. The plans for the electrification call for completion in about four years. By electrifying these lines the Hungarian State Railway will, it is said, save 800,000 tons of coal yearly and reduce the consumption of coal to 1,500,000 tons. It is estimated that if all the railways are electrified there will be no need for Hungary to import coal.

Chilean Electrification Program

The first part of the Chilean State Railway to be electrified will include 116 miles of main line and 144 miles of track. The contract for equipment, as announced in the October issue of the *Railway Mechanical Engineer,* was awarded to the Westinghouse Electric International Company through its South American representatives, Errazuriz Simpson & Company, and amounts to a total of $7,000,000. This is the most important railroad electrification undertaken in 1921 and is the largest single order for electric traction equipment ever received in this country. The equipment will be designed according to American standards.

Disastrous Fire at Weehawkin, N. J.

The freight piers of the Erie Railroad, on the Hudson river, at Weehawken, N. J., about a half mile south of the West Shore Railroad passenger terminal, were damaged by fire on November 3 to the extent of about $2,000,000, the loss including 15 freight cars and great quantities of merchandise in the storehouses and in the cars. Of the seven piers at this place, only three are left standing. The fire started on pier D and this with piers A, B and C was destroyed with its contents; also a four-story brick warehouse. The freight destroyed consisted largely of oil, salt, lumber and flour. Eleven lighters and barges lying close to the piers were damaged, some of them badly.

Developments in the Railroad Labor Problem

There have been several significant developments in the railroad labor situation recently which indicate to some extent what may be expected in the near future. Foremost among these developments are: (1) the preparation of the railroads' case in favor of a further wage reduction averaging approximately 10 per cent and the steps which are being taken to bring this case before the Railroad Labor Board; (2) the presence of leaders of the engineers' and firemen's organizations "on the carpet" before their general chairmen at Chicago, explaining why and how the recent strike orders were recalled, and (3) the continued application of the Labor Board to the question of rules and working conditions.

Extent of Depression in Great Britain

The business depression in Great Britain as shown by traffic statistics of the railways, is severe. In July of this year passenger traffic, as shown by total passengers carried (exclusive of season ticket holders), had fallen 32.8 per cent from the figure for July, 1920, to a total of 101,450,975. Freight traffic declined 36.5 per cent to 1,088,443,125 ton-miles. Average receipts per ton-mile were 2.074 pence (about 4 cents). The average car load was 5.12 long tons and the average train load 123.52 long tons, as compared with 5.45 and 133 for the same period in 1920.

North Western Shop Employees Agree to Five-Day Week

The shop employees of the Chicago & North Western have agreed with officers of that carrier to accept a lay-off of one day each week in order to avoid a reduction in forces made necessary, according to the management, because of light business. The men were informed recently that a 10 per cent cut in the shop forces would be necessary and the men were offered an opportunity to choose between retaining a full force on a five-day per week basis or retaining 90 per cent of the force on a six-day per week basis. The employees voted to accept the five-day week.

St. Paul Makes Drastic Cut in Pay Roll

In order to keep within its allotment, all employees of the Chicago, Milwaukee & St. Paul, other than those engaged in actual operation, were placed on half time for the last two weeks of the present year. Officers of the road are not excepted in the economy order and, from the president down, will sacrifice one week's salary. In some of the departments the employees are working half time, while in other departments the plan is to work a week and then lay off a week. It is expected that the forces will be put back on a full time basis the first of the year but the order will not be revoked until business makes the full force necessary. Other cuts in forces or working hours have been made by the Louisville & Nashville, which has placed its shopmen on a five-day week basis, the Mobile & Ohio, the Southern, the Nashville, Chattanooga & St. Louis and the Baltimore & Ohio.

Director General Reports on Railroad Settlements

A comprehensive report on the status of the accounts of the Railroad Administration with reference to the settlement of the claims of the railroads growing out of Federal control was transmitted to the Senate on December 10 by Director General James C. Davis in response to a resolution adopted by the Senate on November 22 on motion of Senator La Follette. In this the amount due the carriers from the Government as of December 1 on accounts growing out of Federal control, including compensation, money taken over, maintenance, materials and supplies, depreciation and all other accounts, exclusive of additions and betterments, was estimated by the Railroad Administration at $750,670,589, while the railroads owed the Government a balance of $507,628,508 on account of additions and betterments undisposed of as of December 1, leaving a balance of cash required for final settlement, based on the estimate of the Railroad Administration and assuming that the balance due on additions and betterments would be collected by deduction from the indebtedness of the Government to the roads, of $243,042,080.

Clearing of Labor Board's Docket in Sight

The following announcement was made by the Railroad Labor Board on November 21:

"The Railroad Labor Board has disposed of exactly six times as many cases in the last few months as it did in the first period of its existence. The Board was organized in April, 1920. It disposed of 100 cases from April 15 to November 30, 1920. In the same period this year—April 15 to November 15, 1921—it disposed of exactly 600 cases. The round numbers, by an unusual coincidence, represent the actual number of cases carried through to a final decision.

"The increased number of cases disposed of indicates not only the greater rapidity of the Board's work but also how its volume has increased.

"With the recent disposal of 200 cases and the prospect that the new adjustment boards will handle a large amount of the grievance cases which have heretofore been brought before the Board, the clearing of the Board's docket may be said to be in sight."

"Labor" Contributes Some Additional Strike News

Labor, the newspaper published by the Plumb Plan League, reproduces in its latest issue a copy of an order said to have been sent by the Navy Department to all heads of departments and barracks petty officers under date of October 21, directing them to interview all men who come under their jurisdiction, with a view of finding out if any had previous experience in railroading; and to prepare lists showing the previous experience, such as fireman, engineer, trackman, switchman, round house and repair man, or in any duties in connection with railroad operation of all men assigned to each barracks or head of department.

The order also asked for a list of those who had had experience in machine gun crews and were good pistol or rifle shots. The lists were to be submitted to the executive officers on October 24.

The paper draws from this the inference that the Government had made extensive plans for resisting the strike of railroad employees which was called for October 30.

Markham Asks Employees to Repudiate Labor Propagandists

C. H. Markham, president of the Illinois Central, in an open letter, addressed to the employees of that road, asks for a show-down on charges made against the railroads by representatives of railroad employees.

He asks that either the employees back these accusations or repudiate them, and adds that if they know of any irregularities or mismanagement on the Illinois Central it is their duty to bring them to his attention.

The letter contains the names, dates and a resume of charges made by labor representatives such as Frank J. Warne, W. Jett Lauck and Glen E. Plumb. Mr. Markham says: "I cannot believe that these men, calling themselves your spokesmen, reflect the true sentiment of the men of the Illinois Central System, who have worked with the management so faithfully and wholeheartedly in building up a railway system which we pride ourselves in believing is one of the greatest railway systems in the world.

"But, frankly, I have been disappointed that these men have been permitted to continue to pour out unchecked torrents of false accusations without even a word of public protest from the men whom they claim to represent and whose money makes their activities possible."

Reopening of West Albany Shops

The New York Central has leased its repair shops at East Buffalo and at Toledo, as noted last month. No action has been taken toward opening the shops at Collingwood, Ohio.

The company has reopened the passenger car shops at West Albany, N. Y., a meeting of 616 employees having voted almost unanimously to accept the proposition of the company to resume work on a piece-work basis. These men evidently are convinced that they will do as well working directly for the company, or better, than if they were to go into the employ of a contractor. The employees have established a committee which is empowered to conduct any necessary negotiations with the superintendent of motive power.

It is understood that the piece-work rates will average about 25 per cent more than was paid, at piece-work rates, for similar work in 1917. These shops have been closed about 10 months.

Telephoning on Railroad Power Wires

On a trolley railroad near Schenectady, N. Y., on Thursday, December 1, the General Electric Company gave a demonstration of its "carrier current" system of communication by telephone over the propulsion wire of an electric railroad, conversation being held between different trains on the same track, and from trains to operators in stations and vice versa. A second current is superimposed on the trolley wire and the message is conveyed to any desired distance, being picked up at any convenient point and made to energize a telephone instrument. The telephone current is generated at higher frequency than the power supply. Experiments in this line have been carried on by the General Electric Company for a number of years, and on the Chicago, Milwaukee & St. Paul electrified line communication has been carried on in this way for a distance of 60 miles.

Eight-Hour Day Abolished in South Africa

The Southern African Railways have abandoned the eight-hour day for certain classes of employees, according to the Railway Gazette (London). The railways have accumulated a deficit of some $15,543,791 since the fiscal year 1917-1918. The eight-hour day is estimated to cost some $4,860,000 annually. In lengthening the work-day the management endeavored to take into consideration the intensity and continuity of the work done. The employees affected and the length of the new work-day for them are enginemen and firemen, nine hours; ticket examiners and trainmen, ten hours. Overtime will be paid for at 1¼ rate. The duties of other employees will be considered and further adjustments made, but no hours will be increased beyond twelve, including times for meals, and where the work is exacting the present 48-hour week will be maintained.

Freight Car Loading

The number of cars loaded with revenue freight during the week ended November 12 showed a large drop, according to the weekly report of the Car Service Division of the American Railway Association, due largely to the effect of the Armistice Day holiday and election day in several states. The total was 753,046, as compared with 829,722 the week before, 927,586 in the corresponding week of 1920 and 808,304 in 1919.

Loading of revenue freight totaled 673,827 cars during the week which ended on November 26. This was 112,844 cars less than were loaded during the previous week, the decrease being due principally to the observance of Thanksgiving Day. The total, however, was 129,874 cars less than were loaded during the corresponding week in 1920 which also included the same holiday and 65,370 cars below the total for the corresponding week in 1919.

For the week ended December 3, 747,454 cars were loaded, an increase as compared with the previous week of 73,627 cars. For the corresponding weeks of 1920 and 1919 the loadings were 882,604 and 789,286 cars, respectively.

The report for the week ended December 10 showed loadings totaling 742,962 cars, or 4,528 cars less than reported for the week ended December 3. During the corresponding weeks of 1920 and 1919, 95,027 and and 19,014 cars less were loaded.

Locomotive Orders

The Central of New Jersey has ordered 25 Mikado type locomotives from the American Locomotive Company.

The Seaboard Air Line has ordered from the American Locomotive Company 10 Mountain type locomotives to have 27 by 28 in. cylinders and a total weight in working order of 315,000 lbs. and 15 Mikado type locomotives to have 27 by 30 in. cylinders and a total weight in working order of 284,000 lbs. All these locomotives will be equipped with superheaters.

Freight Car Orders

The Erie is building 70 caboose cars in its own shops at Buffalo, N. Y.

The Delaware, Lackawanna & Western has ordered 500 box cars from the American Car & Foundry Co.

The Live Poultry Transit Company, Chicago, has given a contract for 100 poultry cars to the American Car & Foundry Company.

The Pere Marquette has ordered from the Western Steel Car & Foundry Company, 500 box cars, with an option for 500 additional cars.

The Mathieson Alkali Works, Niagara Falls, N. Y., has ordered 20, 30-ton cars for handling tanks from the Standard Steel Car Company.

The Baltimore & Ohio has ordered 500 hopper car bodies from the Pressed Steel Car Company, and 500 from the Standard Steel Car Company, all to be of 55-ton capacity.

The Northern Pacific has ordered 1,200 steel center frame constructions from the Western Steel Car & Foundry Company. These are to be applied to box cars in the railroad company's shops.

Passenger Car Orders

The Philadelphia & Reading has ordered 30 coaches and 5 combination baggage and smoking cars from the Bethlehem Shipbuilding Corporation, Harlan Plant, and 15 coaches from the Standard Steel Car Company.

The New York, Ontario & Western has given an order to the Standard Steel Car Company for 20, 79-ft. coaches; 4, 70-ft. combination smoking and baggage cars; 3, 60-ft. baggage cars and 3, 60-ft. combination baggage and mail cars. These will be all steel cars, equipped with Commonwealth trucks.

Car Repair Contracts

The Chicago & Alton has awarded a contract for the repair of 150 gondola cars to the Streets Company, Chicago.

The Northern Pacific is having repairs made to a number of passenger cars at the shops of the Pullman Company.

The Union Pacific has awarded a contract for the repairs on 500 freight cars to the Pacific Car & Foundry Company, Seattle, Wash.

The Buffalo, Rochester & Pittsburgh has given a contract to the Buffalo Steel Car Company for the repair of 500, 50-ton hopper cars.

The Missouri Pacific has awarded a contract for the repair of 500, 30-ton box cars to the Sheffield Car & Equipment Company, Kansas City, Mo.

The Chicago, Burlington & Quincy has awarded a contract for the repair of 300 50-ton gondola cars to the General American Car Company, Chicago.

The Virginian Railway has given a contract to the Virginia Bridge & Iron Company, Roanoke, Va., for the repair of 1,500, 50 to 55-ton all steel coal cars.

The Chesapeake & Ohio has given contracts for the repair of 200 composite cars to the Ralston Steel Car Company, 500 steel cars to the Illinois Car & Manufacturing Company, Chicago Heights, Ill., and 300 composite cars to the American Car & Foundry Company's shops at Huntington, W. Va.

Shop Construction

Missouri Pacific.—This company has awarded a contract to Joseph E. Nelson & Sons, Chicago, for the construction of a pumping station and water treating plant at Fort Scott, Kan.

Chicago, Rock Island & Pacific.—This company has awarded a contract to T. S. Leake & Company, Chicago, for the construction of a car repair shed, 87 ft. by 200 ft., at Pratt, Kan., estimated to cost $20,000.

Air Brake Association to Hold Convention in Washington

At a meeting of the Executive Committee of the Air Brake Association held at the Hotel Sherman, Chicago, on December 13, it was unanimously voted to hold the regular annual convention of the association at the Hotel Washington, Washington, D. C., May 9, 10, 11 and 12, 1922. Accommodations will be provided in the new Ebbitt Hotel in the adjacent block for those who are unable to obtain rooms in the Hotel Washington, the headquarters of the association. All sessions will be held in the convention hall on the top floor of the Hotel Washington and all exhibits will be erected on the mezzanine floor of that hotel.

The officers of the association hope for a large attendance at the convention because of the necessity for educational work on matters pertaining to the air brake at this time. Many new men have been taken into railroad service during the war years and since who need air brake instruction and numerous air brake devices have been developed which remain to be explained to the older men and to those more recently employed.

MEETINGS AND CONVENTIONS

The Chief Interchange Car Inspectors' and Car Foremen's Association of America will meet in general session at the Great Northern Hotel, Chicago, Monday, January 9, at 9 a.m., for the purpose of discussing and arriving at a uniform interpretation of the A. R. A. Mechanical Section 3 rules, effective January 1, 1922, and all other important business that may come up.

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

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City. Annual convention May 9, 10, 11 and 12, Hotel Washington, Washington, D C.

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Next annual convention June 14 to 21, 1922, Atlantic City, N. J.

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

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

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

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

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Annual meeting Atlantic City, June, 1922.

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

American Society for Steel Treating.—W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention and exposition September 25 to 30, 1922, Detroit, Mich.

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

Canadian Railway Club.—W. A. Booth, 53 Rushbrook St., Montreal, Que. Regular meeting second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal.

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

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

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Annual meeting January 12. Election of officers. Annual reports and paper by G. M. Basford.

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

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

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

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill. Next annual meeting May, 1922, Chicago.

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

Master Boilermaker Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y. Next annual convention Hotel Sherman, Chicago, May 23 to 26, 1922.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting January 10. Paper on Test Department on Railroads will be presented by H. P. Haas, engineer of tests N. Y., N. H. & H.

New York Railroad Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y.

Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

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

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Regular meetings fourth Thursday in each month, except June, July and August, at Fort Pitt Hotel, Pittsburgh, Pa.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo. Next meeting January 13. Paper on Insights and Outlooks with special reference to railroad situation will be presented by Frank B. McMillin, vice-president and general manager of the Hydraulic Press Mfg. Co.

Traveling Engineers' Association.—W. O. Thompson, Marine Trust building, Buffalo, N. Y.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Regular meetings third Monday in each month, except June, July and August.

PERSONAL MENTION

GENERAL

H. W. Salmon, Jr., acting fuel agent of the Missouri Pacific, with headquarters at St. Louis, Mo., has been promoted to fuel agent.

D. C. McAllister has been appointed assistant general air brake inspector of the Northern Pacific, with headquarters at St. Paul, Minn., succeeding E. L. Kenrick, who has resigned.

Ora S. Jackson, whose appointment as assistant superintendent of motive power and machinery of the Union Pacific, with headquarters at Omaha, Neb., was announced in the December issue of the *Railway Mechanical Engineer*, was born at Huntington, Ind., on August 11, 1875. He entered railroad service as an apprentice machinist on the Erie, at Huntington, Ind., after which he worked as a roundhouse foreman and general foreman on the Cleveland, Cincinnati, Chicago & St. Louis for eight years. He then left that road to become general foreman and master mechanic of the Chicago, Indianapolis & Louisville, which position he held for five years, when he became superintendent of motive power of the Chicago, Terre Haute & Southeastern. After three years he was promoted to general superintendent in charge of the mechanical and operating departments, which position he held for five years up to the time of his recent appointment.

O. S. Jackson

G. W. Lillie has been appointed superintendent of motive power of the Denver & Salt Lake, with headquarters at Denver, Colo. Mr. Lillie was born at Omaha, Neb., in 1868. He entered railroad service as an apprentice in the Omaha shops of the Union Pacific and was later promoted to draftsman. He became chief draftsman of the Oregon Short Line at Salt Lake City, Utah, in 1897. In 1899, he left railroad service to become mechanical draftsman for the United States naval construction base at Newport, Va. He re-entered the service of the Oregon Short Line in 1901 in the mechanical department. In 1907 he left to become supervisor of the car department of the St. Louis-San Francisco, with headquarters at St. Louis, Mo., and in 1908, he was promoted to superintendent of the Springfield shops with headquarters at Springfield, Mo. He again returned to the Oregon Short Line in 1910 as master mechanic, with headquarters at Pocatello, Idaho. He left again in 1913, to become mechanical superintendent of the second district of the Chicago, Rock Island & Pacific, with headquarters at Topeka, Kan. In 1915 he entered the service of the Bingham & Garfield as master mechanic, with headquarters at Salt Lake City.

G. W. Lillie

G. J. Churchward, chief mechanical engineer of the Great Western Railway (England), will retire at the end of the present year, and C. B. Collett, the deputy chief mechanical engineer, will succeed him.

George M. Davidson, chemist and engineer of tests of the Chicago & North Western, with headquarters at Chicago, has been appointed industrial engineer, with the same headquarters. He will have general supervision of the laboratories, water supply, timber preservation, fuel consumption and other duties assigned to him by the president. H. D. Browne will succeed Mr. Davidson as engineer of tests.

G. H. Likret has been appointed fuel engineer of the Union Pacific with headquarters at Omaha, Nebr. B. E. O'Neill has been appointed fuel supervisor of the southern district with headquarters at Kansas City. A. L. Coey has been appointed fuel supervisor of the northern district with headquarters at Cheyenne, Wyo., and P. C. Coats has been appointed fuel inspector with headquarters at Omaha, Nebr.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

George Walker has been appointed road foreman of engines of the Atchison, Topeka & Santa Fe at Prescott, Ariz.

E. W. Lostrom has been appointed road foreman of engines of the Northern Pacific, with headquarters at Duluth, Minn., succeeding J. A. Marshall.

W. R. Harrison, master mechanic of the Atchison, Topeka & Santa Fe, with headquarters at Chanute, Kan., has been transferred to Argentine, Kan., succeeding E. E. Machovec.

W. H. Dempsey has been appointed assistant division master mechanic of the Chicago and Milwaukee division and the Milwaukee terminal of the Chicago, Milwaukee & St. Paul, with headquarters at Milwaukee, Wis., succeeding G. E. Passage.

S. G. Kennedy, general foreman of the Atlantic Coast Line at Lakeland, Fla., has been appointed master mechanic of the Tampa district with the same headquarters. Mr. Kennedy was born on May 29, 1876, at Kinston, N. C., and graduated from the North Carolina State College in 1897. In 1902 he became a machinist at the South Richmond shops of the Southern Railroad and later worked for the Pennsylvania, the Seaboard Air Line and Florida East Coast, beginning work with the Atlantic Coast Line at South Rocky Mount shops in 1906. He subsequently served as night foreman, day roundhouse foreman and machine shop foreman, and on July 22, 1918, was made general foreman at Lakeland.

S. G. Kennedy

W. N. Foster has been appointed master mechanic of the Iowa division of the Chicago, Milwaukee & St. Paul, with headquarters at Marion, Iowa, succeeding E. L. Notley, who has been assigned to other duties.

J. A. Marshall has been appointed acting master mechanic of the Lake Superior division of the Northern Pacific, with headquarters at Duluth, Minn., succeeding J. E. Goodman, who has been granted a leave of absence.

J. D. Young has been appointed acting master mechanic of the Central of New Jersey, with headquarters at Ashley, Pa., succeeding A. B. Enbody, who has been granted a leave of absence on account of ill health.

M. H. Haig has been appointed master mechanic of the Pecos division of the Atchison, Topeka & Santa Fe, with headquarters at Clovis, N. M., succeeding W. D. Hartley, who has been transferred to the New Mexico division.

L. E. Fletcher has been appointed acting master mechanic of the New Mexico division of the Atchison, Topeka & Santa Fe with headquarters at Raton, N. M., succeeding T. T. Ryan, who has been granted a leave of absence on account of illness.

G. E. Passage, assistant division master mechanic of the Chicago, Milwaukee & St. Paul, with headquarters at Milwaukee, Wis., has been promoted to master mechanic of the Terre Haute division, with headquarters at Terre Haute, Ind., succeeding J. A. Richards, who has been assigned to other duties.

C. E. Brooks, traveling engineer of the Chicago, Milwaukee & St. Paul, with headquarters at Miles City, Mont., has been promoted to master mechanic of the Bellingham division, with headquarters at Bellingham, Wash., succeeding C. E. Cessford, assigned to other duties on account of ill health. W. M. Anderson has been appointed master mechanic of the Northern Montana division, with headquarters at Lewistown, Mont., succeeding O. A. Coltrin, who has been assigned to other duties.

SHOP AND ENGINEHOUSE

W. A. Rocksberry has been appointed boiler foreman of the Chicago, Rock Island & Pacific at Eldorado, Ark.

P. C. Feick, formerly general foreman of the Frisco at Oklahoma City and other points, is now employed as district foreman of the Oregon Short Line at Nampa, Idaho.

W. A. Worely has been appointed roundhouse foreman on the Arkansas-Louisiana division of the Chicago, Rock Island & Pacific, at Winnfield, La., succeeding J. H. Kelley, who has been assigned to other duties.

PURCHASING AND STORES

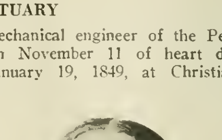
S. J. DeGraeff has been appointed storekeeper of the Southern Pacific of Mexico with headquarters at Empalme, Sonora, Mexico.

G. W. Hanegan, storekeeper of the central and western divisions of the Minneapolis & St. Louis, with headquarters at Minneapolis, Minn., has been promoted to general storekeeper, with the same headquarters.

B. W. Griffith, district storekeeper of the New York Central, lines west, with headquarters at Collinwood, Ohio, has been promoted to assistant general storekeeper, with the same headquarters, and will be succeeded by F. J. McMahon. A. L. Prentice, division storekeeper, with headquarters at Elkhart, Ind., has been promoted to assistant general storekeeper, with headquarters at Collinwood, and he will be succeeded by C. F. Heidenreich.

OBITUARY

Axel S. Vogt, formerly mechanical engineer of the Pennsylvania, Eastern lines, died on November 11 of heart disease. Mr. Vogt was born on January 19, 1849, at Christianstad, Sweden, and was educated in the public schools. He began railway work in June, 1874, with the Pennsylvania at Altoona and remained with that road until 1882, when he went with Schutte & Koehrting, Philadelphia, Pa. In November, 1883, he returned to the service of the Pennsylvania as assistant engineer of tests. On March 1, 1887, he was promoted to mechanical engineer, and remained in that position until February 1, 1919, when he retired. Since his retirement he was connected with the Baldwin Locomotive Works for a short time in an advisory capacity.



Axel S. Vogt

W. P. Hawkins, formerly fuel agent of the Missouri Pacific and for four years president of the Western Coal & Mining Company, died on November 23, at St. Louis, Mo.

SUPPLY TRADE NOTES

Arthur P. Bowen has been elected assistant to the vice-president of the Ryan Car Company, Chicago.

The Rich Tool Company, Chicago, has appointed the Busch Corporation of St. Louis, Mo., its representative in the St. Louis territory.

The Osgood Company, Marion, Ohio, has opened a branch sales office at 1211 Conway building, Chicago, in charge of Arthur B. Sonneborn, as manager.

J. F. Kelly, Jr., has been appointed export sales manager of the Electric Storage Battery Company, Philadelphia, Pa. Mr. Kelly will have his headquarters at 23 West Forty-second street, New York City. He joined the Electric Storage Battery Company in 1909 and has been in the service of this company continuously except during the period of time he spent in military service. He was commissioned a captain in the United States army in November, 1917, at the Plattsburg Training Camp and was assigned for duty as officer in charge at the army supply base, at Port Newark, N. J., serving until his release in January, 1919. Mr. Kelly has spent considerable time with officers of the railroads in Australia, Argentina and Brazil, having recently returned from a two years' trip around the world in the interests of the Electric Storage Battery Company.

J. F. Kelly, Jr.

The F. C. Richmond Machinery Company, 117 West Second street, Salt Lake City, Utah, has been appointed representative of the Orton & Steinbrenner Company, Chicago.

R. W. Levenhagen, vice-president of the Glidden Company, Cleveland, Ohio, has recently assumed direct charge of the sales policies and sales activities of the Glidden organization.

The Combustion Engineering Corporation, New York, has opened a new branch office at 806 First National Bank building, Pittsburgh, Pa., in charge of W. C. Stripe, formerly manager of the Philadelphia office.

The Enterprise Railway Equipment Company, Chicago, has purchased all patents and trade mark "Ingoldsby" of the Ingoldsby Automatic Car Company, a corporation organized under the laws of the State of West Virginia.

Andrew Fletcher, president of the American Locomotive Company, has been elected a director of the American Car & Foundry Company to fill the vacancy on the board caused by the resignation some time ago of Walter G. Oakman.

Gerald Kochenderfer, formerly district representative at Indianapolis, Ind., has been appointed district sales manager of the Warner & Swasey Company, Cleveland, Ohio, with headquarters at Chicago, succeeding H. F. Whitham, resigned.

The Combustion Engineering Corporation, New York, recently opened two branch offices, one at 216 Latta Arcade, Charlotte, N. C., in charge of T. E. Nott and the other at Seattle, Wash., where the company is represented by the Fryer-Barker Company, 1133 Henry building.

The merger of the Haskell & Barker Car Company, Inc., with the Pullman Company, was approved by the stockholders of the Pullman Company at Chicago, on December 20. The directors have been increased from nine to twelve by the election of Edward F. Carry, president of the Haskell & Barker Car Company; John R. Morrow, and Arthur O. Choate.

Manning, Maxwell & Moore, Inc., New York, has removed its Philadelphia, Pa., office from the Lincoln building, to larger quarters in the Pennsylvania building at Fifteenth and Chestnut streets. The company has also removed its Boston, Mass., office from 10 High street to the Textile building, 99 Chauncey street.

Fred Atwater, vice-president and treasurer of the Columbia Nut & Bolt Company, Inc., Bridgeport, Conn., was on November 8 elected mayor of the city of Bridgeport by the largest majority ever given any candidate. Mayor Atwater will still retain his connection with the Columbia Bolt & Nut Company, Inc., with which company he has been associated since 1902.

Charles F. Smith has been elected chairman of the board of directors of the New Britain Machine Company, New Britain, Conn., succeeding F. G. Platt, who resigned on account of ill health. Mr. Smith is chairman of the board of directors of Landers, Frary & Clark, New Britain, and was formerly chairman of the board of the American Hardware Corporation.

The Greenfield Tap & Die Corporation, Greenfield, Mass., has consolidated its small tool and drill divisions. P. T. Irvin, formerly manager of its drill division, is in charge of the consolidation, which will be called the small tool division. Mr. Irvin has for the past three years been sales manager of the Lincoln Twist Drill Company and prior to that was sales manager of Wells Brothers Company, Greenfield.

The Cincinnati Shaper Company and its subsidiary, the Cincinnati Gear Cutting Machine Company, have arranged for a branch sales office in Indianapolis, Ind., with headquarters at 940 Lemcke annex. T. C. McDonald, who has been appointed local representative at Indianapolis, will cover the Indianapolis and Louisville districts, also certain states in the southwest, and will continue as local representative of the Reed-Prentice Company.

B. E. D. Stafford, general manager of the Flannery Bolt Company, Pittsburgh, Pa., died on November 30, at Atlantic City, N. J. Mr. Stafford was born in 1866 in Brooklyn, N. Y., and was educated in the public and night schools At the age of 15 he took up patent office drawing and soon became an expert penman. In order to better himself for mechanical drawing he acquired a practical knowledge of the machine, tool and screw making trades and within a few years ranked as one of the few expert operators in America of the universal type of milling machine and the automatic screw machine. At the age of 21 he was made foreman of the tool shop of a large manufacturer of cotton machinery at Hopedale, Mass., and built most of the automatic machinery for the plant. Later he became a specialist in reducing shop costs and in 1895 was engaged by B. M. Jones & Co. to demonstrate the uses of self-hardening steels. Five years later he was employed as a staybolt salesman by the Ewald Iron Company. In the fall of 1904, Mr. Stafford was engaged by the Flannery Bolt Company to develop and market the Tate flexible staybolt for locomotive firebox service. During the time he has been identified with that concern, Mr. Stafford has done much to advance the methods of locomotive firebox construction. Mr. Stafford lived in Millville, N. J., and funeral services and burial were in Vineland on the morning of December 3.

B. E. D. Stafford

Anton Becker, for 15 years connected in official capacities with The Ralston Steel Car Company, Columbus, Ohio, has resigned to enter the railroad supply business. He has organized The

Becker Sales Company, with office in the Union Central building, Cincinnati, Ohio. In connection with railroad specialties The Becker Sales Company will also have the sales representation of The Ralston Steel Car Company, in certain territory in middle western states.

John L. Artmaier, eastern sales manager of the Buda Company, in charge of the New York office, has been appointed sales manager of the railroad department of the company, with headquarters in the Railway Exchange building, Chicago. J. E. Murray, formerly assistant to Mr. Artmaier, has been appointed eastern sales manager and J. H. Maher, formerly representing the company at Buenos Aires, Argentine, has been appointed eastern export manager.

The Richardson-Phenix Company, Milwaukee, Wis., and the S. F. Bowser & Co., Inc., Fort Wayne, Ind., have consolidated and will henceforth be known as the S. F. Bowser & Co., Inc., with headquarters at Fort Wayne. The filtration and lubrication appliance business of both companies will be conducted by the Richardson-Phenix division, S. F. Bowser & Co., Inc. J. William Peterson, president of the Richardson-Phenix Company, will assume the office of vice-president of the S. F. Bowser & Co., Inc., and will be in charge of the Richardson-Phenix division.

Clarence E. Rood, sales manager of the Gould Coupler Company, New York, died on December 11 after a brief illness, at his home at the Algonquin Hotel, New York City. Mr. Rood was born in Erie, Pa., and early in his career was general manager of the American Express Company in St. Louis, Mo. Later he went to Buffalo where for a time he was a member of Rood & Brown, car wheel builders. He subsequently owned and operated the Rood Malleable Iron Company, Lancaster, N. Y. About 12 years ago he entered the service of the Gould Coupler Company as a representative at New York and at the time of his death was sales manager of that company.

F. N. Bard, vice-president and treasurer of the Barco Manufacturing Company, Chicago, has been elected president, succeeding George M. Bard, who has been elected chairman of the board of directors. C. L. Mellor, sales manager, succeeds F. N. Bard as vice-president and will also act as secretary, F. N. Bard retaining his duties as treasurer. Frank H. Stiles, formerly mechanical representative at Boston, Mass., has been appointed district sales manager with the same headquarters. Mr. Stiles, previous to entering the service of the Barco company, was with the New York, New Haven & Hartford. Arthur S. Lewis, mechanical representative at New York, has been appointed district sales manager with the same headquarters.

The Whiting Corporation, Harvey, Ill., has bought a controlling interest in the Grindle Fuel Equipment Company, manufacturers of complete powdered coal plants, for use in connection with malleable furnaces, annealing ovens, steam boilers, billet heating and various other types of furnaces. The Grindle Fuel Equipment Company has moved its offices to Harvey, and will continue its business under the same name. Whiting Corporation will manufacture all Grindle equipment. The officers are as follows: B. H. Whiting, president; T. S. Hammond, secretary and treasurer and A. J. Grindle, vice-president and general manager; and the board of directors includes the above officers and J. H. Whiting, R. H. Bourne, N. S. Lawrence and A. H. McDougall.

John W. Duntley, one of the founders of the Chicago Pneumatic Tool Company and from 1895 to 1909 president of that concern, was killed by an automobile truck at Chicago on December 15. Mr. Duntley was born at Wyandotte, Mich., on August 16, 1863, and entered business as a foundryman in 1878. From 1884 to 1895 he was engaged in the railway supply business and upon the latter date he organized the Chicago Pneumatic Tool Company. From this date to 1909 he was engaged in expanding this organization, enlarging the scope of the business at the same time by absorption and amalgamation both in this country and abroad. In 1909 he organized and became president of the Duntley Manufacturing Company, manufacturers of the pneumatic cleaners. Of late years he devoted his energy to the Duntley Automobile Accessory Company, Chicago, of which he was president. He was also president of the Libertad Mining & Smelting Company. In 1900, he was decorated with the cross of the Legion of Honor by the president of France.

TRADE PUBLICATIONS

Pumps.—The Oilgear Company, Milwaukee, Wis., has recently issued Bulletin No. 6 fully describing and illustrating its hydraulic control pump which may be connected to any device requiring oil under pressure.

Condenser Coils.—A small folder illustrating and briefly outlining the advantages of Elesco condenser coils for refrigerating and ice making plants has recently been issued by the Superheater Company, New York.

Drills.—The Hisey-Wolf Machine Company, Cincinnati, Ohio, has recently issued a four-page bulletin, No. 105-A, describing and featuring in a full sectional drawing the interesting features of construction of its new super-universal motor drills.

Grinding.—Descriptions and illustrations of typical work done on its grinders, also a partial list of users and a list of parts ground, are contained in the interesting data book of 63 pages which the Blanchard Machine Company, Cambridge, Mass., has recently issued.

Pipe Installation Costs.—The A. M. Byers Company, Pittsburgh, Pa., has recently issued a four-page folder calling attention to Bulletin No. 38 entitled "The Installation Cost of Pipe." Cost analyses of 20 different pipe system installations are printed in this bulletin which contains 32 pages, 8½ in. by 11 in.

Boring, Drilling and Milling Machine.—The Pawling & Harnischfeger Company, Milwaukee, Wis., has issued Bulletin 4F describing and illustrating its new horizontal boring, drilling and milling machine. One of the interesting illustrations included in this bulletin shows how compactly and conveniently all operating levers are concentrated on the saddle.

Tractor Cranes.—The Industrial Works, Bay City, Mich., has issued Catalogue No. 113 illustrating and describing its type BC crawling tractor crane of 20,000 lb. capacity, which is adapted to the needs of road contractors, lumber and coal dealers, gravel, sand and stone producers, foundries, railroad reclamation and storage yards, and moderate-size manufacturing plants.

Turbine Generator Units.—The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has issued Circular 1094-B, describing and illustrating its turbine generator units. Reaction and impulse types of turbines, both the semi-double flow type and the multiple cylinder type, are discussed in this circular. Bleeder turbines and gear turbines are described, and each part of the turbine is given detailed consideration. The generator is also discussed and illustrations are given to show the latest types of construction.

Tube Facts.—The manufacture of condenser tubes at the works of the Scovill Manufacturing Company, Waterbury, Conn., is taken up in detail in a booklet recently issued by this company. Season cracking and corrosion are the two principal causes of failure of condenser tubes. In the Scovill laboratories investigations are being carried on continually to determine and eliminate causes of weakness in the structure of the metal. Modern manufacturing processes to a great extent eliminate many of the defects. Production of seamless tubing by both the drawing and cupping processes is outlined, as well as the production of Scovill Admiralty tubes. Special alloys, as bronze, nickel silver, naval brass, etc., are made into Scovill tubing, as well as the condenser work.

Oil and Stationary Steam Engines.—Two neatly and attractively arranged educational booklets entitled "Oil Engines" and "Stationary Steam Engines," both of which contain numerous illustrations, the principal features of which are brought out in various colors, have recently been issued by the Vacuum Oil Company, New York. In the first booklet the construction and operation of surface ignition oil engines and other data pertaining to classification, field of service, methods of lubrication, etc., are taken up in a thorough and interesting manner. The second booklet on the subject of stationary steam engines is divided into two parts and treats of the classification of reciprocating steam engines, factors of steam engine operation, mechanical principles, lubrication, etc.; also boiler plant and steam production.

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WE GUARANTEE, that of this issue 7,400 copies were printed; that of these 7,400 copies 6,520 were mailed to regular paid subscribers, 9 were provided for counter and news company sales, 220 were mailed to advertisers, 8 were mailed to employees and correspondents, and 743 were provided for new subscriptions, samples, copies lost in the mail and office use: that the total copies printed this year to date were 14,750, an average of 7,375 copies a month.

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EDITORIALS

Inspection of Front Ends

There is one part of the locomotive which usually requires attention out of all proportion to its importance; it is the front end. A great deal of thought has been given to the development of improved spark arresters, nozzles are fitted with care and petticoat pipes are securely braced. Yet in spite of these precautions many railroads find it advisable to inspect the front end at frequent intervals and oftentimes after every trip. The labor cost of loosening from 12 to 24 clamps holding the smokebox door, inspecting the front end and replacing the clamps is a very considerable item. Some roads have adopted improved types of spark arresters and lengthened the period between inspections, but other roads continue the practice of daily inspection regardless of the design of the front end. Possibly this is necessary under certain circumstances to guard against holes in the netting or displacement of draft appliances. If that is the case a new design of fastening for the smokebox door should be adopted. The present type was intended to be a semi-permanent fastening and it would not be difficult to devise an arrangement that would be far more convenient, where the door must be opened frequently.

Innovations in Car Design

One of the most notable developments in the railroad field during the past year has been the remarkable number and variety of new designs of cars that have been introduced. Of these probably the most important is the high-capacity equipment placed in service on the roads that handle coal from the mines to tidewater. The 120-ton cars of the Virginian Railway established a new record for freight equipment in regular service and have demonstrated the efficiency of such large units. By the use of these cars the Virginian has been enabled to increase train loads to as high as 17,250 tons. The 100-ton capacity cars of the Norfolk & Western are likewise noteworthy because of the unique design of six-wheel trucks and the high ratio of load to total weight.

Another radically different type of equipment that promises to effect a considerable saving for the railroads is the container car. Two designs differing somewhat in details are now in use and roads that handle a large amount of l.c.l. freight are experimenting with this system as a means of reducing loss and damage and cutting down the cost of handling package freight.

In passenger equipment the most important development has been in self-propelled cars. A number of automobile manufacturers are now engaged in perfecting small passenger cars propelled by gasolene engines. Recent trials indicate that the cars will be entirely successful for branch line service and will handle the business for a fraction of the cost of the ordinary train hauled by a steam locomotive. Among other notable innovations in passenger equipment brought out during the year may be mentioned tank cars for milk and cable loops for the prevention of telescoping.

This summary indicates that considerable progress has been made during the year, yet Henry Ford has criticized the design of cars quite severely. The only concrete suggestions that he has seen fit to offer thus far are the proposed use of alloy steel to reduce weight and wheels free to turn on the axles to eliminate friction in rounding curves. The railroad world is awaiting with interest the development of the "flivver freight car," as Mr. Ford's proposed design has already been named. Regardless of the success or failure of his design, it must be admitted that Mr. Ford has a clear realization of the possibilities of improved car equipment as a factor in reducing operating costs. The present tendency is toward refinement in car design, and if it continues, equipment built a few years hence will probably be radically different from what is considered standard practice today.

Why Grind Wheel Fits?

The question of grinding driving axle fits in wheel centers has been raised and it may be of advantage to consider some of the reasons why certain railroads follow this practice. The most important reason is that by using grinding machines, wheel fits can be made to within extremely close limits and accurate mounting pressures maintained. Moreover, it is the practice in some shops to grind the journals of new or unmounted axles, and time is saved by grinding the wheed fits at the same setting. Should a wheel-fit become rough in pressing out the axle, or for any other reason, grinding also offers a means of truing the rough parts in the shortest time and with the removal of a minimum amount of metal.

There is no objection to a ground wheel-fit on account of the smooth surfaces. The frictional resistance tending to hold a driving wheel on its axle is dependent far more on the pressure between the two surfaces than on the condition of those surfaces. The idea that a rough fit results in greater holding power is erroneous.

A rough fit is unreliable for either locomotive or car wheels, due to the fact that in mounting the wheel the rough places are ploughed down and the gage does not show accurately the pressure that holds the wheel. If this same wheel is dismounted and applied again there would be a considerable decrease in the tonnage registered. For example, if an 80,000-lb. capacity steel wheel is mounted at a pressure of 65 tons in the first case, the mounting pressure on the second application will be considerably less, possibly 55 or 58 tons, which is below the mounting pressure limit for this class of wheel. In other words, the effect of a rough wheel fit is to show a wheel mounting pressure larger than is really obtained. It follows directly from this that the smoothness, accuracy and close limits of an axle fit, as obtained by grinding, tends to provide a better control of wheel mounting pressures and thus reduce trouble from loose wheels.

Welding Firebox Seams

In comparing the present methods of doing repair work in railroad shops with those which commonly prevailed only a relatively few years ago, one of the most noticeable changes is the rapid extension of welding processes. Considering the large savings in time, labor and material that have been obtained, it is not surprising that it has been advocated and employed in places where its advisability is questionable.

Before undertaking a job of welding, the process to be employed must first be determined. Gas, electric and thermit welding each have distinct fields for which they are best suited, and the limitations of these fields are far better understood today than ever before. After the process has been decided upon, the next thing to be considered is the preparation of the articles to be welded, for the whole process of the welding is often dependent upon the proper preparation before welding itself is started. Following the welding, the internal strains which may have been set up in the work must next be considered and the proper precautions taken to relieve or remove these stresses by after-annealing.

At the present time considerable welding is done in connection with locomotive boiler maintenance work. Much of this has been economical and thoroughly successful. However, the fact must not be overlooked that welding has in a number of cases been followed by serious accidents resulting in loss of life and sometimes in a complete wrecking of the locomotive. There is too much involved when the possibility of a boiler explosion is considered, to warrant taking any unnecessary risks involving its safety. A boiler failure following repairs by welding tends to bring the whole process of welding on boilers into disrepute, although there are places on boilers where welding is a perfectly proper procedure. One safe rule to follow is that recommended by the Bureau of Locomotive Inspection: Never weld around the crown sheet or combustion chamber of the firebox sheets where low water can possibly expose the sheets to steam and thus permit the welded portion to become unduly heated.

The Real Purpose of Shop Schedules

During the early stages of the development of shop scheduling and routing systems for use in railway repair shops, they were usually closely associated with some form of bonus or piece work system of wage payment. It is perhaps not surprising, therefore, that there is an impression in the minds of some railroad officers who were favorably inclined toward shop scheduling prior to the abolition of piece work, that such a system offers no advantages under a straight time basis of compensation, and, indeed, is likely to meet with opposition from the shop crafts as a means of speeding up labor.

No better evidence that these impressions are without foundation could be presented than will be found in the results obtained during the first year's experience with a shop scheduling system at the Milwaukee passenger car shop of the Chicago, Milwaukee & St. Paul, set forth elsewhere in this issue. Prior to the establishment of the shop scheduling system the average output during a period of nearly three years was slightly less than two cars a day. During the first year's operation under the system the output has averaged three cars a day, and less men have been employed than during the former period. The fact that the increased output has been obtained without friction between the management and the shop employees is ample demonstration that shop schedules, rather than being a measure aimed at speeding up the men, is a matter of concern only to the management for reducing the lost motion in the exercise of its own functions.

Indeed, it is reasonable to expect even better results from shop schedules under the hourly rate of wage payment than under piece work or a bonus system. In the latter case the personal interest of each worker in the smooth flow of material and the prevention of delays takes a tremendous load of detail supervision off the shoulders of the foremen, for which they must assume full responsibility under a time basis of wage payment. The shop scheduling system systematizing these details which otherwise would not receive adequate attention, thus preventing delays and assuring that the men are occupied during every hour for which they are paid. It must be remembered that responsibility for loafing by no means always rests with the men.

Some of the better known scheduling systems have been worked out in great detail, not only concerning the operations of the erection floor but following each piece of material through every department of the shop. No doubt these elaborate systems, involving a complete separation of the line and staff functions of shop management, can be justified by the results which they have produced. Nevertheless, the average shop officer cannot be blamed for a feeling of misgiving when suddenly asked to don a garment, ready-made and profusely trimmed with a type of "ginger-bread" entirely foreign to his taste. That the garment itself is of the right quality is demonstrated by the experience of the Milwaukee passenger car shop. How it shall be trimmed may well be left to the decision of those who must wear it.

Turbine Characteristics and Design of Turbo-Locomotives

Those who have been following recent tendencies in European locomotive development have observed an inclination toward the serious consideration of radical changes which would have been passed by as purely visionary but a few years ago. A number of these modifications have not only been propounded but are now being submitted to actual test. Among the most interesting of these is the attempt to utilize the steam turbine. For a number of years the steam turbine has been recognized as the leading prime mover for stationary power plants and more recently has to a large extent supplanted the reciprocating steam engine for marine propulsion. The engineers who have designed the turbine locomotives which already have been built or are under construction at the present time in Sweden, England, Switzerland and Italy appear to have a clear realization of the essential factors and difficulties of the problem.

On account of what is being done in Europe and in view of the fact that the efforts to secure greater economies may soon lead to similar attempts in this country, it will be of interest to note some of the characteristics and limitations of the steam turbine. In the first place the turbine is essentially a high speed machine and in order to show its greatest efficiency the speed at the blades must be maintained within rather narrow limits. The restrictions of space limitations may thus demand a rotative speed of from 3,000 to 5,000 r.p.m. This makes it necessary to introduce a reduction gear between the turbine spindle and the driving wheels of the locomotive. Fortunately decided improvements in high-speed, high-power reduction gears have been made during recent years and with the introduction of double helical gears and improved hobbing machines the gear problem does not appear to be sufficiently serious to prevent their use.

The turbine, unfortunately, has a low starting torque and the usual form is non-reversible. The problem of control consequently involves more than mere reduction gearing. This may require the introduction of some form of variable speed transmission. Reversing may be accomplished by means of the transmission or a separate reversing element may be mounted on the turbine spindle, a practice that is commonly employed in marine turbines.

A comparatively high vacuum is essential for the realization of the full economies to be obtained from the turbine. From 26 in. to 28 in. of vacuum is common in the best stationary and marine practice. Only about half of the work of the turbine is done during the expansion of the steam from boiler pressure to the exhaust pressure of the present reciprocating locomotive engine. The ordinary surface condenser occupies considerable space and requires a large amount of cooling surface as well as a liberal supply of cooling water. The design of a suitable condenser and the handling of the cooling water, including the recooling, which probably will have to be done by air currents, present several real difficulties in securing the necessary capacity. This involves the use of induced or forced draft controlled by a fan.

The turbine characteristics mentioned do not necessarily preclude its use on the locomotive, but they must be recognized and given full consideration in all attempts to work out a practical design of turbine locomotive.

COMMUNICATIONS

Air Openings Through Ashpans and Grates

Chicago, Ill.

To the Editor:

The editorial in the December *Railway Mechanical Engineer* under the caption of "Air Area Through Grates and Ashpans" is timely, as at this particular period many railroads are directing considerable thought toward the modernization of existing power with a view to increasing the overall efficiency.

In the development of an efficient locomotive it is a recognized fact that first consideration must be given to the locomotive boiler and as the firebox in which combustion takes place constitutes the primary factor in boiler efficiency, it follows that the design of the grate on which the fuel is burned is one of the vital points in furnace construction.

During Railroad Administration days the Fuel Conservation Section accumulated considerable data covering current practice on the various railroads throughout the United States insofar as ashpans, grates, front end draft appliances, etc., are concerned. It was found that practically all railroads recognize the necessity of ample air openings through or above the ashpan in order to obtain practically atmospheric pressure underneath the fuel bed under all conditions of locomotive operation and under varying rates of combustion. Undoubtedly, the necessity for and the advantages of ample ashpan air opening was conveyed to the different railroads through their traveling engineers as it was one of the subjects that was repeatedly stressed at several of the Traveling Engineers' conventions. In fact, one member made the assertion, which may be somewhat stretched in facts, that he never realized the advantage of a full air opening under the grates until on one trip he lost the ashpan and the boiler began to steam so freely that it blew up before the pops could relieve it.

While it was found that practically all railroads gave the matter of air openings through the ashpan consideration and endeavored as far as possible to establish a ratio of 14 per cent or more of air opening to total grate area, yet in most cases they stopped with the ashpan. The records show that insofar as air opening through grates is concerned, there was practically no uniformity of practice or design, the ratio of air opening to total grate area ranging from 20 to 50 per cent

It is of course conceded that the design or type of grate must be governed by local conditions; that is, the character and characteristics of the fuel used. Regardless, however, of the type of grate, whether of the box, table or finger type, there should not be such great variation in the amount of air opening through the grate as was found to be the case.

As brought out in your editorial, fuel engineers long ago established the air requirements per pound of fuel in order to obtain perfect combustion. Repeated tests have demonstrated that in practically all instances in locomotive practice, there is a deficiency of oxygen immediately over the fuel bed under the higher rates of combustion. The grates offer the first obstruction toward the inflow of air. The varying thicknesses of the fuel bed and the accumulation of ash on top of the grates offer further restrictions.

The flow of air through any orifice, whether it be through the openings in the grates or the small openings in the fuel bed above the grates, is proportionate to the difference in pressure on either side of the opening. As it is necessary to introduce a given amount of air into a furnace per pound of fuel consumed, it follows that where there are restrictions in the openings, preventing a moderately free flow of air, we must increase the velocity of the air current in order to obtain the same volume in a given time as if no restrictions existed. In locomotive practice this increase in velocity is usually obtained at the expense of locomotive efficiency by increasing the front end vacuum through the reduction in nozzle area.

It is true that in ordinary locomotive operation in American practice where we use an exhaust nozzle of a fixed dimension, the front end draft is automatically increased with the increase in demand on the boiler for steam, yet observation indicates that in the majority of cases this increased demand for steam is anticipated by the firemen who prior to the expected demand increase the thickness of the fuel bed, thus offsetting in a measure the increased flow of air which would be obtained through increased draft.

Investigation of average manual firing practices indicates that the necessity for increasing the depth of the fuel bed is largely brought about through irregular spacing of the air openings through the grates. This irregular spacing has a tendency toward what is termed "pulling holes" in the fire, and the difficulty experienced by the firemen in filling the holes after they are formed leads to heavy firing.

From the above we can therefore draw the following conclusions—Grates should be designed with a view to obtaining an air opening equivalent to at least 50 per cent of the total grate area. The openings should be as nearly uniform in size as possible. A grate with many small openings, provided the sum total of the openings gives an equal area, is preferable to one with fewer but larger openings. The spacing should be uniform throughout. The type of grate should be governed by the fuel characteristics.

A grate designed as outlined will not only overcome in a large measure the "hole pulling" tendency incident to manual firing, but makes an ideal grate in connection with mechanical firing, being suitable for any kind of bituminous coal, i.e., lump, mine run or screenings, as well as lending itself readily to the use of sub-bituminous, semi-lignite or lignite. It also eliminates almost entirely the losses incident to firing up, that obtain with grates of larger and unequal air openings.

The subject is an interesting one and well worth the careful study of all concerned in locomotive design.

F. P. Roesch,
Western Manager, Standard Stoker Company.

New Books

Coal Manual, *F. R. Wadleigh.* 184 *pages,* 4½ *in. by* 6 *in. Published by the National Coal Mining News, Cincinnati, Ohio.*

Numerous books dealing with the subject of fuels and coal have been issued from time to time, but they usually have been written from the technical viewpoint of the engineer or chemist, or to meet the needs of the man in charge of power plants or locomotives. Few books have been available, however, which gave in a concise and accurate manner the general elementary information desired by a large number of men, such as purchasing agents, storekeepers and others who are more or less interested in some phase of the coal question other than that of actual mining. This manual has been prepared by a man who evidently knew his subject and in addition recognized the wants of the men for whom he wrote.

The subject matter has been well arranged and by the use of frequent subheads and an excellent index any information desired can be found readily—features which will increase the usefulness of the book for reference purposes.

Among the subjects covered are: kinds and commercial grades of coal; information in regard to the location of coal fields and the essential differences in the character of coal from various fields and seams; the preparation of coal; coke and gas manufacture; the use of coal in locomotives, stationary boilers and furnaces; storage and prevention of spontaneous combustion; specifications and their use; analyses and effects of various impurities, together with a brief bibliography on the subject of coal.

Report of the Bureau of Locomotive Inspection

Smaller Percentage of Defects—Fewer Accidents—Welding Firebox Crown Sheets Dangerous Practice

THE report of the chief inspector of locomotive boilers to the Interstate Commerce Commission for the fiscal year ending June 30, 1921, shows a decrease in the percentage of locomotive defects and a falling off in the number of accidents. The number of locomotives inspected moreover was larger than in any previous year since the bureau has been in operation. A summary of the report is given below.

Statistics

The tabulations have been arranged so as to permit comparison with previous years, and show the number of locomotives inspected, the number and percentage of those inspected found defective, and the number for which special notice for repairs was issued, withholding the locomotive from service because of having defects constituting violations of the law, together with the number of defects found; also the number of accidents caused by failure from any cause of the locomotive or tender and all parts and appurtenances thereof, together with the number of persons killed and injured as a result of such failure.

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

	1921	1920	1919	1918	1917
Number of locomotives inspected	60,812	49,471	59,772	41,611	47,542
Number found defective	30,207	25,529	34,557	22,196	25,909
Percentage found defective	50	52	58	53	54.5
Number ordered out of service	3,914	3,774	4,433	2,125	3,294
Total defects found	104,848	95,066	135,300	78,277	84,883

NUMBER OF ACCIDENTS, NUMBER KILLED AND NUMBER INJURED AS A RESULT OF FAILURE OF PARTS AND APPURTENANCES OF THE ENTIRE LOCOMOTIVE AND TENDER, BY YEARS

	1921	1920	1919	1918	1917
Number of accidents	735	843	565	641	616
Decrease from previous year (per cent)	12.8	*49.2	11.8	4.1	...
Number killed	64	66	57	46	62
Decrease from previous year (per cent)	3	*15.8	*23.9	25.8	...
Number injured	800	916	647	756	721
Decrease from previous year (per cent)	12.6	*41.6	14.4	4.8	...

*Increase.

NUMBER OF ACCIDENTS, NUMBER KILLED AND NUMBER INJURED AS A RESULT OF THE FAILURE OF SOME PART OR APPURTENANCE OF THE BOILER ONLY FOR THE FISCAL YEARS ENDED JUNE 30, 1912, 1915, 1920 AND 1921

	1921	1920	1915	1912
Number of accidents	342	439	424	856
Number killed	51	48	13	91
Number injured	379	503	467	1,005

DERAILMENTS DUE TO DEFECTS IN OR FAILURE OF SOME PART OF THE LOCOMOTIVE OR TENDER, AND THE NUMBER OF PERSONS KILLED AND INJURED AS A RESULT OF SUCH DERAILMENTS FOR THE FISCAL YEARS ENDED JUNE 30, 1917-1921, INCLUSIVE

	1921	1920	1919	1918	1917
Number of derailments*	8	7	7	2	4
Number killed	.	7	6	.	1
Number injured	30	18	7	2	21

*Only derailments reported by carriers as being caused by defect in or failure of parts of the locomotive or tender were investigated or counted in this tabulation.

A summary of accidents and casualties occurring during the fiscal year ended June 30, 1921, as compared with the year ended June 30, 1920, covering the entire locomotive and tender and their appurtenances, shows a reduction of 12.8 per cent in the number of accidents, 3 per cent in the number killed, and 12.6 per cent in the number injured.

During the first six months of the fiscal year 1921 accidents and casualties occurred at an alarming rate and exceeded those of any like period during the five preceding years. However during the last six months a marked reduction is recorded. The number of accidents and casualties during the year was considerably in excess of those occurring during the year 1919, a large number of accidents

ACCIDENTS AND CASUALTIES RESULTING FROM FAILURES OF LOCOMOTIVES AND TENDERS AND THEIR APPURTENANCES

Part or appurtenance which caused accident	Year ended June 30: 1921			1920			1919		
	Accidents	Killed	Injured	Accidents	Killed	Injured	Accidents	Killed	Injured
Air reservoirs	1	..	1	2	1	2	2	..	2
Aprons	16	..	16	8	..	8	5	..	5
Arch tubes	5	..	5	9	1	15	7	2	9
Ash-pan blowers	5	..	5	6	1	5	11	1	10
Axles	5	..	6	5	..	5	2	..	2
Blow-off cocks	14	..	14	15	..	15	4	..	4
Boiler checks	7	1	7	5	..	6	4	..	4
Boiler explosions	..	..	..	..	..	..	..	..	..
A. Shell explosions	..	..	..	..	..	..	..	..	..
B. Crown sheet; low water; no contributory causes found	20	19	26	24	22	35	31	26	46
C. Crown sheet; low water; contributory causes or defects found	33	24	52	35	19	46	34	13	63
D. Firebox; defective staybolts, crown stays, or sheets	1	2	..	2	..	2	2	..	3
E. Firebox; water foaming	..	..	..	..	..	..	..	..	..
Brakes and brake rigging	6	..	6	3	..	3	8	3	10
Couplers	11	1	13	8	..	8	12	..	14
Crank pins, collars, etc	6	3	8	4	..	4	5	..	6
Crossheads and guides	4	1	4	5	2	3	5	..	5
Cylinder cocks and rigging	4	..	4	..	..	..	2	..	2
Cylinder heads and steam chests	6	..	6	9	..	9	5	..	7
Dome caps	..	..	..	..	..	..	..	..	..
Draft appliances	8	..	9	1	..	1	2	..	4
Draw gear	8	1	8	11	..	9	7	1	6
Fire doors, levers, etc	8	..	8	1	..	11	7	..	7
Flues	32	1	35	45	..	52	33	1	39
Flue pockets	1	1	..	..	..	..	2	..	2
Footboards	8	3	5	23	..	23	7	..	7
Gage cocks	..	..	..	9	1	9	4	..	5
Grease cups	7	..	7	2	..	2	..	..	..
Grate shakers	85	..	85	10	..	10	3	..	3
Handholds	19	..	20	108	..	109	37	1	36
Headlights and brackets	8	2	6	15	1	14	16	1	15
Injectors and connections (not including injector steam pipes)	15	2	13	3	..	27	21	..	22
Injector steam pipes	15	..	17	23	1	29	14	..	20
Lubricators and connections	12	..	12	14	..	15	11	..	13
Lubricator glasses	3	..	3	17	..	17	9	..	9
Patch bolts	..	..	..	..	..	..	..	..	..
Pistons and piston rods	3	..	3	3	1	3	2	..	2
Plugs, arch tube and washout	15	..	18	26	..	40	30	1	34
Plugs in fire box sheets	2	..	2	1	..	2	2	1	1
Reversing gear	65	..	65	59	..	59	31	..	31
Rivets	4	..	5	..	..	..	2	..	2
Rods, main and side	18	..	21	16	2	20	14	..	15
Safety valves	..	..	..	..	..	..	1	..	1
Sanders	..	..	..	1	..	1	..	..	..
Side bearings	..	..	..	..	..	..	1	..	1
Springs and spring rigging	3	..	3	9	2	18	5	2	4
Squirt hose	82	..	82	82	..	82	54	..	54
Staybolts	..	..	..	2	2	1	2	..	2
Steam piping and blowers	9	..	9	13	1	19	8	..	11
Steam valves	11	..	12	17	..	17	9	..	10
Studs	7	..	7	9	..	11	7	..	9
Superheater tubes	1	..	2	4	..	6	1	..	1
Throttle glands	..	..	..	3	..	4	..	..	..
Throttle leaking	3	..	3	1	1	..	1	..	1
Throttle rigging	1	..	1	6	..	6	4	1	7
Trucks, leading, trailing, or tender	6	..	8	1	3	1	2	1	2
Valve gear, eccentrics and rods	10	..	10	6	..	6	9	.	9
Water bars	..	..	..	..	..	..	..	..	..
Water glasses	25	..	25	32	..	32	26	..	26
Water-glass fittings	2	..	2	4	..	4	4	.	4
Wheels	4	1	4	2	1	4	3	.	5
Miscellaneous	91	2	117	87	2	86	35	2	35
Total	735	64	800	843	66	916	565	57	647

resulting in serious injury being caused by the failure of what are frequently termed unimportant parts. For instance, during the year 85 accidents were caused by the failure of some part of the grate-shaking apparatus, 82 by squirt hose, and 65 by some part of the reversing gear, all of which could have been avoided by reasonable care.

There were no authentic records from which comparisons could be made of accidents prior to the enactment of the boiler inspection law. A comparison, however, of the fiscal year ended June 30, 1912, the first year of the law, with the fiscal year 1915, the year in which the law was amended, and 1921, the present year, is of importance, and shows the far-reaching effect of proper inspection and repair, as required by the law and the rules established thereunder.

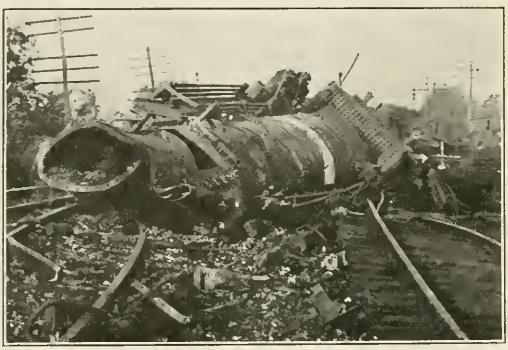
Comparing 1912, covering parts and appurtenances of the boiler only, with the year 1915, the fourth year of the law, there is shown to be a reduction of 50 per cent in the number of accidents, 85.7 per cent in the number killed, and 53.5 per cent in the number injured.

Comparing 1912, with the year 1921, covering parts and appurtenances of the boiler only, there is shown to be a reduction of 60 per cent in the number of accidents, 44 per cent in the number killed and 62 per cent in the number injured.

Comparing 1915, the fourth year of the existence of the law, with the year 1921, there is shown a decrease of 19 per cent in the number of accidents, an increase of 292 per cent in the number killed, and a decrease of 17 per cent in the number injured, due to the failure of some part or appurtenance of the boiler only. Barrel explosions have been entirely eliminated, and while the so-called crown-sheet failures have materially decreased, the great increase in fatalities indicates that the severity of these failures has increased tremendously.

Welded Firebox Sheets

During the year there were a number of accidents investigated in which firebox seams formed by the autogenous welding process were involved, where, through the failure of these seams, it is believed the result of the accident was much more serious than would otherwise have been. Autogenous welding can be used on many parts of the locomotive and tender and on parts of the stayed surfaces of the boiler with safety and economy, but inasmuch as the bureau's accident investigations show that approximately 80 per cent of the autogenously welded seams fail, where they are involved in the accidents, it is believed that such methods should be avoided in firebox crown-sheet seams where overheating and failure are liable to occur, or on any part of the boiler where the strain to which the structure is subjected is not carried by other construction which fully meets with the requirements of the rules, at least until some means has been developed through which the quality and tenacity of the weld may be established in advance of its failure. This should apply on all parts of the locomotive and tender where, through failure, an accident and an injury might result.

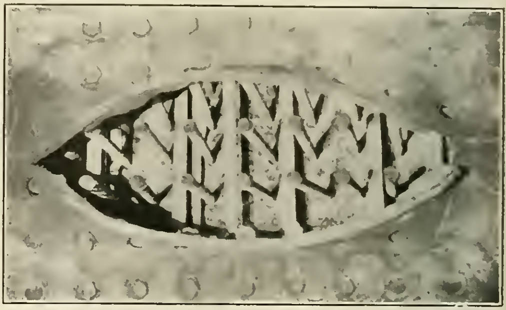


Low Water Caused Crown Sheet Failure and Boiler Explosion

Boiler Explosions

The next portion of the report is devoted to a discussion of the theory of boiler explosions and to what takes place in such occurrences.

The force of a boiler explosion is in proportion to the size and suddenness of the initial rupture and the temperature and volume of the water in the boiler at the time of the rupture. The average modern boiler has a capacity of approximately 500 cu. ft. of water below the crown-sheet and has a steam space of about 150 cu. ft. If such a boiler with 200 lb, pressure ruptures from any cause, so as to suddenly reduce the pressure to that of the atmosphere, the released energy will amount to approximately 700,000,000 ft.-lb. and if the explosion took place in two seconds approximately 690,000 h.p. would be developed.



Crown Sheet Failure Caused by Low Water: Seam Had Been Autogenously Welded

This gives some idea of the force which accompanies many boiler failures, with their serious and fatal results, and supplies the reason for the violence which in many cases is sufficient to hurl the entire boiler several hundred feet.

Explosions result because some part of the vessel is too weak to withstand the pressure to which it is subjected. This weakness may be caused by: 1. Abnormal steam pressure. 2. Weakness in design or construction. 3. Improper workmanship. 4. Corrosion or wasting away of material. 5. Broken or defective stays. 6. Overheated firebox sheets.

A remedy for the first three causes is provided for in the law and rules by requiring that the working pressure be fixed, after consideration of each individual boiler by competent authorities, and by fixing a substantial factor of safety to provide against defects of material and construction.

To protect against failure due to corrosion or other defects caused by wear and usage, the law requires that regular inspections, both interior and exterior, be made and that all boilers be subjected to a hydrostatic test at regular intervals and a sworn report filed showing the conditions found and repairs made.

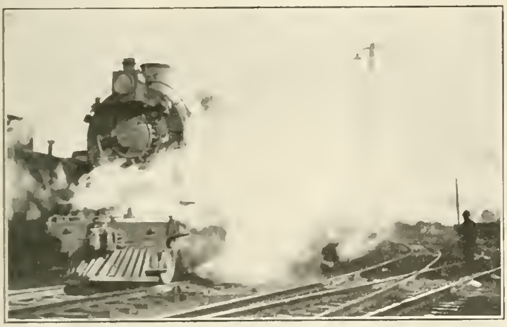
Failure of crown or firebox sheets, due to overheating, may be the result of scale or grease on the firebox sheets or from low water. The firebox sheets and tubes are in contact with the fire, and would become heated to that temperature if it were not for the presence of water in the boiler. As previously explained, the temperature of the water depends on the boiler pressure, but rarely reaches more than 400 deg. F; therefore while the plates are in contact with the water on one side they can not greatly exceed this temperature, although the temperature in the firebox may exceed 2,500 deg., which is about the fusing point of firebox steel.

The heat in the firebox is conducted through the plate to the water in the boiler, where it is absorbed, the sheet thus being prevented from heating to the temperature of the fire and burning gases. If, however, the transmission of the heat to the water is obstructed by scale or grease, or if the water fails to absorb the heat, due to being foamy, the plates will retain the heat, and may become red hot; or if the sheets are unprotected by water from any cause they become overheated. Metal loses strength when heated, and if heated to a high temperature has comparatively little strength to resist the pressure within the boiler, when as a result the sheets are forced off the stays and failure occurs. It is a well-recognized fact that scale or grease may be the direct cause of an explosion. Scale may indirectly cause an explosion by restricting or closing the openings in the water-indicating appliances, thereby causing a false level of water to be registered, deceiving the enginemen.

Water Gages and Glasses

One of the most perplexing problems which has presented itself while operating the modern locomotive is that of securing a correct indication of the height of water over the crown-sheet under all conditions of service.

In the last annual report was included the results of tests made to determine the action of water in the boiler on the water-indicating appliances with respect to their correct registration. These tests established that gage cocks screwed directly in the boiler do not correctly indicate the general



Leaking Badly But Reported Ready for Service: Cylinder Cocks Closed

water level while steam is rapidly escaping from the boiler, and in order to secure a proper appliance it was recommended that a water column to which three gage cocks and one water glass were attached be applied.

As far as the bureau has been able to determine, practically all new locomotives constructed since that report was rendered have had water columns applied. On old locomotives the application has not progressed rapidly, probably due to the difficulty in obtaining necessary appropriations. The necessity for such appliances, however, is practically unquestioned, and some roads are proceeding with the application in a very satisfactory way. It is hoped that in the near future this important appliance will be applied on all locomotives, so that enginemen may have accurate knowledge of the general water level in the boiler under all conditions of service.

Flue Removals

During the year 209 applications were filed for extension of time for the removal of flues, as provided in rule 10. Investigation showed that in 25 of these cases the condition of the locomotives was such that no extension could properly be granted; 22 were in such condition that the full extension requested could not be granted, but an extension for a shorter period within the limits of safety was allowed; 25 extensions were granted after defects disclosed by investigation had been repaired; 38 applications were withdrawn for various reasons; the remaining 99 were granted for the period requested.

Headlights

On July 1, 1920, the rules became effective requiring each locomotive used in road service between sunset and sunrise to be equipped with a headlight which will enable the enginemen to see in a clear atmosphere a dark object as large as a man 800 ft. ahead of the locomotive and that yard locomotives have one light on the front and one on the rear that will enable the enginemen to see 300 ft. ahead of the locomotive. These requirements have been given close attention and have been fully complied with. The lighting equipment with which locomotives are now equipped seems to be meeting with the universal approval of officials and employees required to operate and maintain them.

The fact that not a single formal appeal has been taken from the decision of any inspector during the fiscal year demonstrates that wisdom and good judgment have been exercised by the inspectors in the performance of their duties.

Recommendations

In closing the report the following recommendations were made:

That the act of February 17, 1911, be amended so as to provide for additional inspectors to be appointed by the commission as the needs of the service develop, and that adequate salaries may be paid that will obtain and retain in the service a full corps of well-trained, efficient inspectors, and that the amounts directly appropriated be increased to meet the requirements.

That all locomotives not using oil for fuel have a mechanically operated fire door so constructed that it may be operated by pressure of the foot on a pedal or other suitable device located on the floor of the cab or tender at a proper distance from the fire door, so that it may be conveniently operated by the person firing the locomotive.

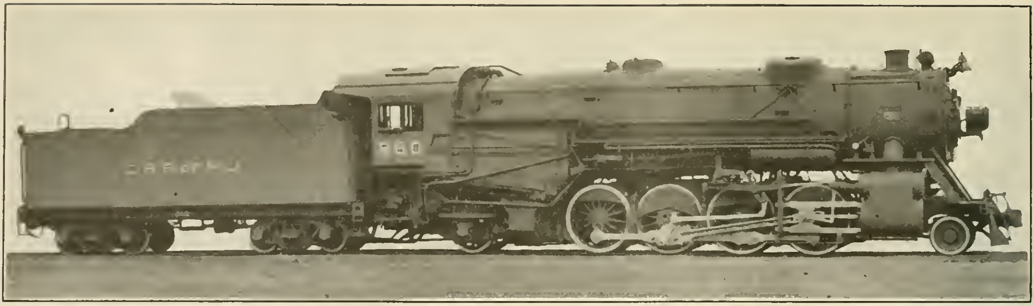
The old swing-type door, which is largely used at present, is almost invariably blown open in case of firebox accidents. The automatic fire door would remain closed if closed when the accidents occur. If open, it would automatically close the moment the operator's foot was removed from the operating device, thus preventing the direct discharge of the scalding water and fire into the cab of the locomotive with such serious results.

The automatic fire door is not a new and untried device, as there are thousands of them in service, and they are required by law in some states. The automatic fire door is also of great value in prevention of serious cracks and leaks in firebox sheets.

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

That cabs of all locomotives not equipped with front door or windows of such size as to permit of easy exit have a suitable stirrup or other step and a horizontal handhold on each side approximately the full length of the cab, which will enable the enginemen to go from the cab to the running board in front of it.

That all locomotives where there is a difference between the readings of the gage cocks and water glass of two or more inches under any condition of service be equipped with a suitable water column, to which shall be attached three gage cocks and one water glass, and one water glass on the left side or back head of the boiler. Investigations have clearly established that gage cocks were screwed directly into the boiler do not correctly register the proper water level over the crown sheet. It is very important that at least two appliances attached separately be employed for this purpose so as to form a double check and so as to have one appliance in case of failure of the other while on the road and away from points where repairs can be made.



Mikado Type for the Central Railroad of New Jersey, Built by the American Locomotive Compan

Rolling Stock Orders Unusually Small in 1921

Decreased Traffic and Idle Equipment Result in Few Domestic Orders; Foreign Purchases Also Small

THE year 1921 was characterized by a falling off in general traffic and consequently by an accumulating number of idle and bad-order locomotives and cars. As a result the orders for all kinds of new equipment were abnormally small.

Locomotives

The orders placed for locomotives for domestic service in the United States in 1921 totaled 239, as compared with 1,998 in 1920. In 1919, the second year of federal control, the locomotives ordered for domestic service in the United States totaled 214; the 1921 figure, poor as it was, luckily succeeded in bettering slightly that ignominious record.

Orders placed by railroads in Canada with Canadian builders totaled 35, as compared with 189 in 1920 and 58 in 1919.

Export locomotive orders for 1921 aggregated 546, inclusive of orders placed by lines in Mexico. This compared with 718 in 1920 and 898 in 1919. The Mexican lines in 1921 placed the largest order for any system in North America, the National Railways of Mexico having ordered a total of 142 locomotives.

TABLE I—ORDERS FOR LOCOMOTIVES SINCE 1901

Domestic orders only

Year	Locomotives	Year	Locomotives
1901	4,340	1908	1,182
1902	4,665	1909	3,350
1903	3,283	1910	3,787
1904	2,538	1911	2,850
1905	6,265	1912	4,515
1906	5,642	1913	3,467
1907	3,482	1914	1,265

Domestic and Foreign

Year	Domestic	Foreign	Total
1915	1,612	850	2,462
1916	2,910	2,983	5,893
1917	2,704	3,438	6,142

Year	Class I railroads	Other American railroads	Domestic industrials	Total domestic	Canadian	For export	Grand total
1918	2,548	7	38	2,593	209	2,086	4,888
1919	....	....	....	214	58	898	1,170
1920	1,668	103	227	1,998	189	718	2,905
1921	190	20	29	239	35	546	830

Production in 1921 totaled 1,121 locomotives for domestic service and 587 for export. The 1,121 although it was several times the number of new locomotives ordered during 1921, was the lowest total the American locomotive manufacturers have experienced for many years. It compared with 1,857 (exclusive of Canada) in 1920. One has to go back to 1897 to find a lower figure than the 1921 performance. A fair number of locomotives were sent to the builders for heavy repairs or rebuilding and this helped the situation to some extent.

During a large part of the year reports showed considerable numbers of serviceable locomotives stored and a high percentage of unserviceable locomotives. On December 1, according to the A. R. A. Car Service Division reports, there were 5,308 serviceable locomotives stored and 12,170, or 18.8 per cent, held for repairs requiring over 24 hours. At various times during the year the "bad order" locomotives approached 20 per cent. It is an interesting fact that this is a matter which received but small attention during the year. The contrast as between the publicity given the bad order car figure and that given the unserviceable locomotive per cent is especially striking. The reason for the failure to pay attention to the locomotive condition situation is quite evident. In a period when expenses had to be cut to the bone, one would hardly have expected the operating officer to overexert himself about his per cent of unserviceable locomotives while he had a sizable number of serviceable locomotives in white lead. It was hardly to be expected either that such a period woud be productive of large orders for new locomotives. However, even at that, the 1921 total

TABLE II—LOCOMOTIVES BUILT IN 1921

	United States	Canada	Total
Domestic	1,121	64	1,185
Foreign	587	51	638
Total	1,708	115	1,823

Comparison with Previous Years

Year	Domestic	Foreign	Total	Year	Domestic	Foreign	Total
1896	866	309	1,175	1908*	1,886	456	2,342
1897	865	386	1,251	1909*	2,596	291	2,887
1898	1,321	554	1,875	1910*	4,441	314	4,755
1899	1,951	514	2,475	1911*	3,143	387	3,530
1900	2,648	505	3,153	1912†	4,403	512	4,915
1901	....	...	3,384	1913†	4,561	771	5,332
1902	....	...	4,070	1914†	1,962	273	2,235
1903	....	...	5,152	1915†	1,250	835	2,085
1904	....	...	3,441	1916†	2,708	1,367	4,075
1905*	4,896	595	5,491	1917†	2,585	2,861	5,446
1906*	6,232	720	6,952	1918†	3,668	2,807	6,475
1907*	6,564	798	7,362	1919†	2,162	1,110	3,272
				1920†	2,022	1,650	3,672

*Includes Canadian output.
†Includes Canadian output and equipment built in railroad shops.

is rather disappointing. One can find consolation at least in the fact that this condition cannot last. The American railroads have got to make up their deferred motive power requirements some time.

With further reference to the domestic orders, the only systems which placed contracts of any size—and even their orders were not large—were the Atchison, Topeka & Santa Fe, the Southern Pacific, the Seaboard Air Line, the Central of New Jersey and the Rock Island. All the additional orders were of small size, being only of from one to eight locomotives. In the small total there is noticeable a comparatively large proportion of Santa Fe and Mountain type locomotives, which is what one would naturally expect. Brick arches and superheaters have now been so generally adopted that it is a rare thing for a new locomotive to be built without them. Stokers and power reverse gears also are usually applied to all heavier power and the past year has evidenced a growing tendency to the more extended use of feedwater heaters and boosters.

The number of locomotives ordered in 1921 for export was small, even if it was double the domestic orders. The largest order, as already noted, was from Mexico—that is, if it is proper to include in the foreign orders, locomotives to be delivered to a road which subscribes to the A. R. A. Code of Interchange Rules, as do the National Railways of Mexico. The other countries which furnish sizable business were Argentina, Chile, China, Brazil and Japan. Much of this business was obtained in spite of the keenest competition, considerable of it from German builders whose quotations were at times below those of the successful American bidder. In such cases the American reputation for prompt deliveries was frequently a deciding factor.

The orders from Argentina were principally from the State Railways. The Japanese business is of interest because Japan has a considerable locomotive production of its own. The Chilean State Railways, which ordered 30 steam locomotives, merit attention because they placed the largest electric locomotive order of the year—35 locomotives for the new electrification out of Santiago.

In looking over the foreign specifications it is evident that the railroads in other countries are appreciating the economic advantages to be obtained from the use of considerably heavier power than that which they have hitherto purchased, although naturally the locomotives are lighter than those used on American roads. It is interesting to note that whereas only one Mallet locomotive was ordered in 1921 by an American railroad, a number were ordered for use in China, these being the heaviest locomotives built for use on any road outside of the United States.

An interesting point in connection with the export trade is the paucity of orders from European countries this year and the absence of Cuba—due to ill-fortunes of the sugar industry—from the list of purchasers. In the foreign field, as well as in the domestic field, the controlling factor was the difficulty, at times insurmountable, of obtaining either the necessary capital or credit. In a number of instances the locomotive builders were obliged to arrange for the necessary financing.

Freight Cars

Freight cars ordered for domestic service in the United States during 1921 totaled 23,346, the lowest for any year on record except 1919. The orders compared with 84,207 in 1920. During the second year of federal control, 1919, practically the only orders placed in North America were those for private car lines and industrials; the total including Canada was 25,899 cars; the 1921 figure succeeded in lowering that unenviable record.

Export orders in 1921 totaled 4,982; this is half the total for 1920, in excess of the figure for 1919, but less than one-tenth the averages for the years 1917 and 1918.

The number of freight cars ordered in 1920 was not large. It did, however, permit the car builders to start 1921 with a fair amount of uncompleted business on their books. The 1921 orders were so few that the year was primarily spent in cleaning up the hold-over 1920 business. The result was minimum production—the totals for the year reaching 40,292 cars built for domestic service and 6,412 for export. For all the fact that the production for freight cars for the past several years has been at a low average, the 1921 total was less than that for any other year for an indefinite period. Fortunately, there was a reasonable amount of work in the form of freight car repairs to alleviate the situation; but it can hardly be said that repair business went very far in that direction.

Table III—Orders for Freight Cars Since 1901

Domestic orders

Year	Freight cars	Year	Freight cars
1901	193,439	1908	62,669
1902	195,248	1909	189,360
1903	108,936	1910	141,024
1904	136,561	1911	133,117
1905	341,315	1912	234,758
1906	310,315	1913	146,732
1907	151,711	1914	80,264

Domestic and foreign

Year	Domestic	Foreign	Total
1915	109,792	18,222	128,014
1916	170,054	35,314	205,368
1917	79,367	53,191	132,558

Year	Class I railroads	Other American railroads	Private car lines and industrials	Total domestic	Canadian	For export	Grand total
1918	101,063	904	12,146	114,113	9,657	53,547	177,317
1919	......	......	......	22,062	3,837	3,994	29,893
1920	51,250	1,044	31,913	84,207	12,406	9,056	105,669
1921	21,003	923	1,420	23,346	30	4,982	28,358

The reason for the small quantity of new orders for domestic service in 1921 is due to several factors—the low net railway operating income; the decreased net ton-miles; the large proportion of idle cars; and the percentage of bad order cars. These factors were more or less interrelated. In a poor year of rather more than ordinary poorness, the existence of any one of them could have been blamed for acting as a drag on freight car business. The combination of them succeeded in making 1921 a record-breaker of the wrong sort.

Table IV—Freight Cars Built in 1921

	United States	Canada	Total
Domestic	40,292	8,404	48,696
Foreign	6,412	745	7,157
	46,704	9,149	55,853

Comparison with Previous Years

Year	Freight: Domestic	Foreign	Total
1899	117,982	1,904	119,886
1900	113,070	2,561	115,631
1901	132,591	4,359	136,950
1902	161,747	2,800	162,599
1903	153,195	1,613	152,801
1904	60,955	1,995	60,806
1905*	162,701	5,305	165,155
1906*	236,451	7,219	240,503
1907*	280,216	9,429	284,188
1908*	75,344	1,211	76,555
1909*	91,077	2,493	93,570
1910*	176,374	4,571	180,945
1911*	68,961	3,200	72,161
1912†	148,357	4,072	152,429

*Includes Canadian output.
†Includes Canadian output and equipment built in company shops.

	United States			Canadian			Grand
	Domestic	Foreign	Total	Domestic	Foreign	Total	Total
1913	176,049	9,618	185,667	22,017	......	22,017	207,684
1914	97,626	462	98,088	6,453	......	6,453	104,451
1915	58,226	11,916	70,142	1,758	2,212	3,970	74,112
1916	111,516	17,905	129,421	......	......	5,580	135,001
1917	115,705	23,938	139,643	3,658	8,100	11,758	151,401
1918	67,063	40,981	108,044	14,704	1,960	16,664	124,708
1919	94,981	61,783	156,764	6,391	30	6,421	163,185
1920	60,955	14,480	75,435	......	......	......	......

The net freight car surplus varied during the year between 68,984 on October 31 to 507,274 on April 8. On December

15 it was 371,044. The year 1921 is the only year on record in which idle cars climbed over the 500,000 mark. The years during which at any time the surplus has gone over even 300,000 are very few. They include 1908, when the highest figure was 413,338; possibly 1914, during a portion of which the total got so large that the compilation of figures was abandoned; in 1915, when 327,084 was reported; and in 1919, when the peak was reached of 448,864.

Large car surpluses and declining totals of net ton-miles are not unusual, such a large percentage of bad order cars, however, was a feature more or less singular to 1921. The bad order cars on January 1 totaled 191,234, or 8.5 per cent. They increased during the early part of the year, until on August 15 they totaled 382,440, or 16.6 per cent. On December 1 this had been reduced to 320,292, or 14 per cent.

Fortunately, the gradually declining percentage of bad order cars indicates an improvement in the situation. In fact, all four of the factors which we blamed for the disappointing 1921 business are, looking at it in the larger way, showing improvement.

Sizable orders were reported in 1921 by but few roads. The Atchison, Topeka & Santa Fe ordered 1,300 gondola and 2,500 refrigerator cars. The Baltimore & Ohio contracted for 3,000 hopper and box car bodies to be used for replacements. The Chicago, Milwaukee & St. Paul placed orders for 2,500 gondola cars. The Lackawanna reported 1,500 hopper and 500 box cars. The Illinois Central secured 1,000 refrigerator cars. Other large orders are reported for the Louisville & Nashville, 2,800 cars, and the Minneapolis, St. Paul & Saulte Ste. Marie, 1,300. The absence of the New York Central and Pennsylvania from the lists is noticeable; these roads, however, received large allocations of U. S. R. A. standard equipment, and the former also placed large orders in 1920.

Another interesting but disappointing factor was the small amount of orders for private car lines and industrials. Canadian orders were likewise conspicuous by their absence.

The export orders for the year were not large. Such business, however, has apparently been brought to a more stable basis than was the case when the larger part of the business was placed by European countries which had car-building plants of their own but which were used for other purposes during the war. The Argentine State Railways purchased 2,000 cars; the Chilean State Railways, 320; China also purchased a fairly large number. The order given a Canadian company for 500 tank cars for the Russian Soviet Government merits more than passing attention. The Chinese orders and those from South America—in the latter case from the state owned railways—prove the contentions made in the recent past that it was among such purchasers that our foreign business was most likely to be found.

Passenger Train Equipment

The passenger cars ordered for service in the United States totaled in 1921 but 246. This is the smallest number in any year on record for at least 20 years, with the exception of the year 1918, when every energy was bent towards war-time activities. Foreign orders in 1921 totaled 155. The figure compares with 38 cars ordered for export in 1920 and 143 in 1919.

The passenger car production, as distinguished from orders, was 1,275, as compared with 1,272 in 1920. Cars built for export totaled only 39.

Although the railroads need passenger cars, they have purchased but few in the last five years in spite of the greatly increased business developed during these years.

The tendency for many years has been towards steel passenger train equipment. The Interstate Commerce Commission in its latest annual report repeats its previous recommendation that the use of steel cars in passenger service be required. The progress in the direction of replacing wooden cars in the past few years has been disappointing. The lack of such progress will only increase the difficulties of the carriers, should the commission's recommendation ever be adopted and put in the form of an act of Congress.

Only two roads placed fair-sized orders for passenger train equipment during 1921. The New York, Ontario & Western ordered 32 cars and the Reading, 50. The latter is expected shortly to order additional cars. The Missouri, Kansas & Texas ordered 54 cars, but 50 of these were express refrigerator cars and are included in the passenger car list only because they will presumably be operated in passenger trains.

Table V—Orders for Passenger Cars Since 1901

Domestic orders only

	Passenger cars		Passenger cars
1901	2,879	1909	4,514
1902	3,459	1910	3,881
1903	2,310	1911	2,623
1904	2,213	1912	3,642
1905	3,289	1913	3,179
1906	3,402	1914	2,002
1907	1,791	1915	3,101
1908	1,319		

Domestic and Foreign

Year	Domestic	Foreign	Total
1916	2,544	109	2,653
1917	1,124	43	1,167

Year	Class I railroads	Other domestic	Total domestic	Canadian	For export	Grand total
1918	5	104	109	22	26	157
1919	....	....	292	347	143	782
1920	1,115	666	1,781	275	38	2.094
1921	207	39	246	91	155	492

Table VI—Passenger Cars Built in 1921

	United States	Canada	Total
Domestic	1,275	361	1,636
Foreign	39	...	39
	1,314	361	1,675

Comparison with Previous Years

Year	Passenger: Domestic	Passenger: Foreign	Passenger: Total
1899	1,201	104	1,305
1900	1,515	121	1,636
1901	1,949	106	2,055
1902	From 1902 to 1907 passenger car figures in these two columns included in corresponding frt. car columns.		1,948
1903			2,007
1904			2,144
1905*			2,551
1906*	....	...	3,167
1907*	....	...	5,457
1908*	1,645	71	1,716
1909*	2,698	151	2,849
1910*	4,136	276	4,412
1911*	3,938	308	4,246
1912†	2,822	238	3,060

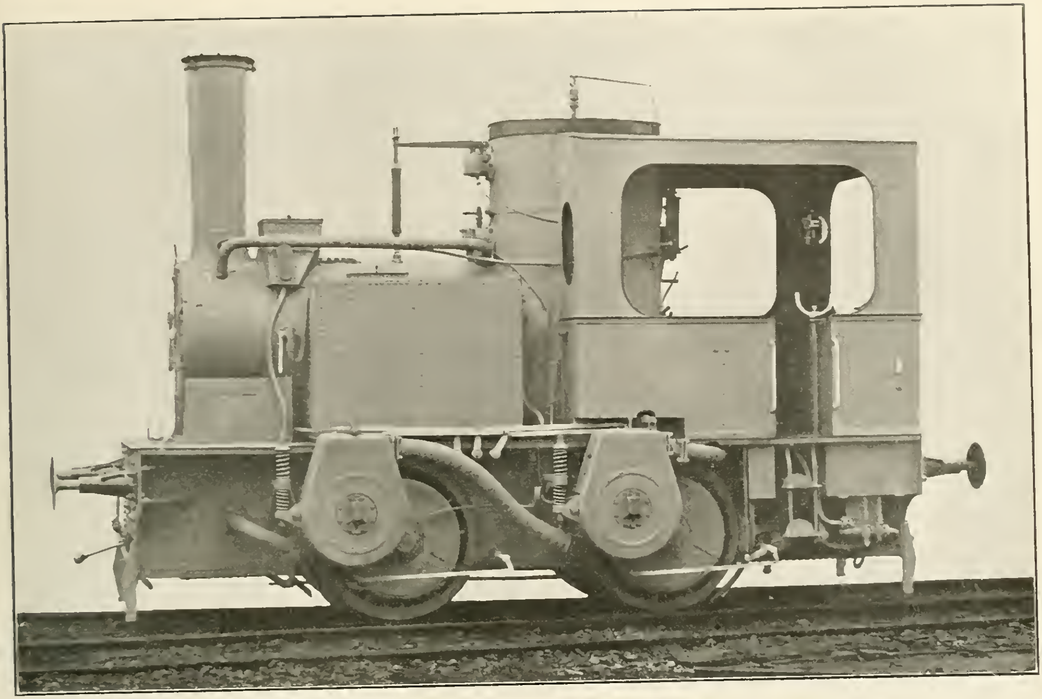
Year	United States: Domestic	United States: Foreign	United States: Total	Canadian: Domestic	Canadian: Foreign	Canadian: Total	Grand Total
1913	2,559	220	2,779	517	....	517	3,296
1914	3,310	56	3,366	325	....	325	3,691
1915	1,852	14	1,866	83	....	83	1,949
1916	1,732	70	1,802	37	....	37	1,839
1917	1,924	31	1,955	45	....	45	2,000
1918	1,480	92	1,572	1	....	1	1,503
1919	306	85	391	160	....	160	551
1920	1,272	168	1,440	....	....	....	....

*Includes Canadian output.

†Includes Canadian output and equipment built in company shops.

South America and China were the largest foreign buyers. The Argentine Government ordered 53, the Chilean State Railways ordered ten, and railways in Colombia, 28. The Tientsin-Pukow of China gave us an order for 45. It is noteworthy that in the case of the Chilean and Tientsin-Pukow cars, all-steel construction was specified.

Of the Total of 1,739 passenger cars owned by the Pacific system of the Southern Pacific, 890 are all-steel, 812 are wood and 37 are of steel underframe construction. The first steel coach, built as an experiment, was completed in the Sacramento shops of the company in 1906, and no wooden passenger cars have been built by the company since 1910.



Italian Locomotive Equipped with Four Turbines

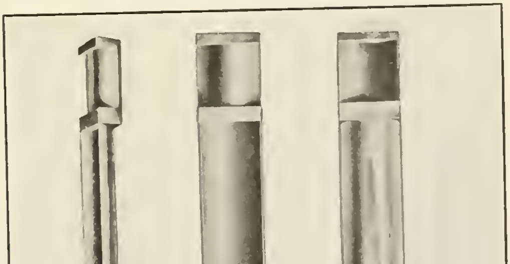
The First Steam Turbine Locomotive

THE first steam turbine locomotive actually constructed was designed in 1907 by Professor Belluzzo of the Ecole Polytechnique, Milan, Italy, and given its initial trial run in 1908 at the works of the Societe Anonyme Officine Meccaniche, Milan.

An old four-wheel standard gage switching locomotive was employed for the purposes of the test, the cylinders and other parts of the reciprocating engine being removed and turbines and necessary control mechanism substituted. This engine had 47¼-in. driving wheels, a wheel base of 6 ft. 6¾ in., a heating surface of 646 sq. ft. and carried a boiler pressure of 145 lb. per sq. in. The weight after conversion was 57,300 lb.

Four turbines were employed, one turbine being geared to each end of the two axles. Steam was admitted from the boiler to the forward turbine on the right hand side, and after passing through this turbine it was further expanded through the rear turbine on the right hand side, then passed to the left hand side of the locomotive, where it expanded through the turbines geared to the rear and front wheels and finally exhausted to the front end and stack. The turbines were spring supported as shown in the illustration and in addition flexible piping was used to connect the turbines. The maximum rotative speed of the turbines was 2,400 r.p.m., which with a gear ratio of 12 to 1 corresponds to a locomotive speed of 28 miles per hour.

As will be noted from the drawing of one of the turbines, it consisted of a steel disc rotor having three sets of blades. Between the rotor blades were two sets of stationary blades and on the inlet side a series of short guide blades which acted as nozzles for directing the steam to the first set of rotating blades. In order that the locomotive might be run in either direction, the blades had the lower portion curved in one direction and the outer portion curved in the opposite

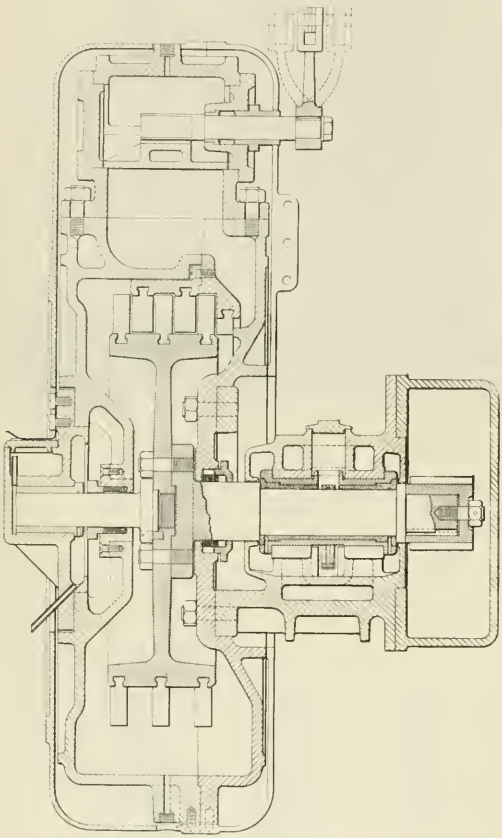


Special Blades for Running Both Forward and Backward

direction, the steam expansion being through the lower portion when the locomotive was going ahead and through the outer portion when it was backing up. An illustration of one of the blades shows the novel arrangement employed.

Each turbine was provided with a steam chest in which three cylindrical distributing valves were fitted. One of the valves furnished steam for running forward at the maximum speed, one for running forward at reduced speed and the third for backing up. The valves on the four turbines were so connected together by rods and levers that each set of four were controlled in unison by a main lever in the cab convenient to the engineman.

All developmental work was necessarily suspended during the war. Although this locomotive was fitted up a number of years ago and tests were not completed or the locomotive placed in regular service, the work which was done is



Sectional View of Turbine

of especial interest at this time in view of the fact that experimental turbine driven locomotives are now in operation in Switzerland and also in Sweden.

This early Italian locomotive has recently been dismantled. However, sufficient information was obtained to induce the builders to bring out a new design for a 1,500 hp. locomotive using superheated steam and an air cooled condenser. The new locomotive is of the Pacific type and it is estimated that the weight will be about 70 tons. Experiments would indicate that the condenser can maintain a vacuum of 28 in. The turbines are rigidly attached to the frames and drive a transverse shaft through double reduction gears. This shaft is provided with cranks from which connections are made to the driving wheels by the usual main and side rods.

The success and economy of the turbine has led to its extensive use during recent years in the stationary and marine fields, this progress being made possible by the improvements in reduction gearing. The steadily increasing cost of fuel, which was already high in many countries, recently has caused a number of engineers to attack the difficult problem of the application of a turbine drive to the steam locomotive. The results of the efforts in this direction will be watched with the greatest interest.

Zoelly Turbine Locomotive for Swiss Federal Railways

THE increasing operating expenses resulting from the rising cost of fuel have given an added importance to locomotive efficiency. Careful study is not only being made of the means for securing an increase in the amount of work obtainable from the fuel used by locomotives of the usual type, but consideration is being given also to the possible substitution of locomotives of a radically different character. The high efficiency of the steam turbine and its rapidly increasing adoption in the stationary and marine fields has caused a number of designers to attack the problem of adapting a steam turbine to the driving of a locomotive.

One of the most notable efforts now being made in this direction is that of Dr. Zoelly, the well-known turbine engineer and general manager of Escher, Wyss and Company, Zurich, Switzerland. A 4-6-0 type locomotive of the Federal Swiss Railways has been converted by the Swiss Locomotive Works at Winterthur from a standard type locomotive with the usual reciprocating steam engine to a turbine-driven engine.

A Zoelly turbine of special reversible type was placed forward of the smokebox, the power being transmitted from the rotor by means of 30 to 1 gearing to a transverse jack shaft above the front truck. The connecting rods were extended forward and coupled to crank pins on discs located on either end of the jack shaft. The turbine was designed for a speed of 8,000 r.p.m. which corresponds to a running speed of 48½ m.p.h.

The boiler is provided with a superheater and a condenser is located between the frames The cooling water is taken from the tender and after passing through the condenser is returned to a longitudinal pipe underneath an elevated hood built over the tender, from which it is sprayed in narrow streams. The air currents formed by the moving locomotive furnish an effective means of recooling the water.

The condensate, which is pure and free from oil, is pumped back into the boiler, it being necessary to add only sufficient fresh water to make up for the losses from the safety valves, whistle and leakage. By continually using the condensed water for feeding the boiler, the formation of scale is practically eliminated. The condensate which is at a temperature of about 125 deg. F. is passed through a preheater and raised to about 250 deg. F. before it goes into the boiler.

As there is no exhaust pipe a blower is used to furnish the necessary draft. The control is by means of three valves, one for the ordinary forward operation, another for starting and for heavy pulls on grades and a third for running backward. The water capacity of the tender is comparatively small as the evaporation of the water while being cooled is only a small loss.

The trial runs which have thus far been made are reported to have shown a saving of some 25 per cent over similar compound locomotives handling the same trains. It is also reported that the running was remarkably smooth, due doubtless to the absence of reciprocating parts. The results of these experiments as well as those now being made by others in Sweden and other European countries will be watched with interest by American engineers.

Essentials of Progressive Motive Power Policy*

Recent Improvements in Locomotives Afford Opportunities for Reducing Transportation Costs

By G. M. Basford

LOOK back a bit. Only a short time ago—only a lifetime—people were 20 days on the road from New York to Buffalo if lucky, if wheels lasted and oxen or horses did not break legs and if food held out. It is different today, when a few hours of luxurious comfort brings us over these few miles with speed and security.

But I am going to say that we do not use our transportation blessings as well as those pioneers used theirs. We have the wonderful steam locomotive. It was here when those pioneers really began to build our great West. But now we have a new steam locomotive. It has been made new in our time, but we are not taking advantage of it. From an efficiency and economy standpoint the new one is as far ahead of that of 1835 as the one of that date was ahead of oxen and horses. If this appears to you to be an exaggeration you must lose no time to learn what has happened in our generation.

Those pioneers had "engine failures" with their Prairie Schooners; they were family tragedies. We have them now. We should not. The Prairie Schooner was not "bought on price." Quality and performance was the thing. When you place performance ahead of price you may have locomotives that will save the railroads.

How often important contributions to the solution of problems, if not the actual solutions, lie so near us that they are overlooked. How often we seek a panacea when what we need is something we already have but do not appreciate! Of this there is no better example than that of the steam locomotive of this wonderful, resourceful country. One of our most vital needs today is the application of good American common sense in allowing the locomotive to play the part it is completely ready to play in the reduction of the cost of transportation, providing we establish suitable locomotive policies.

With respect to the locomotive "policy" means a charted course using all established and safe aids to bring the craft to its logical destination. That destination is "the most tons moved for the least money." After "policy" there must be a plan based upon the fundamental principles of the policy and then a program to execute the plan.

Engineering Improvements Should Be Utilized to Cut Costs

No matter what else we do ours will be a sorry sort of railroading if we fail to find in the treasurer's office the results of the efforts of those who have spent the past 20 years in showing how to increase locomotive power per pound of metal and per pound of coal and who have proven their ability to do it. I say 20 years but it is more than 30 years since this work began. Some of the men who inaugurated this development builded better than they knew. I am thinking particularly of David L. Barnes, George S. Strong, M. N. Forney and H. F. Shaw.

They have many able successors who have worked with factors unknown or undeveloped in the days of engineers who lived a generation ahead of the rest of us and two generations ahead of their own contemporaries. These successors have produced big powerful locomotives, both freight and passenger, that surpass the highest flights of imagination of the men mentioned. For example, a passenger locomotive that will produce at the rate of a cylinder horse power per hour from 16.5 lb. of water and 2.20 lb. of coal and that weighs 121 lb. per cylinder horse power. This was done ten years ago. Lots of engines have been built since that time that cannot do as well. Another example is a magnificent big freight engine with 90,000 lb. tractive effort that will produce one cylinder horse power from 15.4 lb. of water and 2.00 lb. of coal and that weighs 90 lb. per cylinder horse power. This has been done. Do those to whom they mean most know these facts? Do they make full use of them? These are isolated cases showing possibilities, but current practice is far behind them. Every new engine on every railroad ought to be designed and built to equal and surpass the records just referred to.

It is most important to all of us to know the reason why the locomotive on most of our railroads falls so far short of what it may be, should be and must be if American railroads are to "make good" in the present emergency.

Locomotive Improvements Have Far Reaching Effects

Right now railroad officials are striving to increase efficiency and reduce cost as they never did before. Results in car loading and train loading have been great. But no matter what else is done to increase efficiency and reduce cost, bear in mind that improvement of the locomotive augments the effect of every other improvement that can be made. Everything done to make an engine pull more tons per ton of its own weight and per pound of fuel burned helps everything else you do to improve the efficiency of transportation. These facts are not as prominent in the minds of operating officials and of executives as they should be. Why? The locomotive today at its best is not understood by those officials as it should be. Why? Locomotives in everyday service may be made to produce at the rate of less than three pounds of coal per indicated horsepower. Why are so few of them doing this? Can they be made to do it? By co-operation, yes!

Motive power matters must be presented, discussed and decided on a new and appropriate basis. A man of wide experience has said "Whatever the locomotive can do, the railroad can do." As the business of the road is moving trains, that business will be most successful when the mover of trains, the locomotive, is what it should be, is designed, built, operated and maintained to the best advantage.

One of our difficulties is that we are so close to the locomotive as to tend to regard it as we always have regarded it—as a machine that we know all about. We did know all about it as it was in our boyhood but unless we have kept step with the improvements of recent years in locomotive matters we are far behind the times.

We are slow in taking advantage of money making improvements. Forney used to say "The human mind resents the intrusion of a new idea." This is true. The slow progress of locomotive improvements in this country proves that he was right. Europe and Canada led us in the introduction of the greatest improvement that the locomotive ever enjoyed. Europe has 14,000 applications of another improvement that is only just starting in this country, and what country needs these things more than we do?

We need to bring our locomotive problem to the front. We need to elevate it to its proper place in railroading. We need

* A paper presented before the Central Railway Club, January 12, 1922.

to give it the attention it deserves. We need to discuss it and decide the questions it presents by and with men who know and who should and must be heard. Let me ask a few simple but important policy questions that call for answer on every railroad, that are being answered in part by some roads but not as a whole by any road.

Pertinent Questions Concerning Motive Power Policy

What is your policy with respect to locomotive improvements, those factors that collectively give you, according to speeds, from 30 to 80 per cent more power per pound of fuel than you can get from a plain engine? What are you doing about these things when you order new engines and what are you doing about applying them to old ones?

What is your policy with respect to locomotives that for the next 20 or 30 years will be in these services: heavy freight, fast freight, way freight, fast passenger, slower passenger, branch line passenger and freight, yard switching, transfer?

What is your policy and plan with respect to the design of new engines for these widely varying duties? Who decides their earning ability for their working life of 20 or 30 years?

What is your policy with respect to assignment of locomotive power to meet varying conditions of traffic, seasonal or emergency conditions? If this is not done by those who ought to know most about power matters there must be a reason for it.

How do you know just how many new engines to order and what type and capacity to order? Is there a plan for this that looks ahead to that which is coming and is framed on experience of the past?

How do you know that the latest new engines are making good? Do you test them and keep records to show whether your locomotive engineering policy is correct and whether you are making the money from your new engines that you ought to make?

What is your attitude toward locomotive improvements as to application to older engines? Are the applications scheduled after careful, complete surveys of the power and are the improvements applied by program, systematically? Then do you organize to educate the men in the best use of the modernized engines to get the utmost returns for the investment? When you apply a locomotive improvement that is good for 25 per cent greater economy are you sure that you get that economy?

What is your policy with respect to scrapping old power and also obsolete shop machinery? Is it done systematically to take advantage of improvements as Andrew Carnegie did? Did it pay Carnegie to do it?

Do you have and follow an engineering or business policy with respect to your locomotives as a manufacturer does with respect to his investment in his expensive machinery?

How do you know that the enormous investment in locomotives themselves and in the facilities for repairing them are employed to the best advantage? Do you, as one railroad official does, hire a man, a specialist, to organize the use of every locomotive item on which he spends $100,000 a year or more?

Do you know that the mileage engines are making is what it should be and may be? Are you hampering operations by the old time idea that each division is a separate railroad? A passenger engine recently made a run of 1,000 continuous miles without uncoupling from the train. Regular continuous runs of 400 to 600 miles are being made. Are your engines making above the average of 60 miles per day? Herein lies a gold mine.

Are you sure that shops, shop equipment, locomotive terminals and terminal equipment are adequate to get the power back into service promptly and keep it in service continuously until time for the next shopping?

Do you know whether the internal friction of the 2-10-2 type locomotive is greater than the formulæ of the locomotive designers indicate?

Do you know that new locomotives can be built with improvements in design that will permit of safely deferring increases in weight of rail and strength of bridges for years to come?

Are you aware of the fact that the biggest, most powerful passenger engines in the country can be replaced by others that will stress the track and bridges less than the present engines and yet give enough increase in pulling power to reduce double heading and that improved engines will start and pull heavier trains than have ever been put behind any engine yet constructed? I refer to usual main line traffic.

What policy are you following with respect to signaling in relation to locomotive improvements that permit of more rapid acceleration in starting out of sidings, out of yards and across crossovers? The entire question of block signaling, siding locations and location of water and coal stations is opened up anew by the ability to accelerate trains faster and to make longer runs for coal and water. Our railroads were built for the saturated steam locomotive without the vitalizing factors of today. Is your road coming up to date in its use of these epoch making operating factors? If you consider these as mechanical matters and if you regard signaling as a safety measure alone you are missing something. Operating officers —ask signal engineers and mechanical officials to help you operate the road. They are in position to help as they never have been before.

Do you establish a definite plan covering the next three or five years with respect to your locomotive program? Do you keep in mind the fact that new locomotives will last 25 or 30 years and that your record of intelligent grasp of railroading is to be read by others after you are gone?

In the matter of water stops—have you thought of the effect on operating cost of the capacity of tender tanks on freight engines? Do you realize that applying new design tender tanks carrying 15,000 gallons of water would beyond question save more money in direct operating results on some railroads than anything of equal cost that you can do to a freight engine on congested track today with the possible exception of the application of a booster?

Of all these questions the most important today in long range results are the ones that involve the locomotive in its relation to track and bridges and the locomotive in its relation to the use of fuel, but all of these items are important. They are not referred to critically but constructively. There is a way to answer all of them. Some of them already have been answered on some roads. There are men who know the answers. The thing to do is to make it easier for these men to be heard.

Improved Locomotives Demand Changes in Operating Methods

Our railroads were built for the locomotive of the past. They were and are operated in accordance with the locomotive of the past. But the locomotive has changed faster than the methods of using it. A new, refined, efficient power plant is available to take the place of the one that was merely big and heavy. Those who operate our railroads must learn what has happened. For their own sake, the sake of the properties and of the people they serve they must take advantage of the locomotive as it may be, not as it is, to solve the greatest problem they ever faced.

Mechanical men must prepare the case of the improved locomotive and that of the refined locomotive that is ready but has not yet been built. They must be ready to recommend improvements on the new basis—that of their effect on operation and operating costs. They must be ready to present the possibilities of the new locomotive in helping solve track and operating problems. This is merely a matter of preparing for presentation facts that they know thoroughly, but have not been encouraged to present. Mechanical men—perhaps a change in status of the locomotive is coming. Be prepared. Your part in it is vital. Your preparation for it will hasten the change.

Then a way to insure not only the presentation but consideration, discussion and decision of the power problem must be found. The locomotive must be viewed from a new angle. We have been deficient in our conception of it, and of its proper place in operation of the road and in the transportation of the country. Some of us have considered it from the standpoint of a mere pulling unit, not thinking deeply as to anything but drawbar pull. Some regard it merely as a machine that they must take care of and have ready for call. Others have considered it from the standpoint of a power plant very much like any other power plant, as a unit by itself, built and therefore fixed as to improvements. To others the first expense involved seems to be most important. Some look at the expense of maintenance, and these are prone to regard the bookkeeping of the locomotive as satisfactory without a real bookkeeping balance that shows maintenance in terms of the tons the engine hauls. Its effect on track and bridges is the vital matter in the minds of others.

Many Cost Factors Affect Locomotive Policies

We must get people together to talk these things over and show that not one of these opinions taken alone is correct. When engines were small, rates high and wages low these various points of view were natural and were not dangerous, they are nothing less than dangerous now. We must wake up to the great necessity of a locomotive policy that will bring all views into line to permit the use of the best possible transportation machines, because the locomotive pulls everything that goes over the railroad. It must be designed, operated and maintained in accordance with broader business, engineering principles in view of the requirements and the known possibilities of achievement.

Coal formerly cost 90 cents and now costs $4.00. Rails formerly cost $21.00 per ton and recently $47.00 was the price. An engine "simple as a grindstone" is a mighty expensive article to operate today but thousands of them are running that may and should be made efficient by improvements that everybody knows about and everybody accepts as satisfactory. Why don't we use these to the limit?

These improvements have revolutionized the locomotive art. They will revolutionize locomotive operation. Let us hasten the day when the locomotive is considered as a real part of the great transportation machine. It is a big part of the transportation machine. Above all other things every part of a machine must fit each other part. Otherwise a machine is impossible. The locomotive must fit track, tunnels, terminals and other factors, the least change in which means prohibitive cost where bigness and weight and the increased power that go therewith must give place to improvements and refinement that render greater weights unnecessary. It is time to disregard first cost and think of ultimate cost, to forget the limitations of the past and to build anew for the future. It is time to build every new engine on a new plan—to build it for high power with efficiency. Nothing that is known to be worth while and that increases real efficiency should be omitted from a new engine.

An improvement costing $10,000 to buy and even as much as that to maintain each year is a good investment if it nets a saving of $50,000.00 a year. You know what it costs. You do not know what it saves. It is good policy to double the first cost and the cost of maintenance if thereby locomotives will haul enough more tons or make enough more miles to show figures on the right side. This is one way to cut out red figures. How really absurd it is to live as we do in "comparative" figures instead of in constructive figures.

How Shall Recent Improvements Be Utilized?

In its 50,000th locomotive the American Locomotive Company in 1911, over ten years ago, set a pace for Pacific type passenger engines. That engine has proved the success of careful design, use of improvements then available and incidentally of cast steel cylinders and light parts that saved nearly nine tons of weight. But this engine, today among the very best of its class, can be given 25 per cent more power in starting and at high speeds without excessive weight addition.

In its class I1s the Pennsylvania Railroad set a pace for heavy freight engines. Those railroads which have applied capacity increasing factors to their older engines have set a swift pace toward reducing the cost of pulling trains.

How shall the improvements that rendered these two efficient designs possible and also vitalized so many older engines be used to bring the locomotive to "its own" in the possibilities of the future?

To answer—Put the officials who know most about these matters, those who are closest to their progress, those who know most about the difference between the best locomotives of today and those of only a few years ago, put them in position to be heard. Let them understand that they will be heard and tell them to prepare their case accordingly. Today they are on the defensive. Change their status. Let the operating officers who depend upon the roadway and the power, present their problems that relate to both of these factors and then the great operating factors—power, signaling and operation—may be considered as a whole. Nothing new is needed, but a new way of tying these together is imperative.

Power matters are not the only ones that call for new methods. Operating, purchasing, mechanical, accounting, legal, traffic, track and personnel questions, all would benefit by a new deal in organization. If each of these broad divisions of policy on a large road were presided over by a vice president, if these vice presidents or on a small road the equivalent worked regularly and consistently together as a cabinet of highly trained specialists, if every important matter affecting operation were discussed by all these men—leaving to a senior vice president final decision, the thing now lacking would be supplied. The cabinet form of working together is the essential thing.

For example—one official is convinced that heavier rail sections are needed, or that certain bridges need reinforcement. He is probably of the opinion that locomotives will become heavier and heavier and that he must keep pace with the increase in weight. The officer in charge of power will show that for the immediate future increase in locomotive weight is not necessary, in fact, is wrong, and that he can build new engines more powerful but lighter and less destructive to the track than present ones. Operating men want more drawbar pull. To appreciate the possibilities of more power without excessive weight they should take part in discussions that reveal these possibilities. Some officers believe that with a certain amount of money to spend, the largest possible number of new engines should be bought. They may be shown that a smaller number of more efficient engines is the better and financially safer plan. Some officers find it difficult to see the necessity for investing liberally in shop tools, labor saving cranes and hoists, in ash pits and coal handling equipment. They would be quick to see the need and would give their support if they were shown how these factors affect operation. No officer considers first cost when "safety" is at stake. No officer would consider first cost as the real cost if he was a member of the cabinet, whose deliberations formed the basis for the broad policies for the future.

Factors That Will Improve the Economy of Locomotives

To be specific here are some of the factors that will come into the plan that a policy will compel:

Improved cylinder operation, higher superheat and improvements in cut off such as cut off control. Ask the officials of the Big Four about their cut off control as a factor in operation and in saving. Are we to wait years before getting the benefit of what they have done? Why not get it now when we need it most?

Increased boiler efficiency through feed water heating using waste heat and by improvements that compel greater boiler power through improved boiler circulation.

Increased starting power by means of the booster applied to trailing wheels.

Increased starting power and higher power at speeds by means of increased weights on drivers made possible by reduced dynamic augment. Alloy steel parts and refined design render this improvement available.

Improved conditions of combustion by application of the latest developments of the locomotive firebox as a furnace. This means improved fireboxes, more extended use of firebrick arches and mechanical stokers.

Weight per cylinder horsepower may be materially reduced by locomotive designers who are given the order to do their best in this direction. Up to this time they have never had a chance to show what they can do. They have much to offer.

The time has come for these refinements and for many others that are very important but which are not specifically mentioned for lack of space. The time has come for the "free hand" to bring prevailing locomotive practice up to the economically high plane that a few isolated cases have shown to be easily attained.

Savings Will Justify Increased First Cost

The able engineers of the electrical companies long ago learned that the electric locomotive required facilities for its operation and its maintenance that however needed had never been given to the steam locomotive. They spoke. Operating officers and executives listened. They listened because electrification was new, interesting and mysterious. Furthermore, the necessary words had power behind them to compel attention. When trains were stopped by fuses blowing, the fuses being located in a signal tower with no night attendant, the president of the electric company called the president of the railroad on the phone next morning and the thing was fixed. Does the steam locomotive have such attention?

At present the electrical people are making good use of the prevailing oversight of the possibilities of steam. Is this to continue? Is the country to pay the price of this oversight? Are the electrical propagandists to be allowed to get away with even misrepresentations of the efficiency of the steam locomotive?

Consider the high regard in which marine men and manufacturers hold their power plants. They know their dependence upon the power that drives their business. They understand that the power plant that is driving all the time or most of the time must be of the highest type and the most economical, that it is a big investment and must be used accordingly, that ultimate cost, not first cost, is the real cost.

Recent years have brought to the steam locomotive improvements that are comparable with those in marine and stationary development. Marine and manufacturing operations have been rebuilt because of power plant and power distribution improvements. New operating methods must come as a result of the locomotive improvements we are talking about.

It remains to do on railroads the thing manufacturers have done—to build better locomotives, improve old ones and to operate them according to the new conditions these improvements themselves have created. In short, to save fuel and lots of money.

Our locomotive builders are the best in the world. They are building and will build what you want. Why not wake up to what you need and get it? Not only our builders but the concerns that have developed locomotive improvements that are so important have engineers at home and abroad preparing the best, the latest, and more than that, the practical plans needed for the future. One of the builders sent its highest engineering authority to Europe where he spent more than a year in the study of locomotive design and operation under high priced fuel conditions. Then he designed No. 50000, which ten years ago was a milestone in locomotive progress and for ten years has been a leader in locomotive practice in several ways. But nobody wanted it. That cornerstone has been allowed to be obscured by bushes. Other cornerstones have been laid. Are they to go the same way?

Let it no longer be said with truth that there is not a single steam locomotive today on the rails of our country that embodies and represents the best, and all the best locomotive improvements that are available and that have proved their ability to reduce the cost of American railroad operation, of which we are so proud.

Its expense is the most prominent feature of the locomotive. The cost of everything about it is the thing that counts. This is the reason why it is impossible today to build the most economical engine. Of course it costs more to build and to maintain an economical machine than a crude or wasteful one. But cost is only one side of the question. The performance is the real side. Ton miles per locomotive dollar is wanted and no one is getting that figure. "What does it cost?" is the question asked. Change this question. Ask—"What will it do?"

If I were a railroad man I would put on my engines every single improvement I could find that would net a clear 25 per cent on the investment, and there are lots of them that I believe will double that return. Then I would make sure that all concerned understood the construction, maintenance and operation of the locomotive under the new conditions. Next I would see that the improved locomotive was loaded up to and operated to the limit of its economy and saving capacity. Remember that locomotive improvements give the best returns the harder they are worked. I would ask the operating officer how fast he wanted to go and then tell him how much load to give the engine. It would be all the engine could handle in order to pile up ton miles per ton of coal.

Supervision Needed to Get Results

This improved locomotive is different from the old "plain" ones. It will do more work or it will save fuel. To get these results requires more care, better handling by enginemen, better supervision and better operation. A few active young men could accomplish all this on any railroad and make every trip an engine runs a fuel test.

Talking "costs" without considering performance is a monumental mistake. It is my opinion that if the performance, in capacity and economy, of locomotive improvements were known, if individual locomotive fuel records were kept in parallel with ton-mile records, also for individual engines, the entire railroad organization would see a great light. "Acres of diamonds" lie at your feet.

Latent, potent, completely developed and successful but too little understood possibilities for the solution of one of our great problems lie at our very feet. To solve the problem of more tons moved for less money a policy is called for. Then there is no escape from the necessity for a plan followed by a program for its execution.

Cracks in Aluminum Castings.—In concluding a paper on Cracks in Aluminium Alloy Castings, R. J. Anderson, of Pittsburgh, Pa., says that the melting temperatures should be low; overheating in the furnace should be avoided. Open-flame furnaces should be run with a non-oxidizing atmosphere in order to avoid the formation of much aluminum oxide, and consequently occluded dross in the alloy. Skimming should be adequately and carefully done and the melting practice should be conducted as cleanly as possible. Foundry floor sweepings should not be charged into the furnaces unless sieved, and foreign materials should be kept out of the furnace charges. The pouring temperatures should be as low as is consistent with filling the mould readily with metal; high pouring temperatures should be avoided.

150-Ton Shay Geared Locomotive for the Greenbriar, Cheat & Elk

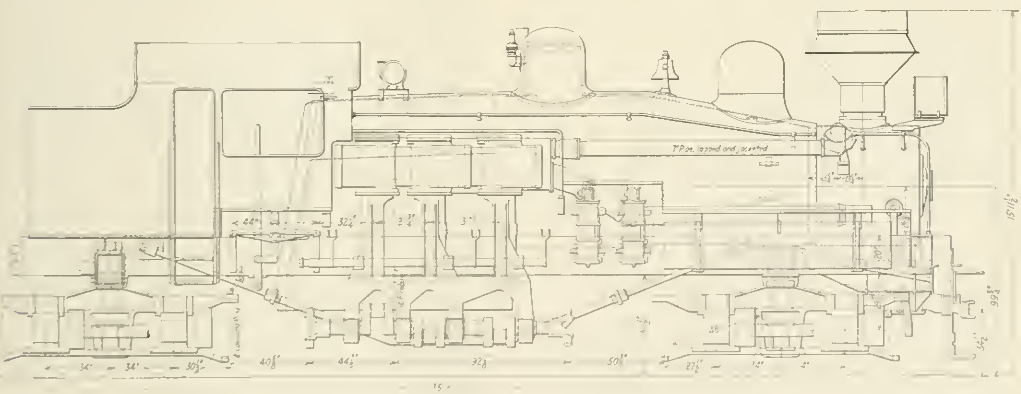
Shay Geared Locomotives for Mountain Roads

150-Ton Shay for Greenbriar, Cheat & Elk—High Sustained Tractive Effort Compared with Mikados

SHAY GEARED locomotives are frequently used on private railroads in rough country, for which service they are particularly suited. The entire weight of the engine and tender being utilized for adhesion, the locomotives are adapted for climbing steep grades at relatively low speeds, while the arrangement of trucks and flexible couplings in the driving shaft provides a short rigid wheelbase, which enables the locomotive to round sharp curves. Furthermore, the distribution of weights makes it possible to operate the locomotive satisfactorily on lighter rails and poorer track than would be possible with locomotives of the usual type.

The Greenbriar, Cheat & Elk Railroad operates between Cass and Elk, W. Va. The country through which the railroad runs is very mountainous and the use of many switchbacks is required to get over the mountains. There is practically no level or tangent track in the 115 miles operated either in the 85 miles of line or in the spurs. The grades are heavy and in many places are as much as seven per cent combined with 32 deg. curves. This combination of grade and curve makes it necessary to have a locomotive of high tractive effort, and at the same time with a very flexible wheelbase.

The freight hauled consists principally of logs, lumber, pulpwood and coal. These products are brought out over this line to the main line railroads for distribution to various points. The cars used are the standard flat or gondola types now in general use on main line roads. The road is laid with 85 lb. and 100 lb. rails, which allow the use of heavy axle loads in providing the necessary motive power.



Side Elevation of 150-Ton Shay Geared Locomotive

To meet the requirements of the freight traffic the Lima Locomotive Works, Inc., in conjunction with the officers of the railroad company, designed and built a 150-ton locomotive of the Shay geared three-truck type with a gear ratio of 1 to 2.45. This locomotive has been in service for several months hauling freight satisfactorily.

A comparison between the 150 ton Shay used on the Greenbriar, Cheat & Elk and the U. S. R. A. heavy Mikado is exceedingly interesting. Table 1 shows the general weights and dimensions of the two locomotives, both of which have practically the same rated tractive effort. The total weight of the Shay locomotive, including tender, is 308,000 lbs., all of which is used for adhesion. The locomotive alone of the U. S. R. A. heavy Mikado weighs 325,000 lbs., of which 240,000 lbs. is used for adhesion and 85,000 lbs. is dead weight. The tender weighs 172,000 lbs. in addition, which brings the total weight of the locomotive and tender up to 497,000 lbs. This, possibly, is hardly a fair comparative weight as the capacity of the tender on the Shay locomotive is only about 60 per cent as much as that of the Mikado but in this connection it must be borne in mind

TABLE 1—COMPARATIVE WEIGHTS AND DIMENSIONS OF 150-TON SHAY AND U. S. R. A. HEAVY MIKADO

	U.S.R.A. Heavy Mikado	150-Ton Shay
Tractive effort (85 per cent)	60,000 lb.	59,740 lb.
Cylinders, number	2	3
Cylinders, diameter and stroke	27 in. by 32 in.	17 in. by 18 in.
Weights in working order:		
On drivers	240,000 lb.	308,000 lb.
On front truck	28,000 lb.	....
On trailing truck	57,000 lb.	....
Tender	172,000 lb.	....
Total dead weight	257,000 lb.	....
Total engine and tender	497,000 lb.	308,000 lb.
Maximum weight per axle	61,000 lb.	51,350 lb.
Wheel base, driving	16 ft. 9 in.	49 ft. 0 in.
Rigid	16 ft. 9 in.	5 ft. 8 in.
Total engine	36 ft. 1 in.	35 ft. 2 in.
Total engine and tender	71 ft. 9½ in.	49 ft. 0 in.
Driving wheels, diameter	63 in.	48 in.
Boiler, style	Con. Wagon Top.	Ext. Wagon Top
Diameter, outside first ring	86 in.	62⅜ in.
Steam pressure	190 lb.	200 lb.
Firebox, length and width	120⅛ in. by 84¼ in.	114 in. by 61¼ in.
Grate area	70.8 sq. ft.	48.5 sq. ft.
Tubes, number and diameter	247, 2¼ in.	166, 2 in.
Flues, number and diameter	45, 5½ in.	26, 5⅜ in.
Tubes and flues, length	19 ft.	13 ft. 6 in.
Heating surface, firebox, including arch tubes	319 sq. ft.	226 sq. ft.
Heating surface, tubes and flues	3,978 sq. ft.	1,656 sq. ft.
Heating surface, total evaporative	4,297 sq. ft.	1,882 sq. ft.
Superheating surface	993 sq. ft.	411 sq. ft.
Tender:		
Water capacity	10,000 gal.	6,000 gal.
Coal capacity	16 tons	9 tons
Ratios:		
Weight on drivers ÷ tractive effort	4.0	5.16
Total weight, engine and tender ÷ tractive effort	8.28	5.16

that the boiler capacity is much less and the necessary tender capacity may be correspondingly reduced.

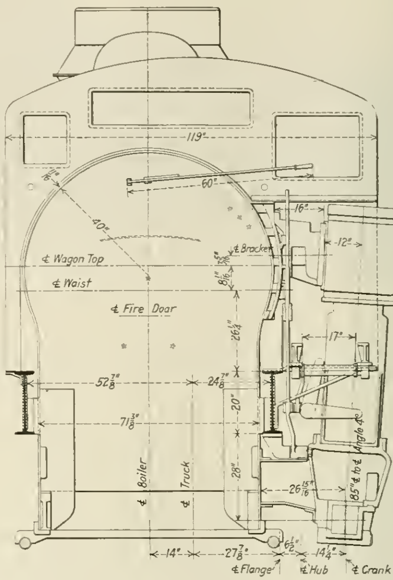
Further interesting differences in characteristics will be noted by comparing the drawbar pull on various grades as shown in Table 2. While both locomotives have practically

TABLE 2—COMPARATIVE DRAWBAR PULL UNDER VARIOUS SERVICE CONDITIONS OF 150-TON SHAY AND U. S. R. A. HEAVY MIKADO

	U.S.R.A Heavy Mikado	150-Ton Shay	Per cent
Tractive effort (85 per cent)	60,000 lb.	59,740 lb.	98
Drawbar pull:			
On level	56,000 lb.	58,500 lb.	104½
On 1 per cent grade	51,000 lb.	55,400 lb.	108½
On 2 per cent grade	46,000 lb.	52,350 lb.	111½
On 4 per cent grade	36,100 lb.	46,200 lb.	128
On 6 per cent grade	26,150 lb.	40,000 lb.	153
On 8 per cent grade	16,200 lb.	33,850 lb.	209
Sharpest curve for engine	300 ft. rad.	179 ft. rad.	60
Lightest rail advised	90 lb.	80 lb.	89

the same train starting capacity on a level track, the Shay locomotive is capable of exerting 28 per cent greater pull on a 4 per cent grade and more than double the pull on an 8 per cent grade. Furthermore, on a 4 per cent grade the drawbar pull of the Shay locomotive is still 77 per cent of the rated tractive effort, while the pull of the Mikado has fallen to 60 per cent, and the difference is still more marked as the grade increases.

The advantages of the characteristics of the Shay locomotive, low total weight, all the weight of the locomotive and tender used for adhesion, and high sustained tractive effort at low speeds on heavy grades make them a desirable type of locomotive under certain conditions. There are many places in main line service where pushers are required and also in



End Elevation of Shay Locomotive

branch line traffic where a Shay-geared locomotive could be used with advantage instead of the heavy direct-connected locomotives commonly employed.

Spanish Northern Railway Electrification Project

A contract for the electrification of 40 miles of the Spanish Northern Railway is announced by the Sociedad Iberica de Construcciones Electricas, of Madrid, Spain, one of the associated companies of the International General Electric Company, Inc., of New York. This initial order constitutes the most recent and one of the largest European railway electrification projects now under development. The high voltage direct current system will be used.

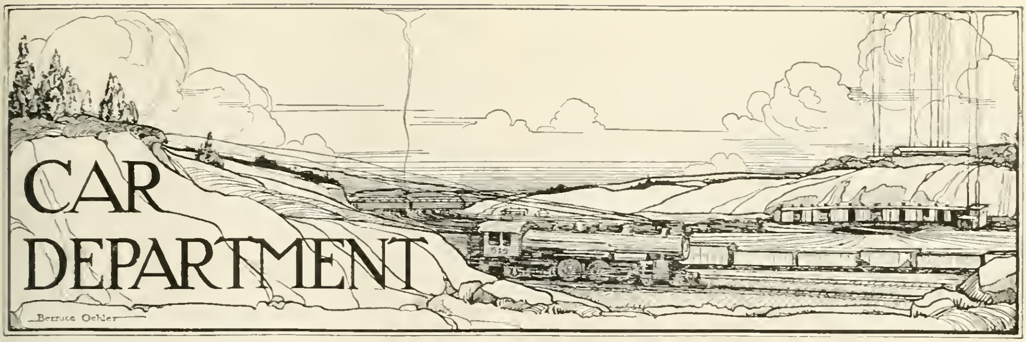
The equipment to be supplied by the Sociedad Iberica de Construcciones Electricas will consist of six 78-metric ton, six motor locomotives, two complete sub-stations, each comprising two 1,500 kilowatt, three unit motor generator sets, transformers and switchgear and the material necessary for line construction.

The first electrification project of the Spanish Northern comprises about 40 miles of the Leon-Gijon line running through the mountains between Ujo and Busdongo. Although this is a single-track line, traffic is extremely heavy, as it is a link between the mining district and the northern seaboard through a mountainous region with many tunnels, considerable grades and severe climatic conditions.

The electric locomotives on order will be of the freight type, with the following dimensions:

Length over buckles	46 ft.
Height	13 ft. 11 in.
Width of cab	9 ft. 8 in.
Rigid wheel base	11 ft. 6 in.
Maximum wheel base	35 ft.

The locomotives will be arranged for regenerative breaking, and will operate at 3,000 volts. The locomotive speed at continuous rating is 13.5 miles an hour. Pantograph collectors will be used similar to those on the St. Paul locomotives, having a double contact shoe.



The Development of the Robinson Connector

Latest Type Incorporates Improvements Suggested by Extensive Service of Earlier Design

THE coupling and uncoupling of cars, either passenger or freight, involves two operations: the engaging or disengaging of the couplers and the connecting or disconnecting of the train lines. The former operations are semi-automatic and are controlled by levers conveniently located at the sides of the car; the latter, however, must still be performed by hand, a method which involves some danger to the employees because it is necessary for them to go between the cars. Coupling train lines is one of the duties of the car inspector which consumes a considerable share of his time. Uncoupling the train line, which should be done by hand, is often neglected and the hose are allowed to pull apart when the cars are separated.

The First Design of the Robinson Connector, Type A

The loss of time in connecting hose and the bad effects of pulling them apart have led railroad officers to look to the automatic train line connector as the solution of these and other difficulties. In discussing the automatic connector a leading railway master car builder said: "There appears to be no room for argument about the need of such a device. The greater life of hose, the absence of broken train pipes resulting from uncoupling cars without first disconecting the hose, the saving of time and labor in making up trains, and the reduction in the cost of pumping air, all of which might be classed as direct or apparent economies, would undoubtedly justify the cost of application alone, but the writer is even more impressed with the benefits that would be secured indirectly. Numerous leaks are found in hose and gaskets at all seasons of the year, almost entirely the result of the practice referred to above; viz., pulling the hose apart, thereby injuring the fabric and inner tube. In the cold weather, however, when the hose freezes, the difficulty in preventing air leakage becomes a controlling factor in the operation of long freight trains and they have to be reduced in length to a point where the air pressure can be maintained irrespective of the tonnage rating or the ability of locomotives to haul them. Even at the best, this factor is responsible for a very great amount of terminal detention and labor on the part of car men trying to stop leaks.

"The connector increases the life of hose because it eliminates all mechanical wear. The hose is never jerked or strained. Frozen hose does not interfere with its operation and leakage and breaks are cut down to such an extent that it is possible to run longer trains."

The problem of the automatic connector was considered by the Master Car Builders' Association in 1908. A committee on this subject submitted a report which recommended a butting type connector with pin and funnel gathering device. From the time this report was issued until the present the Master Car Builders' Association and its successor, the Mechanical Division of the American Railway Association, have given little attention to this subject, although a subcommittee was organized in 1919. In this interval, however, there had been a remarkable development in train line connectors. Since 1910 over 1,000 cars have been equipped with the Robinson connector. Its present performance is such as to command careful consideration and as a history of the development of the device is essential to an understanding of the present state of the art, an account of the successive stages through which it passed will accordingly be given.

History and Extent of Service

In 1910 the first design of Robinson connector was applied to a passenger work train operating on the lines of the Washington Terminal Company, Washington, D. C. Its service extended over a period of ten months and was satisfactory to the railroad officers in charge. Representatives of the Interstate Commerce Commission watched the installation and were so well pleased with it that the commission arranged for an official test of the connector on the lines of the Great Northern at Grand Forks, B. C.

The test was made on the Marcus division of this road, extending between Grand Forks and Phœnix, B. C. The trains hauled were heavily loaded ore trains. Fifty cars were equipped and run interchangeably with 140 unequipped cars. The grade was 3.3 per cent and the curvature in some places excessive, curves of 22 deg. being commonly encountered. Railway officers from various parts of the country were present; the Board of Railway Commissioners at Ottawa delegated representatives, and every conceivable test was made of the connector, each of which it met successfully.

The Robinson Connector Company also tried out in the Great Northern tests a connector with a pin and funnel type gathering arrangement. The experience with this design indicated that it was not satisfactory because it was deficient in gathering range and also because dimensions when once fixed could not be altered. Consequently, no further experiments were made with this type.

These tests definitely established at least one important fact; that this connector made and maintained a perfectly tight joint, thus greatly increasing the effectiveness of the air brake. In submitting its official report on the test of the

Type B Robinson Connector

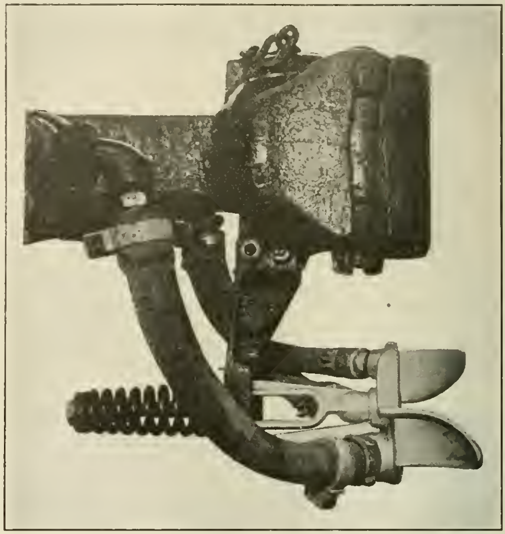
Type A connector the Interstate Commerce Commission concluded as follows: "From information obtained in this test the conclusion is reached that the Robinson connector is a safe and practical device, which if properly installed and maintained, will meet the need for an automatic connector in general freight service and add to safety in train operation on the railroad using it.

"It is mechanically simple in construction and composed of few parts which are easily assembled. It is comparatively light in weight, and of ample strength to withstand all shocks to which it is likely to be subjected in ordinary service. Its gathering range is sufficient to meet all variations between cars in service where car couplers can be made to operate, and it will withstand severe distortion without damage when heads are forced together under conditions where car couplers will not operate.

"It will maintain a tight joint between connector faces, even when gaskets are worn to such an extent that they could not be used with the standard hose coupling, and its use would materially reduce train pipe leakage."

Freight Connectors Installed on Canadian Northern

In view of this report by the Interstate Commerce Commission and in view of the favorable opinion of the con-



Type C Robinson Connector for Passenger Service

nector expressed by its representatives, the Canadian Board of Railway Commissioners became interested in the device and requested the Canadian Pacific, Grand Trunk Pacific and the Canadian Northern to look into it.

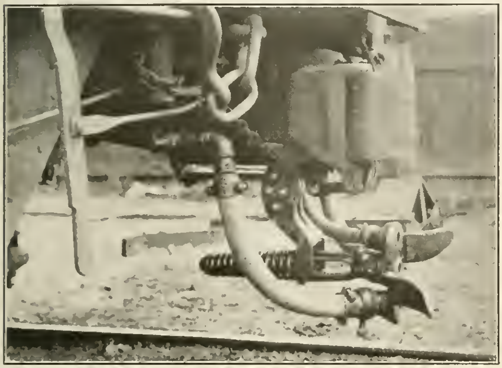
As a result of this request four all-steel hopper cars on the Canadian Northern were equipped with freight connectors of a new design, known as type B. These connectors were installed by the Canadian Northern at its Winnipeg shops in May, 1914, and put in continuous service handling gypsum rock from Steep Rock to Winnipeg during the summer and in coal service between Port Arthur and Winnipeg during the winter months. These cars ran in this service for three years under the most severe track and weather conditions, especially in winter, the temperature from December to March ranging from 10 deg. to 45 deg. below zero. The test came to an end through a wreck on the Steep Rock line, destroying all four cars. No change of hose or gaskets had been made during the whole period and these parts were in good condition at the completion of the test. Reports issued each trip by the train crews handling these cars show no train leakage whatever and all concerned were greatly pleased with the device.

The second installation in Canada was made by the Canadian Pacific, which equipped one passenger train in service between Montreal and Ottawa in February, 1915, with type B connectors. This test proved satisfactory and resulted in equipping 125 passenger cars operating out of Place Viger terminal, Montreal to Quebec, Ottawa, and Eastern Quebec points. These cars were equipped with the type C, an improved design incorporating changes suggested by experience with types A and B.

The Grand Trunk Pacific in April, 1915, equipped one passenger train in service between Winnipeg and Transcona, and three Hart cars in freight service between Fort William, Ont., and Transcona, Man., type B connectors being used. These tests were satisfactory and reports show the high esteem in which the connector was held by Grand Trunk Pacific officers.

Type C Connector in Passenger and Freight Service

In May, 1915, the Canadian Northern equipped a passenger train running between Wininpeg, Man., and Edmonton, Alta., which continued in service until March, 1917, under the most severe track and weather conditions to be found in America. During the winter of 1915 and 1916 temperature went as low as 55 deg. below zero in parts of Saskatchewan. This test proved so satisfactory that the Canadian Northern ordered equipment for 250 passenger cars and 200 freight cars, the latter to be used on the Duluth, Winnipeg & Pacific out of Virginia, Minn.



Latest Design of Passenger Connector, Type 2 H

The new type C connector was supplied for these installations and the freight cars were equipped in February and March, 1917. The 200 cars equipped were steel flat cars in log service between lumber camps of the Virginia & Rainy Lake Lumber Company and Virginia Mill. On the lumber company's lines cars were handled over skeleton track, an abnormally severe condition not to be duplicated in railway service, but the connectors operated satisfactorily without any sign of leakage. Between Virginia and Cusson, on the Duluth, Winnipeg & Pacific main line, cars were handled in complete trains of 40 cars and showed such a remarkable decrease in troubles due to train line leakage that all concerned were impressed with the advantages of the connector, especially in winter weather. No leakage whatever was found in the connectors, whereas similar trains operated over the same line and equipped with ordinary hose couplers showed continual delays on account of creeping brakes and poor brake operation due to train line leakage.

In 1920 two New York Central passenger trains and three locomotives on the Valley division at Dunkirk, N. Y., were equipped with type C connectors, where they continue to give satisfactory service. At about the same time 50 steel hopper cars, engaged in copper ore trade, were equipped on the Mineral Range at Calumet, Mich. The installation operated under extreme climatic conditions such as excessively deep snow and very cold weather and was discontinued only because the mines were forced to close through bad market conditions. The officers of the road who came in contact with the connector were greatly pleased with its service.

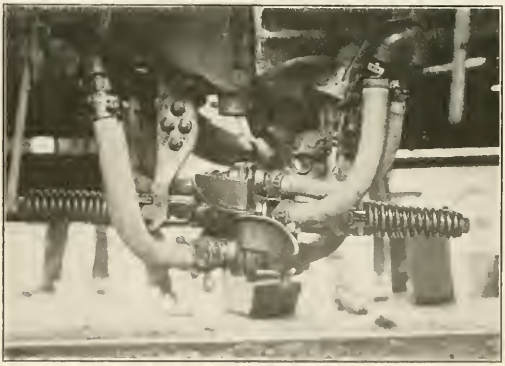
Extensive Installation in Through Passenger Service

From March, 1917, type C passenger connectors continued to be installed on all Canadian Northern trains operating west from Winnipeg, and further orders were placed by this road during 1919 and 1920, when all passenger equipment west of Montreal to Vancouver, B. C., was equipped. This covered trunk line operation amounting to 12,000 miles of railway and included transcontinental trains of 12 to 14 cars each, operating between Montreal and the Pacific Coast, a distance of 3,000 miles. This large installation was the first real trunk line operation ever attempted with any connector and resulted in experience with regard to the requirements for automatic connectors never before obtained.

As the result of this extensive experience, and the study given to connector design for more than 12 years, the Robinson Connector Company has developed a standard connector, embodying advanced features and refinements of design which only long and varied experience could make possible. While differing in refinement of details from the old type C connector, the same fundamentals of connector construction are found in it. It is stronger and more rugged; the gaskets are removable from the rear of the coupling head without parting the cars and the head is somewhat larger in anticipation of changes in the steam heating system now being advocated by many railways.

Objects of the New Design

The objects which the Robinson Connector Company has sought to attain in the new connector are primarily the following: (a) a coupling head of size adequate to permit such needed developments in the head as time may demonstrate to be desirable, without affecting interchange with previous heads; (b) simplicity and speed in the renewal of defective gaskets without parting the cars; (c) a more rugged and powerful bracket and lug foundation for the connector; (d) a spring compression sufficient to compensate for the excessive wear between car coupler knuckles occasionally encountered; (e) increased size in the steam port opening; (f) a reduction in the number of gaskets used; (g) a greater gasket life; (h) to convey the air and steam through the connector head without it contacting with the head, thereby eliminating the necessity of making the head of air-tight material; (i) simplification of interchangeable manufacture.



Type 2 H Connectors in Coupled Position

The first of these objects has been attained by increasing the length and width of the head to 11 in. and 5 in.

respectively. Within this space the three ports may be arranged in any one of several ways. They may, for instance, be cored in the head or they may be formed of separate fittings and suitably mounted in the head, as in the case of the air brake port. These dimensions will readily accommodate any size of port which future developments in the air or steam line are likely to require. The air and signal ports may be increased to 1½ in., and the steam port to 2 in. opening without affecting interchange with previous heads.

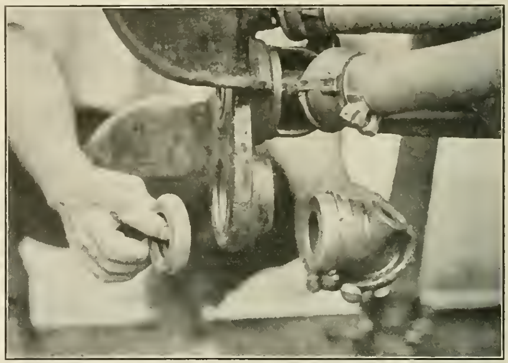
Flexibility of Gathering Range

Another important feature of this type of coupling head is the flexibility of its gathering range dimensions. While there is very little about connector design that is not now known to connector manufacturers and to railroad men who have studied the question, it has not yet been determined what gathering range a connector should have to accommodate most efficiently the varied requirements of service. It is known, of course, that the passenger connector requires a greater gathering range than the freight. The passenger car being much longer, with a considerably greater overhang from truck center to end sill of car, the angle at which the connectors approach is more acute, and hence the gathering range must be greater. But since the conditions under which passenger cars operate are practically known factors, it is not a difficult matter to determine what gathering range the passenger connector should have.

With the freight car conditions are different, however. There are a great many different types and many different lengths of freight cars. They operate under the most severe conditions, being commonly hauled over track on which it would be impossible to run a modern passenger car. Moreover, freight cars receive the minimum of maintenance. These factors complicate the problem of determining what gathering range is most suitable for the freight connector. A dimension has been developed that has so far proved satisfactory, but how it would meet general freight service on hundreds of thousands of cars, only extensive installation can reliably tell.

The magnitude of the field for the freight connector and this inherent element of uncertainty as to one of its most important dimensions, point with emphasis to the necessity for a gathering range which may be varied at will without affecting interchange with previous units of the equipment.

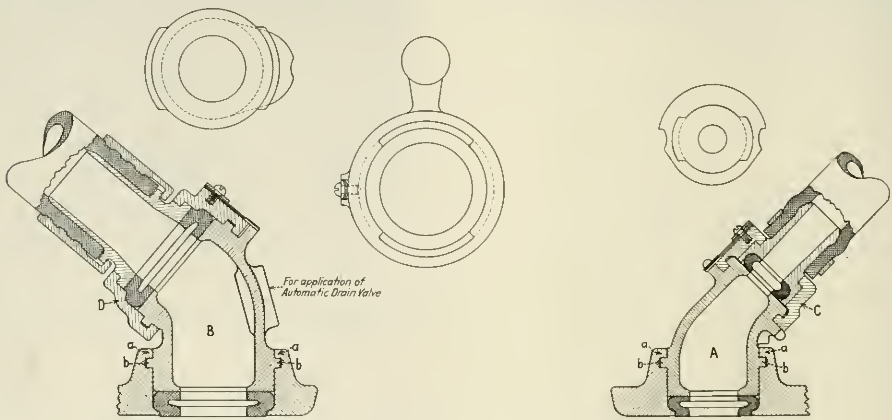
This cannot be done with any type of pin and funnel connector. It is an inherent limitation in all pin and funnel heads that a gathering range once set cannot be changed. The freight and passenger gathering range cannot be dealt with separately with the pin and funnel head. The freight head must be as large as the passenger head, otherwise they will not interchange. A great waste of material and unnecessary bulk to the freight connector arises from this fact.



Steam Connection Removed to Change Gasket

These are among the reasons which led this company to discard the pin and funnel head.

Flexibility of the gathering range dimensions is an inherent advantage of the wing type of head. The spread of the wings may be increased or decreased at will, with a corresponding change in the gathering range without affecting interchange with previous heads. The freight head, having but a single port, may be made to size and be given a gathering range best suited to freight operations, and yet interchange perfectly with the passenger head. The only dimension common to the two heads is the width of the face and the location of the wings with respect to the ports.



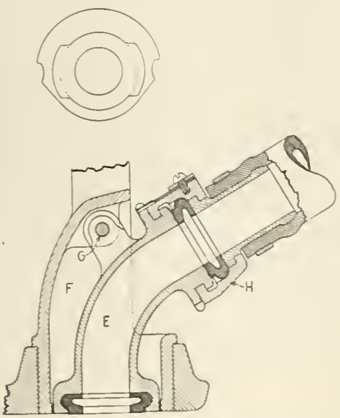
Details of Steam Heat and Air Signal Connections, with Removable Gaskets

A great economy in first cost and maintenance results from this flexibility of design which avoids the necessity of putting metal that is not required into the freight head simply to get it to interchange with the passenger head.

All Gaskets Readily Removable

The second object, simplicity and speed in the renewal of defective gaskets without parting the cars, is attained in the new connector by mounting the signal and steam port gaskets in the face of the head and backing them up by the curved fittings *A* and *B* shown in the illustration. These are removably mounted in the head by a bayonet joint comprising dogs, *a*, on the head behind which the lips, *b*, on the fittings are rotated. The unions, *C* and *D*, for connecting the hose to these fittings are formed in a similar manner.

When it is desired to remove a signal or steam gasket the hose unions are opened and the fittings *A* and *B* are rotated out of the head. This exposes the gaskets which may then be readily removed through the rear of the head. Normally, each of these gaskets is under slight initial compression; in design they are of the air-expanded type. Thus, when the air or steam is admitted the gasket swells into absolutely



Details of Removable Brake Pipe Connection

air tight engagement with its seat in the head and against the front face of the fittings *A* and *B*.

The removal of the brake port gasket is accomplished by a somewhat different process. Here the gasket is mounted in the forward end of a curved fitting *E*, removably held in the connector pipe, *F*, which is pressed with the head, by a pin, *G*. When removal is desired, the pin is lifted and the entire fitting is removed from the connector. To accomplish this it is not necessary to open the union, *H*, by which the brake hose is attached to its fitting. This union is employed solely to facilitate interchange with a car not equipped with the connector. When the interchange period is over the union will be eliminated and the hose mounted directly upon the rear end of the fitting. This produces a simple and efficient air line arrangement.

Improved Design of Bracket and Lug

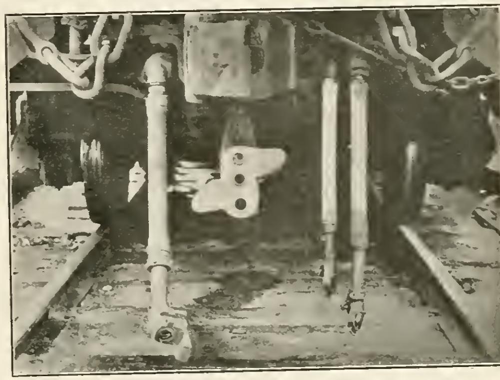
The third object, a more rugged and powerful bracket and lug foundation for the connector, is accomplished by lengthening the lug by which the connector bracket is supported from the car coupler. In the new connector the leverage ratio on the lug bolts has been reduced from 6 to 1 to 2 to 1, and instead of two bolts, four are used. The result is a dependable and powerful foundation for the bracket, a most important consideration.

The fourth object, a spring compression sufficient to compensate for the excessive wear occasionally encountered between car coupler knuckles, is attained by the use of a longer buffer spring and by increasing the length of the connector pipe. In the previous connector this compression was 1½ in., but long experience demonstrated that on account of excessive wear occurring in some coupler knuckles, this was insufficient. It was therefore increased to 2½ in., which permits of the maximum wear on the car coupler knuckles without affecting the rigidity and tightness of the joint between the connector heads when coupled in the slightest degree.

The fifth object desired was increased size in the steam port opening. In the previous connector this opening was 1½ in., which is the dimension widely employed for the present hand-hose coupling. The difficulty incident to properly heating long trains in excessively cold weather has brought about considerable discussion looking to a greater steam port opening. Since many railroad men are of the opinion that the steam port opening must ultimately be increased, an opening of 1¾ in. has been adopted in the new connector. This dimension, however, permits perfectly satisfactory interchange with a connector head having a steam port opening of 1½ in.

The sixth object, a reduction in the number of gaskets used, is attained by using in the steam union the same gasket that is used in the steam port, and by using in the signal port, the brake port, and the brake union a common form of gasket. Thus in the freight connector but one type of gasket is used, a convenience of much practical importance.

The seventh object, a greater gasket life, is attained by giving greater body to the gaskets. In the previous connector



Robinson Connector Fitted for Interchange with Standard Hose Couplings

the air gasket had a face width and a depth of ¼ in., while the width of the steam gasket face was ⅜ in., and the depth of this gasket was ¼ in. In the new connector, the air gasket has a face of ⅜ in. wide and the steam gasket a face ½ in wide. The gaskets are also deeper than the previous design, and the increase in size and resiliency insures longer life.

The eighth object, to convey the air and steam through the connector head without bringing it in contact with the metal of the head, is attained by the improvements previously mentioned. It will be observed from the drawings that the contents of each of the train lines is carried through the head without imposing any fluid pressure on the metal in the head and hence the requirement for an air-tight casting in the head is eliminated. In the case of the brake line, always, of course, the most important line, the air is carried through the head by the fitting *E*. Eliminating the necessity for making the head of air-tight material not only greatly facilitates its production and lowers its manufacturing cost, but makes it a much more efficient part.

The ninth object, simplification of interchangeable manufacture, is brought about mainly by the dimensions and design of the head of the new connector. Various developments may be made within the head without affecting interchange with previous units of the equipment. Forming the gasket seats in the manner shown and mounting the fittings in the head instead of making them an integral part of the head, not only simplifies foundry procedure, but greatly simplifies and reduces machining costs. From this simplification greater ease in maintaining interchangeable dimensions in the several parts naturally results.

Results of Scheduling at Milwaukee Coach Shops

Simple System of Standard Schedules Developed Under Adverse Conditions Lead to Record Output

ONE of the comparatively few shop scheduling systems recently applied in other than locomotive shops has been in operation for the past year at the Milwaukee, Wis., passenger car repair shops of the Chicago, Milwaukee & St. Paul. Although so simple that the full time services of but one man are required for its administration, the system has had a marked effect in increasing output and in doing so has met with no opposition from the men employed.

The Milwaukee shops differ from many coach repair shops in that no track capacity outside the paint shop is available either for stripping or finishing. From the time the work of stripping is started until a coach is finished ready for service it occupies a track inside the paint shop. Hence the total length of time each piece of equipment is in the hands of the shop forces directly controls the output of the shop. No attempt has been made to develop a scheduling system in complete detail for the purpose of following each item of repair work through the various departments, but the utmost care has been used to develop schedules for the work which must be done on the car so that there shall be no interference of one craft with another and that the sequence of the operations of the various crafts shall be arranged to reduce the total time in the shop to the smallest number of days possible.

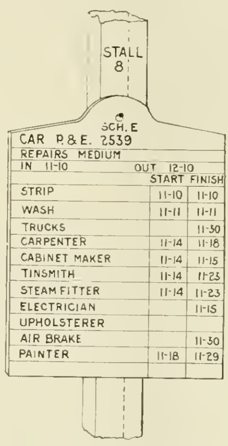
There are 11 standard schedules in regular use calling for from 14 to 24 days in the shop. The schedule illustrated is one of the six, the length of which varies from 14 to 24 days, that cover practically the entire range of repair work in connection with ordinary painting operations. The other five schedules, varying from 17 to 24 days in length, are for application to cars calling for complete paint renewal, starting with burning off or sand blasting. It has been found that with the exception of diners, business cars, sleepers, etc., the outside carpenter work and paint work will determine the length of time required in the shop. Particular care, therefore, has been given to the working out of the carpenters' and painters' schedules and these crafts are carefully checked for strict adherence to them. In the case of some of the other branches of work only the finished date is given, leaving the handling of work which is actually removed from the car, largely at the discretion of the foremen. Adherence to the finished date of all crafts is checked and appropriate action taken in case the frequency of failure to make the schedule indicates laxity or the need of some adjustment.

In repairing sleepers and other high class cars (the C. M. & St. P. operates its own sleeping and parlor cars), should none of the regularly established schedules fit, parts of one schedule are combined with parts of other schedules or new schedules are worked out as circumstances require. Wrecked cars on which there is an exceptional amount of repair work are not scheduled until the point has been reached where part of a schedule can be applied with reasonable certainty that its requirements can be met. No schedule is applied to cars taken in for light repairs.

Aside from the master schedules, to which reference has already been made, the only forms used in the administration of the system are the weekly lists, showing the in and out dates, track location, the class of repairs and schedule designation of each car in the shop; a checking form, one for each car, for the use of the schedule man in noting operations on time or late in a daily check of the shop, and a list of operations overdue or completed ahead of time, issued at the close of each working day. The weekly list is particularly useful to the foremen of outside departments as it gives them all the information necessary to tie their work into the master schedule. In addition to this form the foremen working directly on the coaches have access to the shop blackboards,

Working Days in Shop	Painters		Carpenters		Cabinet Makers	Tinsmiths	Trucks	Steam Fitters	Air Brakes	Electricians	Upholsterer	Silver Platers	Machinist	Working Days in Shop
	Outside	Inside	Body	Platform										
1			Strip	Strip	Strip		Off							1
2	Wash	Wash									Stock Rec'vd	Stock Rec'vd		2
3			Start	Start	Start	Start Roof								3
4														4
5			Finish		Finish					Finish				5
6	Prepare	Start												6
7	Prepare			Finish							Finish Roof			7
8	Prepare													8
9	Color #2													9
10	Color Varnish					Roof Finish								10
11	Ornament													11
12	Varnish #1													12
13	Dry	Finish						Pipes Finish Cover & Test				Stock Finish		13
14	Paint Bottom Varnish #2				Start Trim					Dyn Set up & Electric Board			Dyn. Set up	14
15							On & Level							15
16	Paint Roof	Touch Up (Afternoon)			Finish Trim (By Noon)	Trim (By Noon)			Finish & Test	Batteries OK Dyn. Fin. Test			Dyn. Fin. Test	16
17		Clean (By Noon)	Car O.K.	for Service	at Noon					Tested (By Noon)	Trim Finish (By Noon)			17

Typical Master Schedule, Milwaukee Passenger Car Repair Shops



Shop Blackboard, One at Each Stall in the Coach Shop one at each track, on each of which is entered all essential information relative to the car to which it applies.

The adoption of a set of standard schedules covering a sufficiently wide range of conditions to meet the requirements of the majority of cases has simplified the working of the schedule system. These schedules, blueprinted and bound in book form with a set of simple rules and explanatory notes, are distributed to all persons concerned with the administration of the system. Before a piece of equipment is taken into the shop a schedule is selected and applied by the general foreman after an inspection. The routine work consists principally of a daily check of the shop, making up the daily list of operations overdue and ahead of time and preparing the weekly list of equipment in the shop. This is handled by the schedule man under the direction of the shop engineer.

That ideal shop conditions are not essential for the successful application of the scheduling system, provided it is adapted to local conditions, is evident from the experience at the Milwaukee shops. The present scheduling system went into effect on October 1, 1920, practically at the beginning of the general falling off in traffic movement which led to a universal drastic curtailment of maintenance expenditures. In common with other railroads the Chicago, Milwaukee & St. Paul has worked its shops on short time and with reduced forces during most of the year's experience with the scheduling system. Notwithstanding these unfavorable conditions, excellent results have been obtained.

During the 33 months beginning with January, 1918, a period ending with the establishment of the scheduling system, 1,627 cars were turned out in a total of 830 working days, an average of 1.96 cars per working day. This was a period of practically full time operation, averaging 25.1 working days a month with an average output of 49 cars a month. During the first year of scheduling 572 cars were turned out in 191.9 full working days, an average of 2.995 cars per day with an average of but 16 working days a month. The increase of daily output, amounting to 52.8 per cent, is attributed to the scheduling system. In addition to the scheduled cars in for heavy repairs, an average of ten cars a month have received light repairs.

Prior to the war, from 1901 to 1917 inclusive, the monthly output of the Milwaukee shops averaged 24.5 cars. The highest monthly output during the period was 49 cars. In October, 1920, the first month of operation under the scheduling system, 74 cars were turned out for general repairs which constitutes a record for the shop. In June and July, 1921, the output averaged 3.5 cars each working day, the highest daily average ever obtained.

Furthermore, the increased output has been obtained with less men. The number of men employed on passenger car work averaged 1,122 during the year of scheduling as compared with 1,157 during the first nine months of 1920 and 1,362 during the year 1919. Under the scheduling system 375 men were employed for each car turned out daily as compared with 548 in 1920 and 711 in 1919.

The reduction in the number of working days that cars are held in the shop to undergo general repairs has varied from 0.5 to 8.6 days per car, depending on the class of equipment. The average reduction in the case of steel coaches has been 8.6 days per car, for steel underframe express cars 7.3 days, for wooden milk express cars 6.3 days, and for full vestibule wooden coaches, 5.3 days.

The Preservative Treatment of Car Lumber

Practical Results So Far Obtained Suggest the Desirability of an Extension of the Practice

By H. S. Sackett

Assistant Purchasing Agent, Chicago, Milwaukee & St. Paul

A SIGNAL virtue of wood which alone makes it more suitable for general car construction than steel is the readiness with which it may be protected against natural deterioration or decay by chemical treatment. This is accomplished before placing in the structure with positive assurance that it will be serviceable for the full mechanical life of the part. Steel must be continually painted with rust- and acid-resisting paints to protect it against early failure because of corrosion.

Prior to the last few years very little attention has been given to the influence on car maintenance of decay in wood members of freight cars. Car builders were prone to charge a great majority of failures to mechanical causes. It developed during an exhaustive investigation conducted for a period of two years by a special committee of the American Wood Preservers Association, that the contrary was more to the point.

Analysis of a questionnaire distributed through the Master Car Builders' Association indicated that at least 30 per cent of all repairs to freight cars of all-wood or composite construction were directly due to decay.

This information was, of course, generally based on the experience of the car foremen who supplied it, and it may be assumed that but little care had been given to gathering data that would be conclusive. An effort was made, therefore, to check the estimated figures as provided in the committee report* for which purpose a special clerk was placed by one of the committee members in a western car repair shop, whose experience could give accurate judgment as to whether decay or mechanical failure was the primary cause for the respective repair or replacement.

An interesting fact developed incidentally in this investigation was that during the month that this special inspection was in force 1,100 steel cars and 399 wood cars were repaired at the shop in question. As the shop is located in a section of the country where wood equipment still predominates it may be significant.

It was shown that of a total of 265,666 individual parts or pieces replaced, 82.3 per cent failed directly because of decay, and 17.7 per cent represented mechanical failure. The repairs were distributed approximately as shown in the accompanying table.

The types of cars included in this investigation, which constituted the regular run of bad order cars turned in at this particular shop, were distributed as follows: box, 223; coal, 87; ballast, 23; flat, 20; refrigerator, 19; stock, 17; tank, 10.

These data when submitted to car builders, have caused much astonishment and, perhaps, some doubt. There may be circumstances which would not allow of their application, in toto, to all other shops in the country. However, there is no record of a similarly thorough investigation at any other

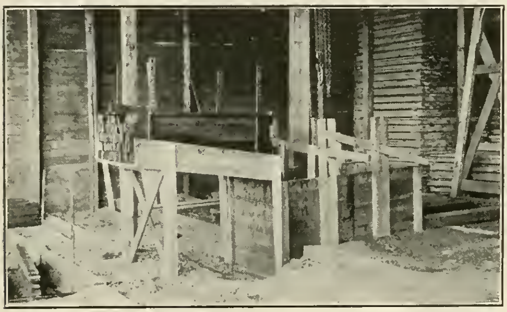
*See the proceedings of the American Wood Preservers' Association for 191[illegible].

point, and it is prudent to give very careful consideration to the facts here disclosed.

The main fact that is gleaned from these data is that the preservative treatment of car lumber is necessary as a matter of straight economy and essential as a conservation measure. This is merely another instance where reasonable precaution—maximum efficiency in utilization—would materially increase the durability of cars as a whole and reduce the cost of maintenance, thus in many cases making unnecessary the substitution of more costly steel equipment. In other words, in the past we have not obtained the maximum service from wood because of our negligence in applying comparatively inexpensive remedial measures and have, therefore, not really learned the ultimate value of wood for the several purposes under consideration.

Distribution of Repairs or Renewals of Wood Car Parts by Causes

Description of part	Causes of failure: Decay, per cent	All other causes, per cent
Draft timbers	0.0	100.0
End sills	34.4	65.6
Deadwood	7.4	92.6
Long sills	68.0	32.0
Sub-sills	26.2	73.8
End posts	32.4	67.6
Coal car sides	80.1	19.9
Running boards	97.3	2.7
Roofing	100.0	0.0
Siding	89.5	10.5
Lining	89.1	10.9
Decking	95.4	4.6
Grain strips	96.5	3.5

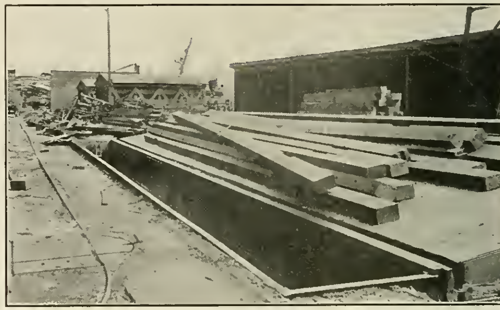


Small Tank for Creosoting No. 1 Common Yellow Pine Decking and Roofing; 250 to 400 Pieces Per Charge Immersed 30 Min.; Repairs Caused by Decay Already Reduced More Than 50 Per Cent

It is true that certain changes in present shop practices must precede the introduction of treated timber in car construction; but that is a comparatively unimportant detail when the more costly changes which the adoption of all steel equipment would necessitate are considered. The latter would not only entail new shop practices but complete reorganization and almost entirely new tools and equipment or rather, duplication of machinery because the composite cars built during the last five years or so would require maintaining the present shops for their repair. Consequently, by following lines of least resistance and choosing the lesser of two evils, if they are to be considered such, immediate adoption of treated car material is a good policy and fits in well with the present desire and need for economy, wherever that may be practicably applied.

Treated material can be used in practically every type of car. Whenever creosoted timber is not suitable because of the fear of contaminating lading, the lumber may be treated with zinc chloride, sodium fluoride, etc. Methods of treatment are standardized and each standard treatment has its own record of achievement under suitable circumstances. There exists no insurmountable obstacle to the practice of wood preservation in car construction.

Refrigerator cars have been in service for between 7 and 10 years with treated sills. At first they were brush treated with creosote and when this had proved worth while the sills were creosoted by the open tank process. To the treated sills were added creosoted sub-flooring and roofing for the undercourse. More important still, never have the owners received a complaint that lading has been contaminated, although some cars of the latter type have been in meat service for over a year.



Open Tank Creosoting Plant for Treating No. 1 Common Yellow Pine Car Sills; Treated Sills Show No Decay After Four to Six Year's Service

When speaking of treated timber for freight cars one naturally thinks first of stock cars, and these surely provide the greatest opportunity for saving in this direction. Stock cars with creosoted sills and decking have been in service for about 12 years without a single repair due to decay, where untreated stock car decking fails in from 4 to 6 years and sills in from 5 to 8 years. However, this is not the limit to which treated materials can be used in this type of car. Practically the entire car should be treated, from sub-sills (on steel underframe cars) to the roof. Where stenciling is necessary that can be applied to special boards, or it can be taken care of by the use of metal numerals and signs, the cost of which would be a small item in comparison to the saving derived from the use of treated lumber.

Condition of Stenciling Applied to Creosoted Surface After Eighteen Months' Service; Surface Prepared by Applying One Coat of Pure Shellac

Coal cars, flat cars, logging cars, caboose and housing cars all offer the same opportunity for economy by protecting the wooden parts against decay. Of box cars the sub-sills and nailing strips may be creosoted and the decking treated with sodium fluoride or zinc chloride where proper facilities are available. It may also be that other parts of box cars could be treated with these latter preservatives, but on that point there exists too little information at this time to allow a definite recommendation.

The particular advantage in addition to obtaining increased service is that preservative treatment allows the use of lower grades of wood, especially the presence of a goodly percentage of sapwood. In fact, sapwood is a partial advantage as it is more absorbent, takes treatment more readily and, therefore, gives greater protection to the stick.

Some shops are applying creosote oil to points of contact of sills, posts, etc., and the specification for the box cars developed during the war required treatment at such points with either paint or creosote. This is a step in the right direction, although paint cannot be considered a preservative in that it does not possess the necessary toxic qualities to inhibit the development of wood destroying fungi, or to kill the spores thereof that may be present on the surface and in the checks of the timber. However, it must be remembered that the value of any preservative treatment is in proportion to its thoroughness. Practically all car shops could equip themselves at little expense to employ the open tank process, and some roads operating pressure treating plants could arrange for the treatment of car material at these plants. The means for the practice of wood preservation, either by the use of surface treatments, the open tank process, or by employment of material treated at commercial or railroad plants with the standard pressure processes, are available in such varied form that no reasonable excuse can be advanced for continuing the abuse and waste of wood due to preventable decay. No repair yard, carpenter shop, or construction point along the railroad but can secure a barrel of creosote and a brush and at least partially protect such wood as it used against decay. As to the technical information involved, that likewise is readily obtainable and can be assembled by every engineering department and reduced to practical instructions to the workmen to bring about the desired results. Consequently, no extended discussion of these details need occupy us at this time. Suffice it to repeat that this is one means by which railroads can save enormous sums now expended for repairs that could be postponed or prevented were the lumber given the proper opportunity to serve its full period of usefulness by the simple expedient of protection against decay, applied before placing in the structure.

Car Inspectors Discuss New Rules of Interchange

Meeting at Chicago to Arrive at a Uniform Understanding of Changes Effective During 1922

For the purpose of arriving at a common understanding of the American Railway Association code of interchange rules, as revised in 1921 and now effective, a one day meeting of the Chief Interchange Car Inspectors' and Car Foremen's Association was held at the Great Northern Hotel, Chicago, on January 9. The meeting was called to order by the president, E. Pendleton (C. & A.), and proceeded immediately to the consideration of the changes in the rules. On completing the discussion of the changes, other questions pertaining to the rules were taken up and a lively discussion of delivering and receiving line liability for the cost of transfers under Rule 2 and Car Service Rule 14, resulted.

At the opening of the afternoon session, President Pendleton called the attention of the members to the death of Henry Boutet on April 25, 1921, since the last meeting of the association, which was organized at a meeting called by Mr. Boutet at Cincinnati in March, 1898, and of which he was president from 1905 to 1911 inclusive.* A committee was appointed to draft suitable resolutions in honor of Mr. Boutet and in appreciation of his work in the early upbuilding of the association.

No association business was transacted. An abstract of the discussion of the rules follows:

Rule 1 now reads:

Rules 1 and 66.

Each railroad is responsible for the condition of all cars on its line, and must give to all equal care as to inspection, *oiling*, *packing* and repairs, regardless of responsibility for expense of repairs.

E. H. Mattingley (B. & O.): There is a question on the interpretation of Rule 66 as it now is written and it might be well to discuss that before we get away from Rule I. Rule 66 now reads:

All journal boxes should be repacked when necessary, using properly prepared packing (new or renovated), in accordance with A. R. A. Recommended Practice, at which time all packing should be removed from the boxes and boxes cleaned; dust guards to be renewed (if necessary) or replaced when wheels are changed.

The date and place (railroad and station) where the work is done should be stenciled on the car body near the body bolster at diagonal corners in 1-in. figures and letters, using the same station initial that is used for air-brake stencil.

No change should be made in the stenciling unless all boxes are repacked.

Why should it be necessary to repack all the boxes on the car and stencil them if you are not going to get paid for it?

C. J. Wymer (C. & E. I.): I think the intent of that rule is that the boxes are supposed to have thorough attention at least once in 12 months.

Mr. Mattingley: Is it the consensus of opinion of this Association that in the case of a foreign car bearing a stencil "Boxes packed, January, 1921," if received on a car track January, 1922, the line having the car in its possession would be supposed to repack those boxes and restencil the car under Rule 66 and Rule 1 as they are now written, without making any charge?

A. Kipp (N. Y., O. & W.): I do not understand that there is any obligation now on any railroad to repack the foreign car. We are going right back to 40 years ago. If the packing in the boxes on the car is suitable to the service that you are going to put the car in that settles it. You can repack or not, just as you like; and with the elimination of the pay for the repacking of the boxes there will be little of it done.

F. W. Trapnell (Kansas City, Mo.): Rule 66 says "should be", it does not say "shall be." It leaves it optional with you to do as you please in the matter; and if you do not think the boxes need repacking at your expense, you are not going to pack them.

Mr. Herring (Southern): As I read the revised rule there isn't any date specified.

Mr. Mattingley: When are you going to repack the other fellow's car when it is on your line?

Mr. Herring: When it is necessary.

Mr. Mattingley: When is it necessary?

*Mr. Boutet's obituary appeared on page 41[illegible] of the June, 1921, *Railway Mechanical Engineer*.

Mr. Herring: That is at the discretion of the handling line.

Mr. Mattingley: The Recommended Practice of the A. R. A. is every twelve months.

E. S. Smith (Florida East Coast): As I understand that rule, it reads they shall be packed when necessary, but they shall be packed in accordance with the M. C. B. Recommended Practice for the care of the journal box packing.

Mr. Parkin (Kansas City, Mo.): Mr. Mattingley says that twelve months was to be the time, but that was in the 1920 rules. In the 1921 rules they left it out and therefore it becomes obsolete.

A motion was made that it be the consensus of opinion of the Association that under Rules 1 and 66 it be left to the discretion of the handling line as to when journal boxes shall be repacked. The motion was carried.

Rule 2.

Interpretation.

Q.—Can a car be refused on account welded truck side which may have been welded previous to January 1, 1920?

A.—Rule 2 gives the receiving line the right to refuse any car which in its judgment is unsafe for movement on its line. It is assumed that this question concerns a truck side with a defective weld.

Mr. Mattingley: It is my opinion that under this interpretation a car with a welded truck side not defective and welded previous to January, 1920, must be accepted in interchange. If in the opinion of the receiving line the weld is defective the car must be transferred at the expense of the delivering line. This would also apply in case of cracked or broken frames.

A. Armstrong (Atlanta, Ga.): Rule 2 gives the receiving line the right to refuse a car which has a defective truck side. That still is a matter of judgment. There is not one per cent of the welded truck sides on which the work is done in accordance with Rule 23.

Mr. Mattingley: Do I understand that if a car is offered in interchange with welded truck frame, or a defective truck frame, that car can be transferred, if loaded, a transfer order issued against the delivering line and the car returned when empty to the delivering line, regardless of the length of crack or percentage of the fracture?

T. J. O'Donnell (Buffalo, N. Y.): You are reading into the interpretation something that should not be there. The Arbitration Committee has given the most logical interpretation that can be given as to the defect and the requirements of the welds. It tells you that you can refuse every car that rules permit you to refuse. I really think that we should leave that just as the arbitration committee has ruled on the interpretation. I am surprised that Mr. Mattingley should want to refuse and transfer a car for a little defect in one of the truck sides.

Mr. Mattingley: Other interpretations have been rendered by that committee in connection with this rule that have not been lived up to. If in my judgment I should refuse a cracked truck frame where the crack is a ½ in., ¾ in., or 1 in. long am I entitled to a transfer order and am I entitled to return the car to the delivering line, according to this interpretation?

Mr. O'Donnell: I should say no. You might just as well say you refuse a car with a ¼ in. crack on your center sill.

Mr. Mattingley. If my judgment says a 1-in. crack or a 1½ in. crack is unsafe, I am perfectly entitled, under this interpretation, to refuse the load and return the car.

Mr. Wymer: Mr. Mattingley is right and Mr. O'Donnell is right. I think there is too much technicality in various places in the country. I recently handled some papers where cars had been transferred for cracks after the car had made some 1,200 miles with a load of meat, and reached pretty near its destination, the delay originated claims. This technicality is costing the railroads money in the way of claims unnecessarily.

Mr. O'Donnell: Our mechanical engineers have told us at what percentage we can weld and at what percentage or over it is better to take the truck side out and scrap it. Why go before the interchange points throughout the country and make something else? If you are going to say that you have a perfect right to transfer cars for anything below 1½ in. you are going to put a club in the hands of your inspectors and they are going to use it to the disadvantage of the business. There is too much transferring for slight defects in truck sides already. There ought to be more welding outfits to get the loads through without transferring the cars. In the last few years I have not seen one of those truck sides fail. According to the rules I have got to give the money against the delivering line when the car is refused, irrespective of whether it can be welded or not if the receiving line says it is not convenient for it to maintain the welding outfit.

F. C. Shultz (Chicago): We have taken the position that inasmuch as the Arbitration Committee has made a rule by which a truck frame can be welded unless the fracture exceeds certain limits or is too close to a previous weld, it can be applied to a load, and we have refused to issue transfer orders.

Mr. Mattingley: I claim that the rules give me the right as the representative of the Baltimore & Ohio to refuse any car with a fractured truck frame or a welded truck frame that in my opinion, as its representative, is not safe to go over its line. Do not conflict the requirement of Rule 23 with Rule 2. Rule 23 simply tells how to perform the work, and under what conditions to weld and not to weld, and has nothing to do with the acceptance or refusal of the car.

Mr. Shultz: The only question now is whether or not you can consistently repair a fractured truck frame within the Rule 23 while the car is under load. That is the only question at issue. You do not have to disturb the contents to do it. If you do not see fit to provide facilities to do it that is your disability, in my opinion.

R. A. Kleist (B. & O.): Rule 2 does not require you to weld a truck frame under load, and a transfer order should be given. Whether the welding can be done or not does not matter.

The Chair: The interpretation that is placed on this rule, in my opinion, is entirely clear and I believe Mr. Mattingley's contention is absolutely correct.

Mr. O'Donnell: I move the following resolution: The chief interchange inspectors in interpreting the rules feel that the utmost efforts must be made to maintain the metal truck sides in accordance with Rule 23, but when conditions warrant transfer of the lading the receiving line can apply Rule 2 and the delivering line be held responsible.

The motion was seconded and carried.

Mr. Fitzgerald: The second paragraph of section (c), Rule 2, reads:

Cars of 80,000 lb. capacity and over, equipped with A. R. A. Standard axles, may be loaded to maximum shown in Column "A" of Rule 86, which is the total weight of car and lading for the respective capacities given.

The table in Rule 86 quotes the varying capacities of cars and includes the 60,000-lb. capacity cars.

A 60,000-lb. capacity car with new steel sills and metal ends, if loaded to more than 95,000 lb. would be too heavy on the journals. The loading rules and Rule 2 permit you to load to 66,000 lb. load capacity but if you take the light weight of the car with the weight of the betterments added, you would exceed 95,000 lb. on the rails and overload the journals. I believe there is an interpretation which is not now covered in these rules.

Mr. Gainey: I believe that came out in the rules of 1916 or 1917. The arbitration committee said they based the weight of the car on the journal and that you could not load a 60,000-lb. capacity car to more than 95,000 lb. total weight.

Mr. Fitzgerald: Will all concerned agree that the 95,-

000-lb. limit shall govern us in interchange of equipment? If a 60,000-lb. capacity car, loaded to 66,000 lb., weighs more than 96,000 lb., under rule 86 we are entitled to reject the car, but Rule 2 refers only to 80,000-lb. capacity cars and over.

R. J. Overton (Southern): You will note the loading rules allow 10 per cent in excess of the stenciled capacity of a car. With the average weight of the 60,000 car something like 35,000 lb., that would make a total of 101,000 lb.

Mr. Gainey: In some parts of the country they are transferring cars if the gross weight is over 95,000 lb. Other places are paying no attention to it. They are letting it go up to 106,000.

Mr. Fitzgerald: I believe in the 95,000-lb. limit because the journal is designed at a certain factor of safety to carry that weight. If we agree to observe Rule 86 and forget about Rule 2, it would be generally understood that those cars would not move if loaded over 95,000 lb. light.

Mr. Overton: This question has come up in several ways on the Southern and our mechanical engineers have taken the stand that they are going to be governed by the 10 per cent excess of the stenciled capacity of a car, on 60,000 capacity cars regardless of the total weight on the rail.

Mr. Cheadle: I know of a number of cars recently reaching our line of the old wooden construction with non-A. R. A. axles where the load weighed 66,000 lb. and that weight added to the light weight of the car exceeded 95,000 lb. In other words, that was a heavier load on the non-A. R. A. axle than A. R. A. axles are supposed to carry under Rule 86. The practice in our territory is to be governed in transferring the cars by the transportation department. They tell us whether the car is overloaded or not and we transfer it according to the information we get from them, because they have the bills and in the average railroad yard the car inspector has no access to them.

Mr. Fitzgerald: I move that it is the sense of this meeting that we be governed strictly by Rule 86 so far as the loading of the car is concerned.

The motion was seconded and carried.

Rule 2 and Car Service Rule 14

Mr. Halbert: Rule 2 and Car Service Rule 14 show what the delivering and receiving lines' responsibilities are in the transfer of loads. Rule 2 (e) does not require the acceptance of loaded cars in interchange "when cars can not pass approved third rail clearances or overhead clearances for electrical conductors of the American Railroad Association." We have had quite an argument in our territory over that and I would like to hear the opinion of this body as to who is responsible for the transfer in that connection.

Mr. Wymer: Section (d), Rule 2, says the delivering line will pay the cost of transfer of lading of open cars when dimensions of lading are in excess of published clearances of roads over which the shipment is destined. Now, section (e) refers to approved clearances of the A. R. A. They have certain approved clearances, I think, in regard to the third rail, etc., which I do not think have anything to do with the clearances of an individual railroad.

Mr. Halbert: Rule 2 (d) takes care of the lading on open cars. Car Service Rule 14 (e) has a foot note which says the word "cars" covers both closed and open cars, but not the lading. The foot note comes under an item for which the receiving road pays the cost of transfer or rearrangement, but paragraph (e) especially calls attention to paragraph (d) and I made the decision that the delivering line was responsible for the transfer of a load from a car that is too high or too wide to pass the published clearance of any railroad which the car goes over.

William House (Southern): Car Service Rule 14 says the receiving road shall pay cost of transfer or rearrangement when the cars cannot pass clearances, except as provided in paragraph (d), or when cars cannot be moved through on account of any other disability of the receiving line. Rule 2 (d) refers only to the lading on open cars. If a line delivers a box car too high for an A. R. A. third rail clearance, and would be at the expense of the delivering line. But if that box car is found too high for the individual published clearances of the line over which it is going to travel, it is up to the receiving line to transfer that car at their own expense.

Mr. Halbert: If a car is too high or too wide to pass the published clearances of the receiving line, which are published monthly I understand, according to Rule 14 (d), I think the receiving line is entitled to a transfer.

Mr. Armstrong (Florida East Coast): At Miami, Florida, a furniture car is loaded almost every day. Is it my business as a car inspector to note what lines it will pass over before it gets to its destination?

President Pendleton: I would consider that it is your duty to inform the agent that the car will not pass the published clearances of the roads over which it is to travel and he would be responsible for the cost of transferring before it reached its destination.

Mr. House: Suppose a Santa Fe box car is loaded in the Far West, consigned to St. Louis, and there it is reconsigned and routed over the Southern. Between St. Louis, Mo., and Louisville, Ky., the Southern has four tunnels. We find that it will not clear these tunnels, and we cannot run it. Is it proper to penalize the delivering line for the cost of transfer because we cannot run it or is the Santa Fe supposed to build cars that will clear our tunnels?

This question came up for discussion at Louisville among the car foremen at that point and they ruled as Mr. Halbert did, that the delivering line should pay the cost of transfer. The Monon took exception, the matter was investigated and went to the superintendent of the L. & N. and he ruled that a receiving line was to pay the cost of transfer on box and house cars that were found too high for the clearance of the line they were going to travel over, and it is being handled that way at the present time.

This discussion ended without action, Mr. Halbert stating that the question at issue had been referred to the Arbitration Committee.

Rule 3.

Interpretation No. 6

Q.—This rule permits the refusal of cars when not complying with the various requirements specified. If such cars are loaded, can they be refused, or must they be accepted and transferred at the expense of delivering line and empty car returned?

A.—Cars, whether loaded or empty, must not be offered in interchange if not equipped with an efficient hand brake, per Section A; and United States Safety Appliances or United States Safety Appliances Standard, per Section K, in good order.

Tank cars, whether loaded or empty, must comply with the requirements of Section E and P.

None of the other objections referred to would permit rejection of lading.

Mr. Fitzgerald: The interpretation states that the load must be accepted, but does not say what disposition to make of the car that violates the principles of Rule 3. Suppose we have a car offered in interchange with wooden brake beams. The rule says the car will not be accepted in interchange, but the interpretation states that we cannot reject the lading. What is the disposition?

Mr. Kleist: It is entirely at the option of the receiving railroad, but if they decide to transfer the car they may do so at the expense of the delivering line.

F. W. Trapnell (Kansas City): I would like to ask where there is anything in this rule that will authorize me to give a transfer for a car with two wooden brake beams.

Mr. Fitzgerald: The interpretation plainly indicates that we do not have to take the car, but we are supposed to take the lading. We agreed in a meeting a year ago that to refuse the car in interchange was the right thing to do, and that in thirty days we would not have any question as to wooden brake beams or any of the items referred to in this rule—that they would be taken care of by the road having the car in its possession rather than go to the expense of transfer.

Mr. Trapnell: Rule 2 states that "A foreign bad order car previously delivered under load must be received back by the delivering line." If one road gets a car from another with wooden beams it can transfer the load and return the car, but it transfers it at his own expense. It can repair and bill the car owner, however.

Mr. Wymer: We had a case where a car was offered with a coupler other than the 6-in. by 8-in. shank type D, required under section (0). The car was built after November 1, 1920, and was transferred. We have been asked for transfer authority, which I have declined under Rule 2, which requires that loaded cars offered in interchange must be accepted, with the exceptions named in sections (a) to (e) inclusive. This is not one of the exceptions.

Furthermore, the car service rule says the delivering line shall pay the cost of transfer or rearrangement when transfer is due to defective equipment that is not safe to run according to A. R. A. interchange rules, except where the repairs can be made under load according to Rule 2. The coupler is not defective. If that car had been stenciled as built prior to November 1, 1920, it would have been perfectly safe. A stencil date is not a question of safety.

Mr. Fitzgerald: There is no question but that Rule 2 has reference to defective conditions. But there is no defect on a car equipped with wooden brake beams; it is merely a car moving contrary to the A. R. A. standards. Certain rules have been adopted for the standardization of equipment and in order to get standards certain cars are prohibited from movement in interchange. One of those items covers wooden brake beams, regardless of whether they are defective or not. I contend that such a car may be transferred and returned to the delivering line, the Arbitration Committee already having ruled that we would have to take the load. Certainly if they rule that we have the right to reject the car itself and transfer it for a condition that the delivering line is responsible for, then the delivering line should pay the cost of that transfer. We have got to interpret these rules as they are written. It is not a question of our judgment. If it is a bad rule and we live up to it for a short time it will be changed, but if we say that we are not going to apply the rule because it would not be good judgment to do so we have the rule for several years, and cars are running all over the country with wooden brake beams, for instance.

Mr. Wymer: I think we will have an interpretation on that question. It has been placed before the arbitration committee.

Mr. Armstrong: I do not know what percentage of the cars today are moving with wooden brake beams, but through the Atlanta gateway of 10 roads we had only two in the first six months of 1921.

Mr. Cheadle: This question has been talked of at every convention I have attended and the final outcome has always been that if the car is empty you can reject the car. The construction put on the rules everywhere in our district is that if the car is loaded it is handled according to Rule 2; when it is empty it is handled according to Rule 3.

Mr. Starr: I do not believe there is a man present who has a superintendent of motive power that would stand for his spending $5 to $25 to transfer a car for an owner's defect. If you get the car with wooden brake beams, you can apply the beams and bill the owner.

Mr. Fitzgerald: I move that it is the opinion of this body that Rule 3 and the interpretation in question 6, entitle receiving line to transfer a car offered in violation of the rule, and that the delivering line should assume the expense of transfer, the empty car to be returned as violating the rule.

The motion was lost.

J. E. Vittum (Columbus, Ohio): The second paragraph of Rule 4 reads:

Rule 4.

Defect cards shall not be required for any damage so slight that no repairs are required nor for raked or cornered sheathing roof boards, fascia, or bent or cornered end sills, not necessitating the shopping of the car before reloading.

We have such things as floor planks cut and side planks cut and slightly damaged by fire, and we pass them over as non-cardable defects, taking a record of them, however. They arrive at another interchange point and they are carded against us.

When the Arbitration Committee said "defects so slight that no repairs are required" and "not necessitating the shopping of the car before reloading," did they have any reference to damage by fire or cut floor planks or cut side planks? I would like a candid opinion from the chief car inspectors so that we can have an understanding on this point.

Mr. O'Donnell: In our association at Buffalo any defects to the sheathing, roof, fascia or other parts that endanger the roof or the side of the car, which may damage the lading for the present load or the next load to be put in it, we either cut the car out and repair it or put on a defect car and let it go to the point of unloading. Then we expect the road having the car to respect the rules and repair it. But unfortunately they do not. Any gondola or hopper car that is cut and boarded over, presents a cardable defect. I do not care whether the car comes back to you or not. It is not a perfect car and we are obliged to protect the owner. Any slight fire damage that does not require repairs or endanger the future service of the car should not be carded. Defect cards are not to be put on equipment for fun. Last year and two years ago we all agreed that we would stop carding slight damages, but we have got back into the old rut again. In a way I admire Mr. Shultz. He will card something in Chicago going east and we will tell him there are certain items he has overlooked. He says, "Our rule is that nothing will be given unless we personally see the car," and he stands by it.

James Reed (New York Central): Mr. O'Donnell says we are falling back into the old rut. That is not true. There are only a few railroads that are doing this unnecessary carding. Every day a bunch of defect card stubs goes over my desk from not more than four railroads out of thirty-six or forty railroads entering Chicago. It would take a basket to carry those stubs. I think that this is the place to come to some understanding, if we can. The men out on the firing line are not responsible. It is the man in charge of those men. They do not want to do this unnecessary work. It is up to us to go out to these men and tell them what we want done.

I refer to the western lines that are continuously carding defects on cars which go to their destination and come back without any repairs being made, although there is a notation on the card, "Shop when empty."

Mr. Shultz: There is no difference between a car delivered to an owner and a car passing through interchange. If cards are not required in the one case they are not in the other. It doesn't hurt to have a few sills scratched on the corners where it does no damage. You do not take out a pedestal because it happens to be chipped in the corner. Neither do you remove any car sheathing. We have considerable trouble with the car owner to keep him from plastering his own car. In fact, we have more trouble with that than the car he offers in interchange.

The settlement with private car lines is at their gateway where we have a chance to discuss it. We have less trouble with the private car lines than we have among ourselves.

There are only two conditions under which a car should be carded: If the parts are destroyed and the car is offered empty or is under load and can go to the destination.

J. A. Coleman (Cincinnati, Ohio): Mr. Vittum states that the defects are slight, but he takes a record of them. If the defect is worth taking a record of, it is bad enough to card.

In Cincinnati they handle quite a number of open top cars and we card in such a way as to facilitate the movement of the car, the defect being a cardable defect. If the floor boards or side boards are cut out, that is a cardable defect. What good is such a car at a mine? A miner will not nail a board over it. He will want to pass it on to the road handling it empty.

M. W. Halbert (St. Louis, Mo.): If I get a car in my territory with the floor boards and side boards cut out I will give the receiving line a card against the delivering line.

A. Armstrong (Atlanta, Ga.): We are handling quite a number of coal cars through the Atlanta gateway and my instruction to inspectors is in the event of one floor board cut which is properly boarded over on an empty car that the car may be moved along.

Mr. Trapnell: Such defects are carded to some extent in Kansas City; it is a matter of judgment.

W. J. Stoll (Toledo, Ohio): We card cars with the floors cut out and also cars that are damaged when the damage is on the outside of the car.

George Lynch (Cleveland, Ohio): I agree with Mr. Trapnell that it is entirely a matter of judgment. Much stress has been placed on satisfying the owner. The chief joint inspector, as I understand it, and not the car owner, is the man to say whether defect cards should or should not be issued. If the owner desires to appeal from your decision he has that right. Then the case would be decided on its merits.

We are carding when floor planks are cut through, if we know it. We do not always know it. If the fire damage is burned through the boards, sides, end or floor, we also issue the card; but if the inside of the car is scorched and burned —I do not care how badly as long as it cannot be seen from the outside or below the floor—we do not issue a defect card. I do not know that we can get anywhere on the question of all having the same opinion. We would have to change human nature in order to do that. The rule leaves this as a matter of opinion all through.

Rule 32.

Interpretations Nos. 7 and 8.

(7) Q.—If car is cornered, derailed or sideswiped, and damage is not caused by any of the five conditions named in Section (d), is it handling company's responsibility?

A.—Yes. The five conditions named in Section (d) are only some examples of irregular switching and cover cases of unfair usage other than is covered by other paragraphs of this rule.

(8) Q.—Was Item (e) intended to include the defects on car with missing coupler?

A.—No. This item only applies to defects on adjacent car caused by handling car with missing coupler.

Mr. Shultz: Under Rule 32 in the case of a car delivered to the owner of a connecting line with no evidence of unfair usage, how is it possible to determine whether this car was not in an accident with other cars which were given unfair usage? Whose obligation is it to furnish the information that that car was not so handled?

A Member: The delivering line.

Mr Shultz: I say it is too; but if he cannot furnish it or does not furnish it, does he automatically become responsible for this damage?

President Pendleton: What action would you take in your territory?

Mr. Shultz: I ask the delivering line to furnish the information as to how the car was damaged and they reply invariably that they don't know anything about it. That still leaves it open. I know of a number of cases where a car has been ordered home with all the sills broken, and with no other evidence of unfair usage on it. This becomes a handling defect for that car, and my opinion is that the delivering line must show that the car was not damaged in unfair usage.

Mr. Stoll: We know just what the handling line has to do in case of a car being broken in two or with more than four sills broken in the car. Rule 43 will clear that up.

Mr. Halbert: That comes under Rule 43. If the delivering line cannot furnish the receiving line the information called for it will have to be responsible.

C. S. Shearman (Chicago): A car came into the stockyards with a record showing that it was the seventy-second car in the train. The train had broken in two between the fifth and sixth cars and it was claimed that there was no damage which would warrant the defect card being issued. In other words, it was stated that the car was damaged under fair usage. Yet the car has two wrecked trucks on it. Can you explain how that happened under fair usage?

President Pendleton: In that case there would be evidence enough on the car for the chief interchange inspector to make a decision under the rules.

Mr. Shultz: The case I have in mind is between two western lines where the delivering line broke a car in two. The delivering line knows nothing about it. Is the receiving line entitled to a card?

The Chair: Not under the rules. You have got a case of that kind.

Mr. Stoll: Automatically in that case if the delivering company can prove that the car was handled in fair service and broke in two they are exonerated.

Mr. Giblin: If a car is broken in two the delivering line should be able to say whether or not they broke it or how it was broken. If they cannot I believe they should be responsible.

President Pendleton: I understand a decision just rendered covers that case.

Secretary Elliott: A car arrived on one of our repair tracks with eight sills broken and in our opinion the car was a bad car. However, that is immaterial. We wrote the case up to the car owner and told him we had no record of how the damage occurred; our switching reports did not show anything at all. The owner came back and said under the rules we had to tell him how the damage occurred. We stated we didn't know and we didn't have to tell him. We sent it to the Arbitration Committee, which said we did have to tell him, and that we would have to repair the car at our own expense, which we did.

Mr. Wymer: That seems rather against all the principles of law and equity. In that way a man charged with murder is guilty until he is proved innocent.

Secretary Elliott: I think myself that the decision is unfair, because in checking cars last year we found a number of cars any of you would agree with me were really bad cars. We found in checking up with our switchmen that they did not know whether they had handled the car fairly or unfairly. If it is nothing more than breaking a coupler, if there is any chance to cover it up so that they do not have to make a damage report, they try to cover it up.

Mr. O'Donnell: Was the car delivered broken in St. Louis?

Secretary Elliott: When that car came into our yard, as far as we know, it was absolutely all right.

Mr. O'Donnell: Couldn't you as the handling line say to the owner that the car was damaged in ordinary switching?

Secretary Elliott: No, we could not.

Mr. O'Donnell: You have nothing to the contrary. Where there is a case of doubt take the safe side.

Secretary Elliott: We always thought we could, but the Arbitration Committee said we must have something to show that we did not handle the car unfairly.

H. L. Reynolds (Wabash): A car coming home from the west travelled over a trunk line, went to a switching line in Chicago and lay on their line for 30 days. When the car came home it showed signs of being wrecked; steel center sills were damaged; and there were marks of the cable where they picked the car up. Nobody knew anything about it. It came home and we could not get a defect card for it. Should not the trunk line be responsible for the loss?

President Pendleton: Absolutely. You had the evidence there that the car had been in trouble on somebody's road.

Mr. Herring: This particular question was discussed in Montreal and, as I recall it, we agreed that the proof rested with the handling line.

Rule 33.

Interpretations 2 and 3.

(2) Q.—Are repairs to safety appliances chargeable to car owner on car derailed, cornered, sideswiped or subjected to any other Rule 32 condition where there is no other delivering line damage on the car, it being understood that damage to running boards on tank cars, due to sideswiping and cornering is never chargeable to owner?

A.—In such cases owners are responsible for the expense of repairs to running boards, except on tank cars; handholds, ladders, ladder treads, sill steps, brake shafts, uncoupling levers and parts of these items where not involved with other delivering line damage.

(3) Q.—Are the same repairs chargeable to car owner on a car not derailed but associated with another car that was derailed when the latter only developed other delivering line damage?

A.—Yes.

Mr. Trapnell: A car is derailed and you have a brake beam missing caused from the derailment. You let the car go home to the owner. Is that a cardable defect when offered in interchange?

A. Herbster (New York Central): Brake beam missing cannot be a cardable defect because you cannot run a car without brake beams.

Mr. Lynch: We have a practice at Cleveland whereby the cars are interchanged by puller service. Those trains travel from eighteen to twenty miles and brake beams are lost in transit. The car is hauled into a receiving yard where there is interchange inspection. We do not issue a defect card for the missing beam, but we try to get the delivering line, if the beam was lost on their line, to furnish a beam or their defect card. There is such a thing as cars being delivered with missing beams. But we have nothing in the rules to provide for those things and we must work out a local practice.

Mr. Trapnell: I take Rule 33 to mean that the owner is responsible for the safety appliances to his car unless there is other delivering line damage to the car making cardable defects, and I so ruled. My decision was appealed to the Arbitration Committee and this is their decision:

Q.—Are defective or missing brake beams caused by derailments cardable defects when there are no others?

A.—Your letter of September 14, above stated was considered by the arbitration committee at a recent meeting. I am instructed to advise you that defective or missing brake beams caused by derailments are cardable defects, whether or not involved with other delivering line's damage.

So you cannot put any practical interpretation upon the rules as they are written.

Eugene Head (Wabash): Is not a missing brake beam covered by Rule 3?

Mr. Adams: You cannot have an efficient hand brake if you have not a brake beam.

Rule 87.

Any company making improper repairs by using material which the repairing line should carry in stock, as prescribed in Rule 122, is solely responsible to the owners, with the exception of the cases provided for in Rule 57 and 70. Such improper repairs must be corrected within nine months after first receipt of car on home line, to justify bill.

The company making such improper repairs must place upon the car, at the time and place where the work is done, an A. R. A. defect card, which card must state the wrong repairs made, *and which will be authority for bill for both material and labor for correcting the wrong repairs.*

Interpretation.

Q.—Does the substitution of bolts for rivets in coupler yoke (in emergency cases) constitute wrong repairs for which defect card should be issued?

A.—Such substitutions are considered as temporary repairs for which no charge should be made nor defect card issued, provided the repairs are due to owner's defects. If such repairs are made in a case of delivering line defects, defect card should be issued to cover the expense of standardizing the repairs.

Mr. Jameson: That interpretation covers the case where yoke bolts are applied in place of rivets. If yoke bolts are removed and yoke bolts are applied where rivets are standard to the car will this also be considered as temporary repairs for which no charge shall be made nor defect card be issued, when these repairs are owner's defects?

R. J. Owen (Southern): That is simply perpetuating wrong repairs and I would handle it the same as if rivets had been removed. There would be no repairs.

R. J. McGrail (Chicago & Alton): There are a number of cars in the draft gear of which bolts are standard. If you apply bolts in that case you would be allowed to charge.

Mr. Jameson: That is another question. But on account of the delay to equipment many owners at outside points on their own line are putting bolts in; one of our shops may get that car and under the same circumstances may put in bolts again. The owners themselves have made those wrong repairs, and it appears to me unjust that we should not be able to make a charge in such circumstances.

Mr. Martin (Baltimore & Ohio Railroad): It seems to me that the arbitration committee answered that question. That is not wrong repairs, it is temporary repairs, and a road perpetuates temporary repairs when it puts in bolts. It has the option to put a rivet in and charge for it.

A. S. Sternberg (Belt Railway of Chicago): Even if the car came from the owner with bolts applied in place of rivets, the repairing line should not perpetuate the temporary repairs but should apply rivets and make a charge.

Mr. Jameson: We are charged by foreign lines for the application of the yoke bolts to our cars on which rivets are standard and when we take exception to that bill they claim that they are not substituting bolts for rivets but that they are simply making the repairs as per the car's standard because it carried bolts when it came to them.

President Pendleton: Perhaps some other handling line put those bolts in before he got it, but that does not make it standard to the car.

Mr. Cheadle: The A. R. A. standard is a 1¼-in. yoke rivet. Unless there is a question of transom draft gear, it makes no difference whose car it is, bolts are wrong.

[The remainder of the proceedings, largely a discussion of Rule 101 and the prices in Rule 107, will appear in the next issue.—Editor.]

Cost of Repairs in Railroad and Contract Shops

In testifying before the Interstate Commerce Commission at the time of the inquiry into the railroad rate situation, S. M. Felton, president of the Chicago Great Western gave comparisons of the cost of work in railroad and contract shop.

Mr. Felton said that his road had saved a considerable amount of money owing to the difference in labor costs through the repair of cars in outside shops. Work which the Chicago Great Western estimated would cost $1,100 per car, cost only $800 under contract while the cost of repairing five locomotives which that company has sent to outside shops was about 30 per cent less than what the same work would have cost in the company shops.

He told of having steel freight cars repaired in this manner and said the work was done for about one-third less than it would have cost had his road had the facilities to perform the work. A large part of the equipment which that road had repaired outside, Mr. Felton said, was equipment which had been roaming around the country during the period of federal control under the general plan of pooling equipment.

Free Life Insurance on D. & H.

L. F. Loree, president of the Delaware & Hudson Company, in a circular to employees dated January 1, announces a contract between the D. & H. and the Metropolitan Life Insurance Company, of New York, under which all employees who have been in the service of the road two years or more and who make application on prescribed forms, may have free life insurance to the extent of $500; and may take, at very low rates, additional insurance, up to an amount equal to their respective annual salaries (but not over $5,000).

Advantages of a Manufacturing Tool Room*

Discussion of the Importance of Manufacturing Tool Rooms in Modern Railroad Shops; Several Efficient Jigs

By J. H. Painter
Shop Superintendent, Atlantic Coast Line, Rocky Mount, N. C.

MANUFACTURING tool departments should be located as nearly central as possible on railroads operating 1,000 miles or more, all special tools or jigs being made at this one shop, from sketches furnished to the mechanical engineer, who in turn makes blue prints so that all parts will be standard. We have all advanced in knowledge since the tool room of some years ago which was located as a rule in the machine shop with a leading man in charge, supervised by the machine shop foreman. The latter was then, as now, shouldered with many new problems each day so that often he could not give much time or attention to the operation of the tool room. Many suggestions offered and submitted to the leading man, therefore, were worked out according to a somewhat limited experience.

The manufacturing tool room of today is a separate department in charge of a capable man who devotes his entire time to it. All serviceable tools are kept in the different distributing tool rooms, located conveniently to the machine, erecting and boiler shops in the locomotive department, and the planing mill and steel car shops in the car department. All tools such as air motors, air hammers, air hose and all other tools are returned to the distributing tool rooms in the different departments. If any repairs are needed the employee returning the defective tool is furnished with a serviceable one, which presents delay. The tools accumulating in the different distributing tool rooms are sent to the manufacturing tool room each afternoon, and all repairs are made in that department for the reason that there both repair parts and competent, experienced repair men are available. A large saving, both in material and labor, is effected by having a place for everything in the tool room and keeping everything in its proper place.

Tool Room Equipment

The following equipment is recommended for a manufacturing tool room: one 18-in. engine lathe; one 16-in. engine lathe with backing-off attachment; one 14-in. engine lathe; two universal milling machines, small and large, with all attachments; three die grinders; two universal tool grinders; one surface grinder with magnetic chuck; two drill grinders; one 24-in. radial drill press; two sensitive drill presses; one stock cut-off machine; two emery wheel stands, large and small; one tool cabinet, and two electric furnaces with quenching baths.

Often we have blamed the tool dresser or hardener for a reamer or tap that was warped, when, if the matter was carefully traced back to the steel before it was cut off from the bar, it was found that the tool hardener was not to blame. Many other causes can be attributed to a warped tool. The modern tool maker realizes that a piece of steel must be straight and centered true before putting it in the lathe for turning. If 1/32 in. more of metal is turned off from one side of the bar than the other, the reamer or tap will be warped no matter how careful the tool hardener may be. The system of equalizing the steel by heating to a low red and dipping in warm oil after the red has disappeared will prevent the steel from cracking and springing when being hardened. This process also removes all hard spots from the steel.

More attention is given to the making of accurate duplicate parts in the manufacturing tool room than in other departments for the reason that the tools are often used later by inexperienced men who cannot be depended on for accurate work otherwise.

Chuck for Making Front End Main Rod Keys

A special chuck, illustrated in Fig. 1, was developed at the Rocky Mount tool room for making front end main rod

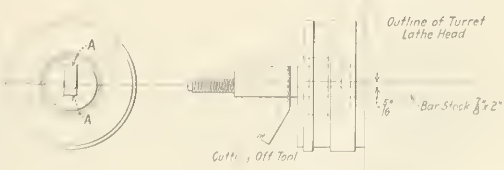


Fig. 1—Chuck for Front End Main Rod Keys

keys on turret lathes and we have found this method to provide a considerable saving in machining these keys. Two of the chuck jaws AA are made 5/16 in. off center and

*From a paper presented before the Southern and Southwestern Railway Club.

hold the bar of iron in position so the adjusting screw on the end can be turned and threaded as shown. The cutting-off tool is then brought into play and the key subsequently given the required taper.

Machining Tank Valve Bodies

Before using the tool, shown in Fig. 2, tank valve bodies were chucked in a lathe, bored and seated by a machinist or apprentice, thus making a lengthy, expensive operation. Considerable time is saved by the tool illustrated which consists of a bar of machine steel turned to a No. 5 Morse taper

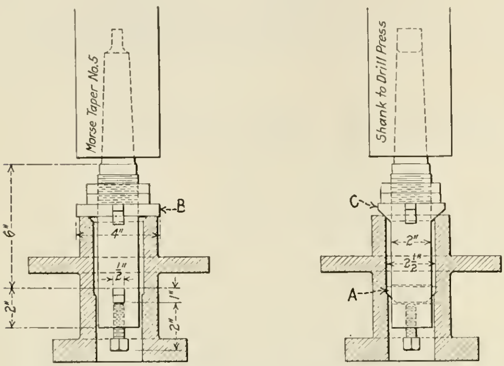


Fig. 2 Tool for Machining Tank Valve Bodies

on one end for insertion in the drill press spindle. The other end is slotted at three different points to receive double-acting cutters, *A*, *B* and *C*, arranged to bore, face and seat the tank valve respectively in one operation. We machine about five valves on the drill press to one on the engine lathe. The operation is performed by a special drill press man, no lathe chucking, setting up or similar operations being required. The bar is made of machine steel and all cutters of high speed steel. Brake cams are machined in the same way.

Making Wheel Lathe Forming Tools

Before the method of machining wheel lathe forming tools illustrated in Fig. 3, was installed in the manufacturing tool room, all forming tools were shaped to size, thus causing the labor cost to run very high. Several chucks have been made for this work but holding only one tool. By holding four tools we effect a considerable saving in the cost of the work.

The forming tools in the rough are drilled with a one-inch hole at the flange end, thus leaving less metal to be removed by the milling cutters. The latter are made in two separate pieces and of the same contour as called for by the M. C. B.

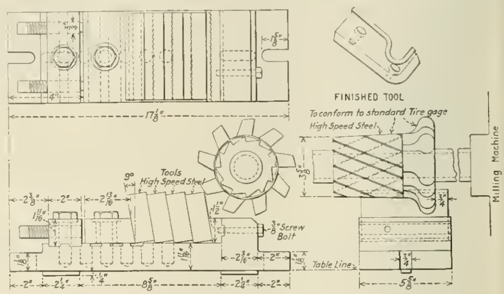


Fig. 3—Wheel Lathe Forming Tool Chuck

rules, having a taper of 1 in. in 20 in. This allows the tools to fit square in the chuck while the cutter makes the required taper. The teeth are spaced quite far apart in the cutter in order to allow ample clearance for the chips. Two cutters are used to make forming tools, one standard for trailer and driving wheel tires, and another for tender truck and switch engine tires. It became necessary to have two tools when the flange of tender and switch engine tires was changed from 1⅛ in. to 1 in. high. This method of making forming tools saves approximately 65 per cent over former methods.

Ripping Flue Expander Segments

A fixture, shown in Fig. 4, was designed to hold flue expanders so that they can be cut in segments without leaving any burrs. By the use of the fixture the saw cuts each piece clear through and no pieces are left to be ground or filed. When removed from the fixture each piece stands alone, and all pieces are interchangeable. Referring to Fig. 4, the body *A* is made of steel tubing, *B* being a plug welded in one end. *C* is a plug which follows the expanders and is provided with a key which slides in the end of the barrel, thus causing the slots in the plug to always come in line with the slots in the body of the jig. *D* is a plug or long nut which screws in the end and holds the expanders tight.

In cutting the expanders we drop eight (or more accord-

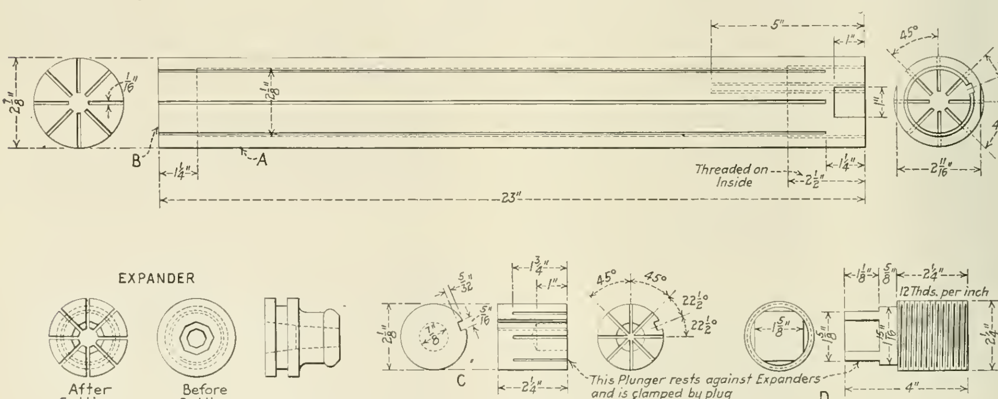


Fig. 4—Fixture for Use in Manufacturing Flue Expander Segments

ing to the length of body *A*) in the barrel; *C* follows. The nut or plug *D* is then tightened down and the dog or driver placed on the square end of the nut. The index head, or miller, is set so it will follow in each slot; then the milling is done. The slots in the fixture are milled 1/64 in. larger than the segments are to be cut. By using a triple head and three fixtures we can mill 36 expanders at one setting, making body *A* long enough to hold 12 instead of eight. The same feed is used with three cutters, as the machine can drive them with ease. By using this fixture we save on one operation alone five segments out of eight; that is, we can rip eight with this jig as quickly as we could rip three with the old mandrel. Another advantage is that when the eight segments are finished they are all separate segments. On the old style mandrel there are three to break apart, then grind or file.

Jig Used in Milling Taps and Reamers

A special jig, Fig. 5, was designed so that three spiral reamers can be milled at the same time. The angle plate *1* is made of cast iron; the spindles or centers are made of 2¼ in. tool steel hardened and drawn. The inside center remains stationary, while the other two can be moved in and out. The three head centers are all movable. The object in

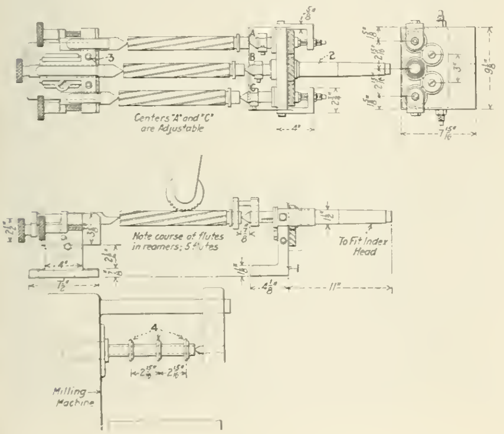


Fig. 5—Tap and Reamer Milling Jig

having the spindles or centers move in or out is to make each of the three milling cutters stop at the head of the reamers when milling spiral flutes. The spindles and centers can be adjusted so that any ordinary spiral can be cut on a reamer. The center spindle *2* is placed in the socket of the index head and is geared to the other two, so that all three will rotate in the same direction. The dead centers are placed in a single stand, two set screws *3*, being used to lock the three dead centers. The gears are cut spiral, thus overcoming practically all lost motion. The two back live spindles are graduated so that when reamers are milled to eight degrees or any other spiral, the spindle can be set before the reamers are placed in the jig so that the cutters will reach the end of the flute at the same time.

When the jig is ready for operation the index head turns and the reamers turn with it, just as if all was solid. The milling cutters are shown at *4*, spaced with blocks, each cutter being of the same size. Practically all frame reamers are made with five and six flutes, eight degrees spiral. When using this jig we always use the same speed and feed, just as though we were using one cutter. The labor cost is reduced about 60 per cent.

Adjustable Mandrel for Turning Eccentric Cams

Although practically no new locomotives are now equipped with the Stephenson valve gear, there are many of these old gears still in service and an adjustable mandrel of value in turning the cams is shown in Fig. 6. The job is preferably done on a boring mill, but can be performed on a lathe. The base *A* of the fixture is clamped firmly in a central position on the table or face plate of the machine. The graduation plate *B* shows six different throws and answers for all common Stephenson valve gears. We use only two mandrels,

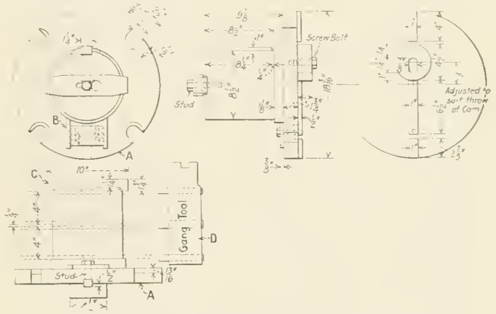


Fig. 6—Adjustable Eccentric Cam Turning Mandrel

16½ in. and 15½ in. The top clamp *C* is made so that one turn of the cap bolt releases the clamp. The clamp is then slid over and lifted off.

In using the mandrel each throw can be easily obtained without removing the mandrel from the machine bed. Two eccentrics are machined at the same time, ¼ in. space being allowed between them. They are provided with a keyway before turning and fit over a key in the mandrel. After being

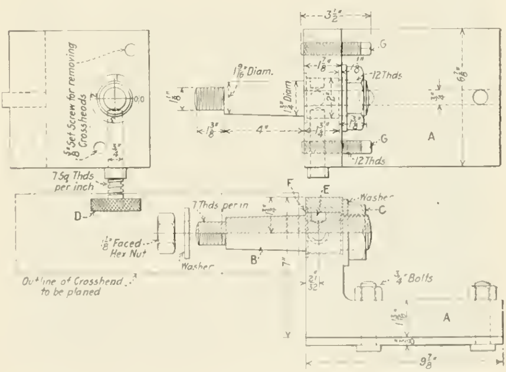


Fig. 7—Jig for Use in Planing Valve Stem Crossheads

turned on the outside, the gang tool *D* is used and both cams are finished at the same time for the lips on the eccentric straps. By using this mandrel we save the cost of laying the blocks off in order to secure the proper throw. The mandrel does this and holds the blocks rigidly and allows a much heavier cut to be obtained and therefore the time saved by its use is considerable.

Jig for Planing Valve Stem Crossheads

For machining valve stem crossheads from the rough, or after metal has been applied, the jig, shown in Fig. 7, has been developed. The objects of using the jig are first, to reduce the time consumed in the operation; second, to produce more accurate machining, and third, to cause the operator to be more interested in the work, due to the fact that the crosshead is set up only one time.

In applying the jig to the planer table, *A* represents the base of the jig which is placed on the planer or shaper, being held in alinement by the tongue which fits in a slot in the table. Two bolts and nuts fasten the jig securely in place. The crosshead is applied to spindle *B*, being held in position by the nut and washer shown. After one side of the crosshead has been machined the nut *C* is loosened, also screw *D*, thus allowing spindle *B* to revolve freely. The crosshead is given one quarter of a turn, screw *D* tightened and locked in hole *E*. Nut *C* is then tightened when the second side can be planed. The other sides are planed in the same way. The spindle *B* has four holes into which screw *D* threads tightly as each comes around. This makes practically an index head with four positions 90 deg. apart. When the crosshead is ready to be removed the two screws *G* are tightened, thus causing the crosshead to be removed without a blow from a hammer. By using the two screws the spindle can always be kept in excellent condition.

Since using this jig we have reduced the operation of planing a valve crosshead 75 per cent as determined by actual time studies, counting the time from floor to floor. The base of the jig is made of cast iron, the spindle of 2½ in. high carbon steel, hardened and drawn. *F* is a bushing in the cast iron base. The spindle is ground in so there will be no lost motion. The construction is such as to insure accurate work, prevent the loss of time in using surface gages, and increase production.

Grain vs. Flesh Side for Leather Belts

During the latter part of the past summer, tests of the capacity of the grain and flesh sides of leather belts were begun in the research laboratory at Cornell University under the direction of R. F. Jones, director of the laboratory. Covering a period of more than two months, continuous tests were run on the testing apparatus belonging to the Leather Belting Exchange, which is being operated under the supervision of the university, using five 4-in. single belts, 30 ft. long, of different manufacture. They weighed from 16 to 18 ounces per sq. ft. Every effort was made throughout the tests to standardize conditions and to reduce the probable error to a minimum; all this unquestionably was accomplished. All five belts were run long enough previous to the experiments to have been thoroughly "run-in," and had reached a condition of constant capacity when the records were taken.

The method of procedure was to take horsepower readings from the belts first when running on the grain sides, and then when running on the flesh, the power being gradually increased until about 4 per cent slip had been reached.

In considering the results, it must be remembered that a leather belt is at its lowest point of capacity when new, largely because of the elasticity of the leather and the newness of its surface. Leather belts are well stretched in the process of manufacture, so that when the belt is put on the pulley there may be as little stretch as possible consistent with thorough lubrication and retaining the natural life or elasticity, which is such a valuable property of the leather belt. When a new leather belt is placed on the pulleys, however tightly, it will elongate under load. But after the tension of the load has been removed it returns very nearly to its original length. This stretch is an annoyance when installing a new belt, but it is of the nature of a safety valve, protecting both belt and machinery.

To review the details of each individual test would require more space than is here available. Suffice it to say that a summary of all of the results is clearly in favor of the grain side from the standpoint of power transmission. In fact, it may be concluded from it that under reasonable shop tension, the flesh side will average only 50 to 60 per cent as much horsepower as the grain side. At higher tensions the flesh side will do better, averaging from 50 to 100 per cent as much power as the grain, depending upon the belt, the tension and the conditions of service.

A curve plotted from the readings taken when the belts were running on the flesh side is similar both in shape and capacity to that given by many of the leather belt substitutes. All that can be said of the test belts run on the flesh side is that the data obtained from them were more uniform than that taken when they were running with the grain side in contact with the pulley.

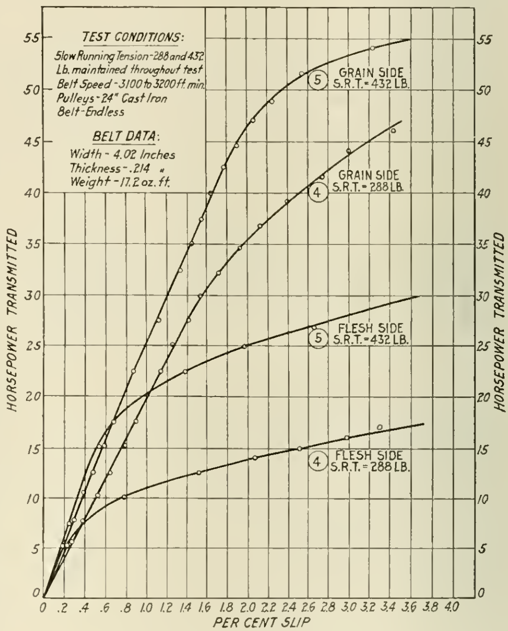


Chart Showing Results of Belt Tests

Using the horsepower transmitted and the percentage of slippage as the co-ordinates, on Chart PT 57, which is representative, the grain tests showed an almost curveless gain in horsepower up to 53, when the slip reached about 3 per cent for belts running at a slow running tension of 432 lb. In the case of the test belts operated at a slow running tension of 288 lb., the 3 per cent slippage was reached at about 44 h.p. With the belts running on the flesh side, however, the 3 per cent slippage mark was reached at 28 h.p. when operated at a slow running tension of 432 lb., and at 16 h.p. when the tension was 288 lb.

In short, the evidence produced from the mass of data obtained leaves no reasonable doubt but that there are distinct advantages in power transmission to be had from running leather belts on the grain side. It is simply another case where scientifically obtained evidence must outweigh arbitrary opinions held usually by reason of personal and, oftentimes, inaccurate observation.

High Power Surface Grinder a Useful Shop Tool

Description of Typical Machine Operations Economically Performed on Blanchard Vertical Type Grinder

THE grinding machine in its early stages was for the most part a low power tool, used exclusively for finishing operations. As the grinder demonstrated its value, however, and came into more general use, there was a gradual development until at the present time grinding machines are available of sufficient power to finish castings and forgings from rough stock in one operation with a considerable saving in time, reduced labor cost and increased accuracy of work.

Several different types of production grinding machines have been developed and are now being used in railroad shops with extremely satisfactory results. Among these may be mentioned the high power vertical surface grinding machine with rotating work table, made by the Blanchard Machine Company, Cambridge, Mass. Typical operations, economically performed on this machine, are described in the following article, and include grinding such locomotive parts as cylinder packing, slide valves, balance plates and steam chest covers, valve strips, rod washers, rod keys, crosshead keys, grease cellars, small links and link blocks, and hammer die blocks within the capacity of the machine. These are but a few examples of many parts which could be mentioned.

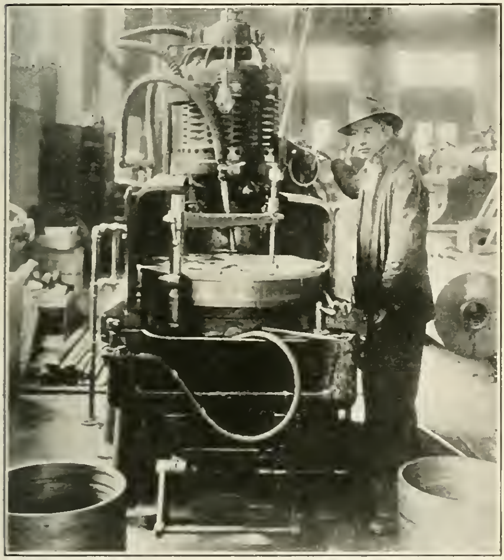


Fig. 1—Blanchard Direct Motor Driven Grinder Finishing Crank Pin Collars

Although Blanchard grinders with belt drive can be furnished if desired, the No. 16 direct motor-driven machine, illustrated in Fig. 1, is recommended as being the most efficient and desirable to install for general railroad machine shop work. The production of this machine is greatly augmented by the rotating table which is made in the form of a magnetic chuck and grips the work by the turn of a switch, thus practically eliminating the time required to set up work. The chuck is 30 in. in diameter and work up to 12 in. high can be ground on the belted machine, or 14 in. high on the direct motor driven machine. A continuous reading caliper attachment graduated in thousandths, is provided for rapidly and accurately measuring thickness. This is shown in the illustration.

Crank Pin Washers and Cylinder Packing

The crank pin washers shown on the machine in Fig. 1, are made of steel of approximately 7¾ in. outside diameter, 2½ in. inside diameter and ½ in. thick. They are received either rough forged or rough machined and ground on both sides, approximately 1/32 in. of stock being removed from either side to a limit of plus or minus .01 in. Seventy-five washers can be ground per hour. Should some practical shop man question the need for an accuracy of .01 in. on a crank pin washer, suffice it to say that much greater accuracy could be obtained if necessary with no increase in time or effort.

The essential advantage of grinding packing rings is that both sides can be held parallel and to size within extremely close limits. While greater accuracy can be secured on the grinding machine, it is doubtful if a limit of more than plus or minus .003 in. would be justifiable or necessary. Another advantage in grinding packing rings is that a coarse feed may be used in cutting the rings from the packing pot on the boring mill, thereby reducing the machining time for this operation. It may be argued that there is no advantage in grinding the sides of packing rings to close limits when the grooves in which the rings fit are not machined so accurately. The reply to this is that if piston ring grooves are machined as accurately as possible with modern equipment and packing rings are kept to within close limits of accuracy, the best fitting ring which it is possible to obtain under the conditions will be assured, the life of the rings will be increased and steam leaks reduced.

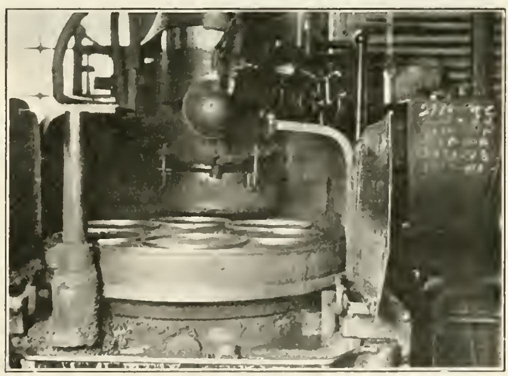


Fig. 2—Finishing Air Compressor Packing Rings

All sizes of packing rings in common use can be ground. Those shown in Fig 2 are air compressor packing rings approximately 9½ in. in diameter. When cylinder packing rings are ground, the records show that a 24 in. ring can be ground on two sides, removing approximately .01 in. per side and to a limit of plus or minus .003 in., 20 rings being ground per hour.

Truing Slide Valves

Slide valves are ground, as illustrated in Fig. 3, and can be finished in one setting without subsequent hand work. Previously, new valves were either milled or planed and then scraped to a good bearing. As the scraping was a hand operation, it consumed considerable time but by grinding, scraping is entirely eliminated and the grinding time is considerably less than would be required to mill or plane the surfaces. The two valves shown in the illustration are made of cast-iron of approximately 19 in. by 8½ in. by 4½ in. over all dimensions. These valves are ground from the rough on two sides with 3/16 in. of stock removed from each side, the limit of accuracy being plus or minus .006 in. Six valves can be ground per hour.

As with other grinding operations this one possesses a particular advantage in the case of worn slide valves with glazed and extremely hard surfaces. These surfaces are too hard to be scraped without preliminary machining but are ground true rapidly, economically and with the removal of a minimum amount of metal. Had there been only one valve to grind it would have been placed in the center of the chuck

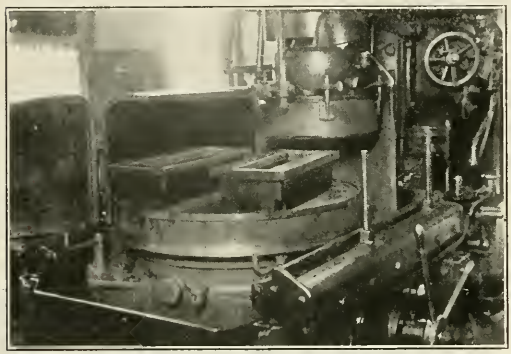


Fig. 3—Worn Slide Valves Are Trued by Grinding

and a higher chuck speed used, reducing the time proportionately.

Grinding Driving Box Grease Cellars

Driving box grease cellars are usually made of cast-iron and on account of the thin sections the castings oftentimes are so hard that it is difficult to machine them. They are also comparatively weak structurally and if subjected to undue clamping strain are liable to crack. From a consideration of the above facts it is evident that the machining of driving box cellars is an operation particularly adapted to being performed on a grinding machine equipped with a magnetic chuck. Cast-iron driving box cellars 10 in. by 8 in. by 6 in. in size are received in the rough, two sides only being ground (the ones which make the fit in the driving box). One-eighth inch of stock is removed from each side of the box, the limits of accuracy being plus or minus .01 in Fifteen cellars can be ground per hour.

An incidental advantage of grinding driving box cellars or other castings from the rough is that patterns can be trimmed closer since the grinder does not need to go below the hard surface of the casting. All that is necessary is to clean up the surface. Forgings for rod keys and other small parts can also be made much closer to size with the single requirement that there be enough metal to clean up the surfaces to finished size.

Segmental Retaining Rings

When work is held magnetically, setting up time is practically eliminated and it is easy to change from one job to another. For example, after grinding main valves or steam chest covers, the machine can be used immediately without further adjustment, save lowering the grinding wheel spindle, for grinding a set of retaining ring segments. A group of eight of these segments is shown on the grinding

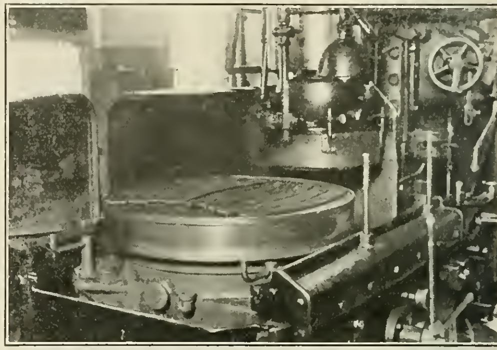


Fig. 4—Magnetic Chuck Facilitates Holding Retaining Ring Segments

machine table in Fig. 4 ready for grinding. They are approximately 21 in. by 2½ in. by ⅜ in., being received rough from the blacksmith shop, where they are bent to the required arc to fit the driving wheel center with which they are used. Both sides of the segments are ground, approximately 1/16 in. of metal being removed from each side, or enough to clean up the surfaces. About 27 segments can be

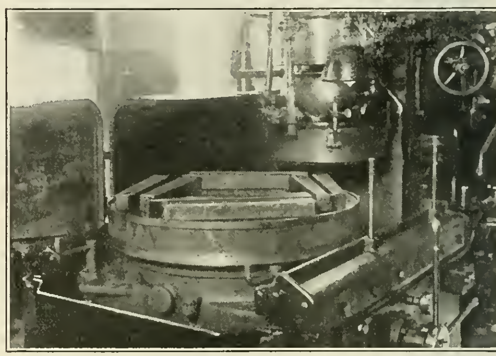


Fig. 5—Main Rod Keys Being Dressed for Further Use

ground per hour depending upon their size and the number that can be placed on the chuck of the grinding machine.

Miscellaneous Grinding

Main rod keys can be forged or roughed out from bar stock with heavy feeds and finished on the grinding machine. These keys are made in many different sizes, being ground on two sides and approximately 1/16 in. of metal removed from each side. An allowance of plus or minus .01 in. is adhered to for this work and while this limit may seem unnecessarily close it can be obtained without slowing down the production of the machine and will result in better fitting keys. With 12-in. keys 1¼ in. thick, and having a taper of 2½ in. to 1¼ in., 36 keys can be ground per hour. With 10-in. keys, ½ in. thick and having a taper of 3 in. to 2¼ in., the production is 30 per hour. Worn main rod keys can also be dressed as shown in Fig. 5 and made ready for use again. For this latter work the rapid set up and quick removal of just enough metal to clean up the surfaces is a most important advantage

Owing to the extended foot on the Walschaert link, it would usually be too long to be held on the table of the Blanchard grinder but the smaller Stephenson links and link blocks can be ground effectively on this machine. Stephenson links, 24 in. by 8 in. by 3 in. thick, are ground on two sides, approximately ⅛ in. being removed from each side to the limit of .006 in. Six links can be ground per hour.

Pedestal braces, made of cast-steel, 18 in. by 7½ in. by 7½ in. are ground on two sides, ⅛ in. stock being removed per side with three braces placed on the magnetic chuck at one time. Twenty minutes floor to floor is the time required for grinding. Another important use of the Blanchard as well as other types of grinders is due to the present tendency to electrically weld many broken parts and build up worn places with electric welding. Tools and cutters, subsequently used to finish these built-up places to size, often will not stand up under the hard usage but with the grinding machine. welded surfaces are finished quickly and smoothly to the exact dimensions required.

An Investigation of the Art of Milling*

Conclusions Drawn from an Investigation of Milling Cutter Action Carried Out at the University of Michigan

THE practice of milling has, during the present century and the last decade of the nineteenth century, encroached decidedly on the field occupied by the shaper and planer. The action of milling possesses advantages over shaping; it also has its drawbacks. Much work must be done before we can state the relative merits or potentialities.

In the art of milling, the only published investigations have been handled by machine-tool builders. Attention has in consequence been focused more on the machine than on the cutter. Further, in the investigations already made, the objects sought have usually had the defect of being too immediate. This paper describes an attempt to investigate the fundamental principles underlying the action of milling.

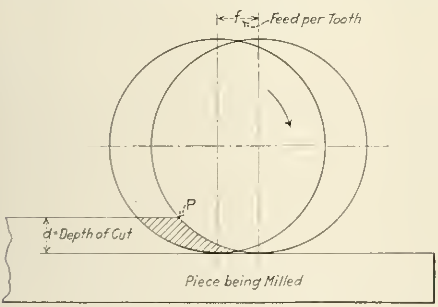


Fig. 1—Shape of Milling Chip

It is shown in the present investigation that metal is removed more efficiently with thick chips than with thin chips. It follows from this that, other conditions being equal, including speed and feed per minute, the cutter with the fewest teeth gives the greatest efficiency. However, it is evident that the efficiencies of two cutters with different numbers of teeth are equal provided the table feeds be adjusted so that the same feed per tooth is effected. This gives a definite working theory on the influence of spacing.

In addition to the present investigation, experiments published in substantiation of the advantage of wide spacing agree in confirming this theory. It is definitely established that for a given material, tooth shape and sharpness, thickness of chip is the sole criterion of the efficiency with which metal is removed in milling and that increase of spacing over that required for free cutting is a handicap. Present-day high-powered cutters have several times the chip space needed. Limitation of machine power has doubtless been the chief factor in giving false bias to the influence of spacing.

A Dynamical Study of Single-Tooth Action

The chip taken by a plain slab mill is very different from the chip taken by a lathe or shaper tool. A milling chip is shown exaggerated in the shaded portion of Fig. 1. The two circles show the outline of the cutter at the beginning and at the end of the interval taken for the cutter to revolve through the angle subtended by one tooth. The shaded portion will therefore represent the material removed by one tooth and will have an area $f \times d$.

The chip starts infinitely thin and its thickness gradually

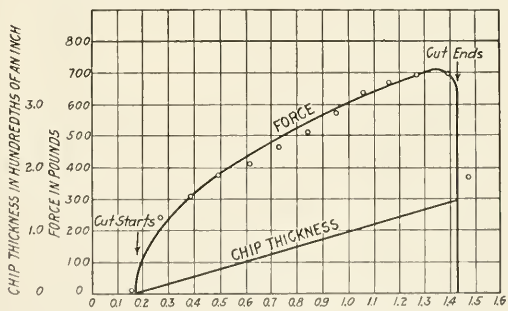


Fig. 2—Force-Space Curve of Chip Formation

increases to a maximum just before the finish, from which point it quickly decreases. This decrease is practically instantaneous in an unexaggerated chip. The question arises, how does the force vary throughout the cutting of this chip?

The first problem is to find how the tangential force varies in relation to chip thickness. For measuring this force while the chip is being formed under reasonable commercial velocity conditions, a dynamical measuring method is the only solution, as a chip is completely cut in about one-tenth of a second.

An example of a chip study made with a special chip in-

*Abstract of a paper presented by John Airey, professor of engineering mechanics, University of Michigan, and Carl J. Oxford, chief engineer, National Twist Drill & Tool Company, Detroit, Mich., at the December, 1921, annual meeting of the American Society of Mechanical Engineers.

vestigator is given in Fig. 2, where it is very clearly shown that the force employed is not proportional to the chip thickness. In other words, material is removed more efficiently as the chip becomes thicker. This is confirmed later by experiments on varying feeds and furnishes the true explanation of the supposed advantages of coarse-tooth cutters.

Over twelve hundred chips were cut and the energy computed. These were taken at three different cutting speeds, viz., 17.5, 32 and 44 ft, per min., respectively. The average of the energy required at different speeds was remarkably equal. If the energy used at lowest speed be taken at 100, the results are:

Speed in ft. per min.	17.5	32	44
Energy	100	101.8	97.4

As there appears to be no law in this and the variation is slight, presumably due to experimental error, the conclusion was reached that speed does not influence energy required.

Influence of Rake and Feed. The results of the analysis of sixteen sets of chip formations each in cast iron, bronze, machine steel and carbon tool steel are given in the following table. The consistently superior economy of heavy feed is observed. Taking the 0-deg. rake tool as 100, we have:

	Cast Iron	Bronze	Machine Steel	Carbon Tool Steel
Production of 0-deg. rake tool =	100	100	100	100
Production of 10-deg. rake tool =	133	113.2	118.7	106
Production of 20-deg. rake tool =	138.4	123	157.2	112.2
Production of 30-deg. rake tool =	142.1	118	172	112

Effect of Lubrication. Various experiments were run with lubricants. The results must be taken qualitatively rather than quantitatively. This topic offers an important field of investigation for future experiments.

In milling there is a decided influence entirely apart from heat-conducting properties. If the surface exposed by the last chip was very slightly smeared with an oiled finger (the oil film was scarcely discernible), the energy consumed in taking the next chip was from 10 to 25 percent lower in nearly all cases.

TABLE 1 EFFECT OF LUBRICATION

Milling Cutter: Clearance angle, 5 deg.; rake angle, 10 deg.; spiral angle, 0 deg.; diameter, 6 in.; number of teeth, 34; depth of cut, 0.3 in.; width of cut, 0.5 in. Material: Alloy steel No. 10.

Exp. No.	Feed in. per min.	Speed r.p.m.	Vol. per Tooth cu. in.	Torque in-lb.	Cu. in. per hp-min.
1026 Oil	0.92	27.9	0.000145	306	1.018
1026 Dry	0.92	27.9	0.000145	364	0.855
1027 Oil	2.36	27.9	0.000375	760	1.070
1027 Dry	2.36	27.9	0.000375	875	0.930
1028 Oil	3.10	19.3	0.000710	1335	1.148
1028 Dry	3.10	19.3	0.000710	1430	1.071

The results of six experiments, which merely touched the fringe of the effect of lubrication, are given in Table 1. It is dangerous to generalize too broadly from a few results, but one can at least conclude that lubrication effects a reduction of energy and that this reduction appears more pronounced in light cuts. It should be again noticed that this is almost pure lubricating action and that the conduction of heat by the oil plays only an insignificant part.

Effect of Spiral. A 34-tooth non-spiral cutter 6 in. in diameter and having a 10-deg. rake was run in comparison with cutters similar in all respects excepting that they possessed a 12½-deg. spiral angle. Two cutters with left- and right-hand spirals, respectively, were used in combination, thus eliminating end thrust. Two different combinations of speeds and feeds were used. The material cut was machine steel. The results were as follows:

R.p.m.	Feed, in. per min.	Cu. in per hp-min. 0-deg. spiral	Cu. in per hp-min. 12½-deg. spiral	Lost output of spiral cutter
28.1	0.92	0.422	0.338	20 per cent
16.1	0.92	0.568	0.458	19.4 per cent

The authors are well aware that a general belief exists in the superior power efficiency of spiral cutters. Frequent statements to this effect can be found in the literature of the subject. In this investigation it has been impossible to substantiate these. It is difficult to understand the growth of the belief that spiral cutters are more efficient, because abstract analysis leads to the conclusion that spiral cutters must be inferior to straight cutters. By "inferior" the meaning intended is in reference to power efficiency only. The use of a spiral angle is heartily recommended, for it results in continuity of action, tends to avoid chatter, and keeps the driving power more smoothly constant. The smallest angle consistent with smoothness of action should be used.

Theory of Tooth Spacing. Opinions differ on the influence of tooth spacing or, in other words, the relative merits of coarse-tooth compared with fine-tooth cutters. Many cutter manufacturers standardize two types, the fine-tooth cutter and the "high-powered" cutter. Experiments have been published purporting to show the advantage of coarse-tooth cutters. Possibly many others have been made and have probably convinced the experimenter that the claims made were justified.

There is an interesting delusion in this subject and it is unfortunate that it has held sway for so long, for it has resulted in inefficient types of cutters being used. Most of the so-called high-powered cutters today on the market would be improved if more teeth were given.

It has been demonstrated earlier that the force required to remove metal does not increase in proportion to the chip

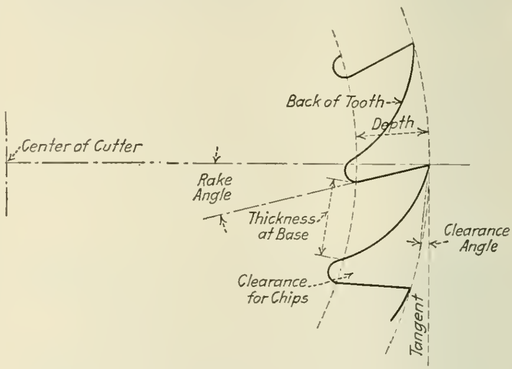


Fig. 3—Definition of Terms

thickness. It follows directly from this that as feed is increased the force will not increase in proportion.

Another way of stating the last paragraph is that the heavier the chip the more metal removed per hp-min. If one were to make a comparison of two cutters with different numbers of teeth but run at the same speed and feed per minute, then obviously the cutter with fewer teeth would remove the metal with less power because the chips are thicker, there being fewer teeth cutting per minute for the same amount of metal removed. It appears illogical, *a priori*, to suppose that the force action of a single tooth under any given set of conditions should be influenced by the location of neighboring teeth, *if free cutting is in operation.* This view is fully substantiated by experiment.

Referring to the preceding paragraph, if the feed has been increased with the fine-toothed cutter in the ratio of a number of teeth in the two cutters (thereby making a chip of the same thickness as with the coarse-tooth cutter), *then exactly the same cubic inches per hp-min. would have been removed as were removed with the coarse-tooth cutter, and more actual cubic inches of material would have been removed per minute, provided the limit of machine power had not been reached.*

If comparative tests had always been analyzed from the point of view of chip volume (or maximum chip thickness, if the depth of cut varies), then the unmerited virtue of wide spacing would never have been recognized.

Shape of Tooth

The following six features of a tooth will be discussed:

a Clearance	*d* Depth
b Rake	*e* Thickness of base
c Shape of back	*f* Clearance for chips.

These features are defined in Fig. 3:

Clearance. Excessive clearance does not reduce the cutting force, does not appreciably affect the life of the tool in normal wear, but does tend to chattering action; also it weakens the cross-section near the cutting edge and increases liability to snip. Clearance should therefore be kept to a minimum. Three degrees was found to be ample but 5 deg. was usually used. In many tool cribs it might be desirable to standardize at 8 deg., due to the possibility of an error of a few degrees. In practice it is customary to speak of clearance in thousandths of an inch at the heel of a land. This is obviously a safer method, as the heel might bind for any given clearance angle if the land were sufficiently extended. However, for scientific analysis it is better to use degrees.

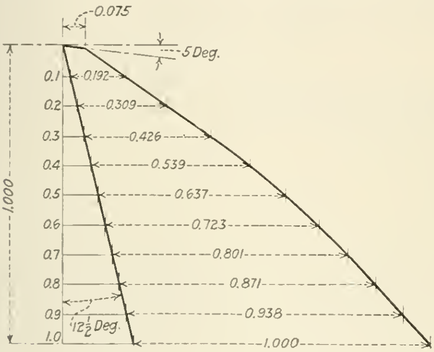


Fig. 4—Ideal Shape of Tooth

Rake. From a power-consumption standpoint rake is increasingly beneficial as it becomes greater. The advantage of rake, though, does not increase at so fast a rate after about 15 deg. is passed. Further, this is influenced by the kind of material being cut. On the other hand, the life of the cutter might be influenced disadvantageously by giving the teeth excessive rake.

It is believed that the greater the rake, the longer the life, from a simple abrasion standpoint. An increase in rake, however, necessitates a decrease in the heat conductivity of the tooth, as a consequence of which increased wear due to rising temperature is more likely to occur. A compromise can be obtained only by experiments on endurance and this is treated later.

While the decided power advantage afforded by rake is indisputable, it is not advisable to jump too far in the higher regions. Had the importance of developing cutter design in this direction been acted upon decades ago, as it should have been, then we should be on a much safer footing, as a considerable amount of data would have been available regarding action of greater rakes in all types of situations.

Under the circumstances, the authors believe and recommend that cutters be given 12½ deg. rake; further, that for any definite job it might be very desirable to go beyond this, even as high as 25 deg., but that 12½ deg. may safely be taken as a minimum, with the possible exception of rare and unusual jobs.

Shape of Back. The ideal tooth is that which is just as likely to break in one place as in another. Any deviation from this shape is providing useless excess strength and is detracting from chip room or deleteriously increasing tooth spacing. An ideal tooth shape is given in Fig. 4, with construction data.

Depth. The depth is controlled partly by the length of grinding life expected, but chiefly by the spacing, which in turn will be shown to depend on chip clearance. It is not possible by any method of calculation to predetermine the chip space necessary for given conditions of cut. The space actually needed is a function of the shape of the chip, depending on just how tightly it rolls, manifestly a condition not lending itself to computation.

This feature can be determined only by experiment, but one fact should be kept clearly in mind in considering this, viz., that the shape of the space between teeth is equally important with its net area. The shape should be such as to prevent the chips from "packing," for this quickly causes the power to increase abnormally. Narrow, wedging bottoms must be avoided. The prevention of packing is facilitated by a spiral cutting edge; it is less liable to occur in thin cutters than in thick ones.

Thickness at Base. For a given depth, the thickness at the base is controlled by the ability of the tooth to resist fracture. This is, in turn, dependent on the quality of steel. Thickness at the base is taken as equal to depth in the recommendation here given. This is fairly consistent with present practice and gives an ample factor of safety for cuts that are customary.

Clearance for Chips. Chip clearance should be sufficient to accommodate the heaviest cut that it is desired to take, and no more. It has previously been shown that if clearance is more than necessary or if the cutter is used for chips smaller than the maximum possible, then metal-removing possibilities are being sacrificed. Chip-clearance requirements govern the spacing, and this in turn fixes the number of teeth in a cutter for a given diameter.

Design Formulas. Formulas for determining the number of teeth for a known diameter of cutter and for determining the depth are given below, and a geometrical construction for obtaining shape of tooth has been given in Fig. 4. The arguments demonstrating the rationality of these are given in an appendix to the complete paper.

Let n = number of teeth

R = radius of cutter in inches

d = radial depth of straight face in inches

then

$$n = 19.5\ R^{1/2} - 5.8$$
$$d = 0.215\ R^{1.2}$$

General Consideration of Removing Metal by Milling. It is an interesting and profitable line of thought to consider, in its broadest phases, the problem of removing metal by milling. The first factor to be considered is chip thickness. In order to remove the maximum amount of metal per hp-min. the chips should be as thick as possible.

The chip weight is limited by the endurance properties of the cutting tool, as is also the cutting speed, which is the second factor to be considered. Various experimenters in lathe-tool action have shown that, for a given tool, the chip weight and the cutting speed are interrelated. It should be remarked here that the degree of bluntness permissible in a milling cutter is very slight, when compared with the allowable bluntness of a continuous-cutting tool.

The greatest metal-removing capacity occurs when the product of chip volume and cutting speed is at a maximum. Let us assume that the most advantageous combination of speed and thickness is known for a given tool and material, so that these factors may be kept constant. It then follows that the closer the teeth are together, the more metal will be removed per minute, provided, of course, that the spacing of the teeth is not so far reduced that clogging of the chips takes place. Since power efficiency is determined by chip thickness only, it is evident that this is not altered by varying the tooth pitch.

If it is possible to keep the feed per tooth constant and decrease the tooth spacing without exceeding the power of the milling machine, the ideal conditions are achieved, i.e., the maximum volume of metal is removed per minute with the expenditure of the least possible power. Suppose, however, that the limit of the machine's power is reached before the minimum possible tooth spacing is obtained.

The problem now assumes a different aspect. We have already obtained the maximum power efficiency by virtue of using the thickest possible chip. If the tooth spacing is to be decreased, the power of the machine will be exceeded unless some of the other factors are changed. If the feed be reduced, the chip becomes thinner. This results in a decrease in the power efficiency coupled with a decrease in the amount of metal removed per minute.

Suppose that we leave the feed constant, decrease the tooth spacing, and at the same time reduce the spindle speed so that the feed per tooth remains the same. The power efficiency will then remain constant, as will the amount of metal removed per minute. Furthermore, the decrease in peripheral speed will result in a lengthening of the life of the cutter between grinds.

We have thus demonstrated that fine spacing is superior to coarse spacing, regardless of whether the cutting speed or the power of the machine be the limiting factor. In the first case, the fine-toothed cutter will remove more metal per minute. In the second case, the fine-toothed cutter will wear longer between grindings, due to the decrease in cutting speed.

Testing the Efficiency of Air Motors

An Apparatus for Determining Whether Machines Are Delivering Full Power Without Waste of Air

By R. M. Arthur

In view of the great number of air motors in the average railroad shop it is quite important that they be economical in the use of air and powerful enough to perform drilling and reaming operations quickly without consuming more of the mechanic's time than necessary. It is possible to tell in

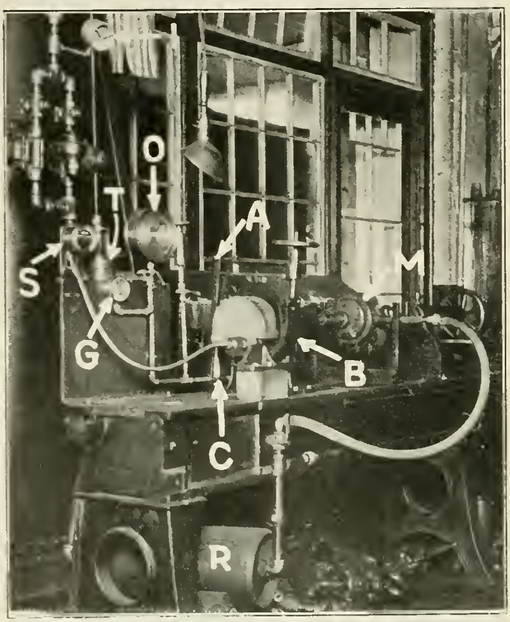


Fig. 1—Air Motor Testing Device on Lathe

a general way the condition of an air motor by its sound when running and the amount of pull on the handles but this method is unreliable and unscientific to say the least and with the object of getting exact figures on air motor operation the apparatus, illustrated in Fig. 1 for testing air motors, was developed.

The testing bench in this case consists of an old lathe, the tail stock of which is used for supporting the feed screw of the motor *M* under test. The handles of the motor are supported by two adjustable brackets bolted to the lathe bed as shown in the illustration. In place of the lathe head stock, a special casting *D* (better shown in Fig. 2) carries a shaft mounted on roller bearings with a tapered hole in the right end so that by using suitable couplings the shafts can be con-

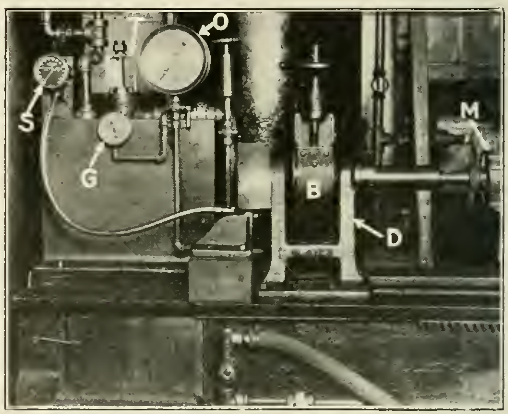


Fig 2—Close-Up View of Brake and Gages

nected to the shaft of any style of motor to be tested. This shaft also carries a brake pulley 8 in. in diameter which is surrounded with a band brake *B* (Fig. 1) lined with wooden blocks. The brake is prevented from rotating by an arm *A*, 7 15/16 in. long, suitably connected to a piston operating in the small cylinder *C* filled with oil. The hand-wheel illustrated provides means for tightening or loosening the brake band about the pulley and thus controlling the load on the motor. Gage *O* is connected to the oil cylinder through piping and registers the pressure in the oil cylinder, being proportional to the torque developed. The speed of the motor and consequently of the brake pulley is registered by means of a speedometer *S*, the gearing arrangement being such that the speedometer reading, multiplied by five, equals the revolutions per minute of the air motor.

Compressed air, the initial pressure of which is measured by gage *I* is supplied through two feed valves connected in parallel and passes through an air measuring device *I* to the small reservoir *R* and thence by a flexible tube to the air motor under test. The pressure of the air as passing through the measuring device is shown by gage *G* and this is the pressure under which the air motor operates.

In order to eliminate all unnecessary work in calculating the horsepower of a motor under test, the diameter of cylinder *C* which contains the oil and piston resisting rotation of the brake band is determined as follows:

Assume that Hp. = horsepower developed
$\pi = 3.1416$
F = total pressure on brake arm in pounds.
R = effective length of brake arm in feet
N = revolutions per minute
r = radius of piston in cylinder *C* in inches
P = pressure indicated by brake gage *O*

$$\text{Then Hp.} = \frac{2\pi FRN}{33000}$$

$$\text{also} \quad F = \pi r^2 P$$

$$\text{In this case } R = 7\ 15/16 \text{ in. or } \frac{7.9375}{12} \text{ ft.}$$

$$\text{and } \frac{2\pi \times \pi r^2 R}{33000} \text{ was made } \frac{1}{10000}$$

$$\text{therefore } r^2 = \frac{33000 \times 12}{10000 \times 2\pi^2 \times 7.9375} = .253$$

$$\text{and the piston diameter} = \sqrt{.253} \times 2 = 1.006 \text{ in.}$$

$$\text{therefore HP} = \frac{2\pi FRN}{33000} = \frac{2\pi \times \pi r^2 PRN}{33000} = \frac{PN}{10000}$$

It is evident then that with the diameter of cylinder *C* equal to 1.006 in. as determined above, the product of the brake gage pressure *O* and the speed of the air motor in revolutions per minute divided by 1,000 will give the horsepower directly without further computation.

Tests were run on a No. 2 air motor, the observed readings and calculated data being shown in the table, the results also being plotted in Fig. 3 for more easy comprehension and comparison. Brake gage pressure, air pressure, brake horsepower developed, air consumption and air consumption per horsepower per minute are all plotted against the speed of the air motor. Referring to the table it will be noted that the air pressure was approximately constant throughout the test which was begun with the motor operating at a full speed of 335 r.p.m. and with no load. Brake gage pressure was increased by turning the hand-wheel and readings taken at eleven different points until the brake gage pressure became 77 lbs. when the motor stalled. Speedometer readings were taken; also the number of cubic feet of free air per minute as registered by meter *T*. The readings of this meter had to be corrected in accordance with a table of correction factors as shown in the first column of the calculated data. The torque in foot pounds is a definite function of the brake gage reading and is obtained by multiplying this reading by the area of the piston in cylinder *C* and multiplying that product again by the effective length of the brake arm in feet. As previously stated, the revolutions per minute equal the speedometer readings multiplied by five; also the horsepower developed is obtained as previously shown; the cubic feet of free air per horsepower per minute is the

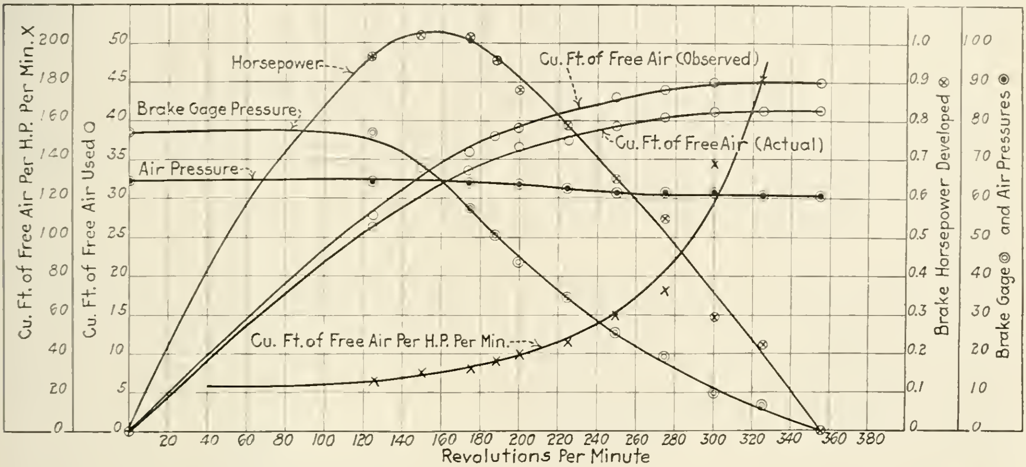


Fig. 3—Curves Plotted from Test Data Showing Air Motor Characteristics

Table of Observed Readings and Calculated Data in Air Motor Test

Observed readings				Calculated data				
Air pressure in pounds	Brake oil gage pressure	Speedometer reading	Cu. ft. of free air per min.	Cu. ft. of free air per min. (corrected)	Torque in foot pounds	Revolutions per minute	Horsepower developed	Cu. ft. of free air per hp. per min
61	0	71	45	41.4	0	355	0	. . .
61	7	65	45	41.4	3.7	325	.227	182
62	10	60	45	41.4	5.3	300	.300	138
62	20	55	44	40.5	10.5	275	.550	73.7
62	26	50	43	39.4	13.7	250	650	60 6
63	35	45	41	37.6	18.4	225	.790	47.6
64	44	40	39	36.6	23.1	200	.88	41.6
64	51	37.5	38	35.8	26.8	188	.955	37.5
64	58	35	36	33.8	30.5	175	1.015	33.3
64.5	68	30	34	32.2	35.7	150	1.020	31.6
64.5	77	25	28	26.5	40.5	125	.965	27.5
65	77	0	0	0	40.5	0	0	. . .

quotient of air consumption corrected, divided by horsepower developed.

A glance at the curves (Fig. 3) will show some of the outstanding characteristics of the air motor. The two things in which shop men are mostly interested is the amount of power developed and the air consumed. It will be noted that the actual consumption in this case was lower than the observed but decreased from a maximum amount when the motor was running at high speed under no load. In other words, less air was being used when the motor was operating at a speed of 160 r.p.m. and developing its maximum horsepower than when it was running free under no load.

The practical method of using these curves is to connect up a motor which has been reported defective and measure and record the brake gage pressure and air consumption at a speed of say 160 revolutions per minute. If the brake gage pressure is much lower than 65 lbs. and the air consumption much above 35 cu. ft. of free air per min. it is apparent that the motor is not only failing to develop its rated horsepower but uneconomical in the use of air. The logical thing to do is to give the motor a general overhauling, make sure there is no undue leakage of air past the pistons, take up lost motion and carefully clean and lubricate throughout. The use of this air motor tester should effect important savings by the detection of inefficient air motors and showing up the ones which are wasteful in the use of air. By failure to develop full rated horsepower the latter also consume an undue amount of the operator's time and thus add to the labor costs.

One caution should be observed in making tests and that is to maintain as nearly as possible constant air pressure. The results secured in this test for example were obtained with an air pressure varying from 61 to 65 lb. and would not apply for any other pressure. As a matter of fact, this pressure is rather low (90 lb. is recommended by the motor manufacturers) and particularly in the case of large motors, it may be found necessary to install a booster in the line and obtain a higher pressure. Practically no difficulty will be found in maintaining the brake equipment and speedometer but it may be necessary from time to time to clean out the feed valves and air measuring device to make sure that they are not clogged up and thus rendered ineffective and inaccurate.

Carbonization With Wood Charcoal*

It would be safe to say that ordinary wood charcoal alone, when considered in comparison with wood charcoal, plus so-called energizers, is little used at the present time. Charcoal has been used and discarded by many hardening and carbonizing rooms but not always for the same reason. The experiments given in this article have been performed on a regular commercial scale to determine the carbonizing effect produced by the use of wood charcoal alone.

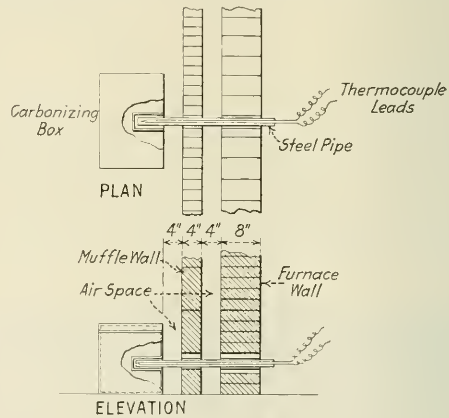
In industry the action of absorption of carbon by steel when heated to the proper temperature for an hour or two in intimate contact with a carbonaceous material is known as case carbonizing, while the same process when extended over a considerable length of time, say a week or more, and where the pieces treated are large with consequent absorption of much carbon, is known as cementation. The former treatment, or case carbonizing using wood charcoal only, is the one under discussion in this article.

In general, to overcome the drawbacks encountered through possible brittleness, the practice of case hardening, or producing a high carbon case on a soft piece of steel is resorted to. There is room for argument and there is considerable diversity of opinion as to whether case hardening is the only recourse at all times, or whether the entire piece of higher carbon and sometimes plus alloys properly heat treated, would not serve the purpose equally well.

With proper treatment of a case carbonized piece after removal from the furnace, and with the elimination of the rather sharp line of demarcation between the high carbon case and low carbon interior, the result obtained is a piece of steel having the desired hard surface with a backing of soft, tough and malleable steel. In short, the latter will not stand wear or abrasion, since it is easily deformed, whereas the former is able to withstand the necessary wear and abrasion. The material used in these tests were drop forgings made from acid bessemer steel of composition approximately: carbon, 0.15; manganese, 0.70; sulphur, 0.050; phosphorus, 0.060 per cent. The pieces were cheap and it is to be noted that the care and time expended in packing did not compare with that for pieces such as gears, which necessarily must be almost perfect.

Method of Conducting Tests

For reasons given later, and explanation of the carbonizing action as understood, it was not deemed essential to take any special precautions as to mesh of the charcoal, although



Carbonizing Box

the material was a powdered mixture with pieces up to 30 mesh. Such precaution as observing that the carbonizing material was free from moisture was considered a routine one, but always should be strictly observed. The procedure followed was to place a layer of charcoal to a depth of one inch on the bottom of the carbonizing box, pack in one layer of forgings each about 12 in. long as closely as possible, cover with charcoal and see that there were no pockets by using a wooden ram; adding another layer of forgings and repeating until about even with the top. Charcoal was then heaped on top of the forgings, the cover pressed down, and the opening around the cover raised at times an inch from the box, and finally luted with a mixture of ordinary clay and water.

After the boxes were removed from the furnace, it was often noticed that as much as one-fourth of the charcoal had been burned, indicating considerable leakage of air into the box because of the cracking of the clay luting. Such condition can be remedied easily by the use of more modern appliances, for example, carbonizing boxes with grooved covers.

In spite of production operations just outlined, the forging when allowed to cool in the boxes and removed, showed a

*A paper presented by H. Schagrin, chief chemist, United States Naval Ordnance Plant, Charleston, W. Va., at the Indianapolis convention of the American Society for Steel Treating.

silvery color indicative of very little surface oxidation. The statement made above that a good portion of the charcoal had been consumed by air leakage, does not necessarily mean that the air came directly in contact with the pieces to be carbonized. The air, from the evidence at hand, must have combined with the charcoal to form the oxide gas carbon monoxide which we know is the real factor in carbonizing.

All up-to-date hardening rooms are now equipped with pyrometers. However, there are many that still depend upon the eye for temperature reading. In such cases, where failure of parts results, it is of course impossible to consistently trace trouble. There has been a great deal written on the proper placing of thermocouples in doing carbonizing work, and care as well as common sense must be exercised in maintaining a uniform temperature in a furnace where there are a number of burners. If the fuel be oil fed from a pump, care must be taken to see that the pulsating action of the pump does not have a direct effect upon the flame. During these experiments some trouble was caused by water in the fuel oil. If the fuel be gas, the proper precaution must be taken to see that the flow of gas is maintained at a constant pressure. The condition of the burners must also be such that the temperature can be regulated easily. The location of the burners are of equal importance.

The carbonizing boxes were all charged when the furnace was at a temperature of about 300 deg. F. The objects of the tests primarily were to determine the amount of penetration that takes place at 1400 to 1500 deg. F. and at excessively high temperature, say 2000 deg. F. Heat treatments are not discussed. Close control was kept at all times on the temperature of the pieces to be carbonized by having the fire end of the thermocouple set in the middle of the box. As an optical indication to the treater, a bar 4 by 4½ in. of the same steel as that being carbonized was inserted in the box in such a way that it could be withdrawn to note the color.

Other Tests

Other work with various kinds of carbonizing materials containing charred leather, powdered bone, charcoal and prussiates in varying proportions, has proven that absorption of carbon by the steel first takes place at about 1400 deg. F., but to produce even a light case at this temperature would require a prohibitive length of time. The determining factors in carbonizing, when comparing the treatment of identical materials and using the same carbonizing compound, are time and temperature. Although it is evident that some carbonizing begins at 1400 deg. F., the time of carbonizing properly should be considered from the time the work has reached the temperature desired.

The standard mixture of 60 parts charcoal and 40 parts barium carbonate intimately mixed gives good results, but is costly. The reaction claimed during carbonizing for this mixture, as forming carbon monoxide and cyanide of barium with the nitrogen of the air, seems less probable than the reaction by which carbon dioxide is released from the carbon dioxide reacting with the charcoal to give carbon monoxide. The next cycle will release oxygen as soon as absorption of carbon takes place, to form more carbon monoxide. The idea has also been advanced that the ash of wood containing alkali carbonates, would form alkali cyanides with the nitrogen of the air. This is doubted, as is the reaction above for the formation of the barium cyanide for the reason that the cyanides formed probably would have more decided effect than is actually the case.

To withstand bending stresses, it is not desirable to carbonize to more than 1.00 per cent carbon. Satisfactory results were obtained by maintaining the work at temperature of 1850 to 1900 deg. F. for one hour. For production work, this allowed two charges per furnace for a working day of 10 hours. It was found that charcoal was a cheap and satisfactory casing material where a normal penetration of about 1/16 in. for about 1½ to 2 hours carbonizing period was desired. For periods over a greater length of time than indicated, other compounds must be present with the charcoal to cause a deeper penetration.

Device for Thawing Frozen Switches

By J. H. Hahn,
Assistant Machine Shop Foreman, Norfolk & Western,
Portsmouth, Ohio

During severe winter weather considerable difficulty is often caused by frozen switches. An effective device for thawing switches in a minimum time and with little trouble is shown in the illustrations. The thawing is done by a manifold, shown in Fig. 1, fastened to the pilot beam with

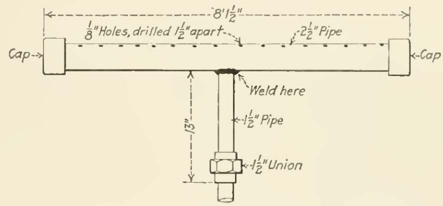


Fig. 1—Manifold Through Which Steam is Directed on Frozen Switches

suitable clamps and placed at right angles to and about four to six inches above the top of the rail. Dry steam is taken from the dome through the connection shown in Fig. 2, and by turning on the valve and moving the engine slowly over the switch points, snow and ice can be melted.

The manifold is made of a piece of 2½ or 3 in. pipe drilled with a row of ⅛ in. holes spaced 1½ in. apart. Caps are provided as shown, a short piece of 1½ in. pipe being welded at right angles to the manifold. Extra heavy pipe and fittings are used throughout and while only one steam valve was used, it would be possible to put another valve in the steam line on the running board if so desired.

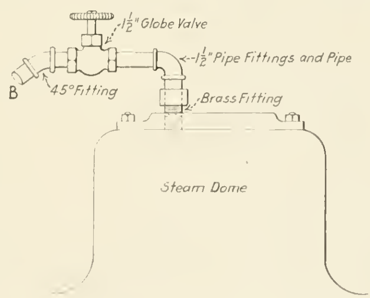
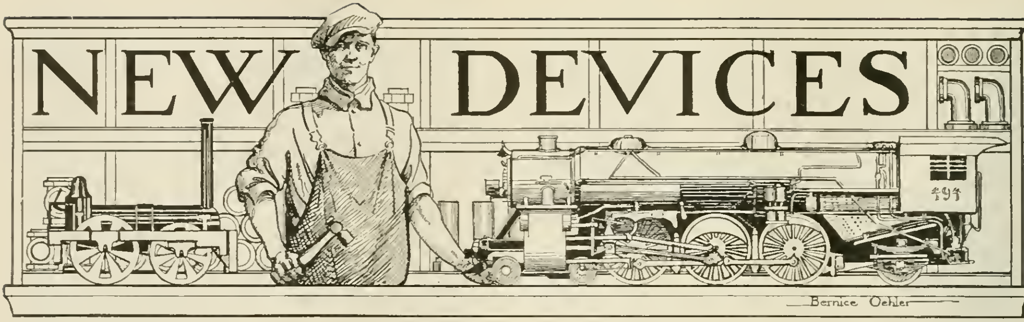


Fig. 2—Dry Steam is Taken from the Steam Dome

New Steel Alloy. According to the Canadian Engineer, A. H. Coplan, managing director of the Hull Iron & Steel Foundries, Hull, Quebec, announces that he has perfected a method for the manufacture of Chromite, an alloy of steel, at a cost not exceeding that of cast iron. "Chromite," says Mr. Coplan, "has a much greater power of resisting the destructive effect of heat than has cast iron, and will therefore be largely used in the manufacture of grate bars for locomotives, steamships, etc."



Improved Hanna Locomotive Stoker, Type H-2

THE Hanna stoker, made by the Hanna Locomotive Stoker Company, Cincinnati, Ohio, belongs to the class in which the fuel is delivered in front of a jet of steam by which it is blown into the firebox and distributed over the surface of the grate.

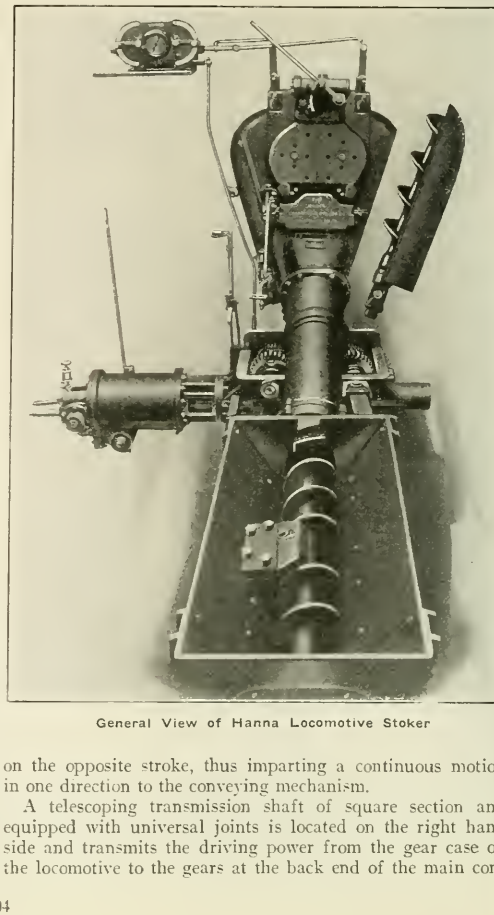
In general the stoker consists of a steam cylinder which, by means of a rack and pinions rotates a screw conveyor by which the coal is brought from the tender to the locomotive. The coal is then delivered to two screw elevators enclosed in a housing embracing the firing door and elevating on each side of the same. These elevators deliver to two oscillating chutes from which the coal drops upon a distributor plate over which it is blown into the firebox and by means of which it is given the proper distribution. The details of the mechanism have been in process of development for a number of years. The speed of the conveyor screws can be varied at will to deliver any desired quantity of fuel; or, in case of clogging or jamming, the conveyor screws can be reversed. Coal may be scattered evenly over the surface of the grate or the delivery concentrated in one place.

Engine and Conveyor of Simple Design

The motive power is derived from a single cylinder steam engine having a diameter of 11 in. and a stroke of 16 in. The valve mechanism is similar to that used in 9½ in, and 11 in. air brake compressors. Should the conveyor become jammed either by large lumps of coal or by foreign substances such as bolts or stone, it may be necessary to reverse the motion of the piston before it has completed its full stroke. To accomplish this there has been introduced a reversing valve of the piston type operated by a lever in the cab through a system of bell-cranks and rods. The two steam passages from the main slide valve, instead of leading directly to the opposite ends of the cylinder, are carried to the reversing valve chamber, the arrangement of ports being such that by the movement of the reversing valve the steam is caused to flow to the opposite end of the cylinder from that to which it flows when the valve is in the other position.

The end of the extended piston rod is coupled to the rack by means of a key. In addition to the usual stuffing box on the cylinder head, the piston rod passes through a second stuffing box on the rack housing, which is an oil tight case. The rack housing is bored out to take the rack guide which is fitted with two side keys. A bearing and wearing strip is inserted between the rack and the rack guide to take the downward thrust of the rack as it works back and forth to drive the gears. The outer end of the housing is closed by a cap. the removal of which furnishes access to the rack.

Mounted on top of the rack housing is the gear box in which is located the nest of gears which drive the screw conveyor and the two elevators. There are two pinions in mesh with the rack which are so connected by gears and clutches to the conveyors that one of the pinions acts as a driver on the out stroke of the piston while the other pinion becomes the driver on the opposite stroke, thus imparting a continuous motion in one direction to the conveying mechanism.

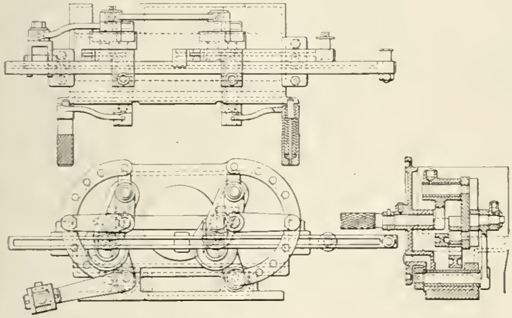


General View of Hanna Locomotive Stoker

A telescoping transmission shaft of square section and equipped with universal joints is located on the right hand side and transmits the driving power from the gear case on the locomotive to the gears at the back end of the main conveyor shaft on the tender. This arrangement provides the necessary compensation for the movement between the locomotive and the tender.

The casing of the conveyor on the tender terminates in a ball joint at the front end where it is joined to an inclined circular section which connects the tender to the locomotive. The short conveyor screw in the connecting section is attached to and is driven by the conveyor screw on the tender, a universal joint being used for the connection of the two portions. The elevating screws are independent of the conveyor and are driven direct from the gear case by two universal connections located on the front portion of the gear case.

The pinions driven by the rack are provided with clutches



Control Box

which can be reversed by means of a lever at the left of the firedoor. Should it be desired to run the conveyor screws backward, the pressure on the rack is first relieved by reversing the engine as previously explained, and the gear clutches then shifted to bring the extra gear into action which reverses the motion. In addition to these devices a coupling has been provided at the top of the gear case whereby the transmission shaft may be cut off and the conveyor stopped without shutting down the engine. This clutch is operated by a lever on the deck at the right of the firedoor.

Coal Distributing Mechanism

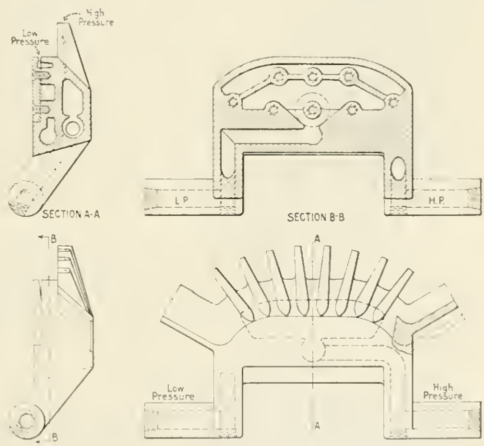
The coal after being conveyed from the tender to the locomotive and raised by the elevators falls upon two oscillating chutes which swing to and fro as they drop the coal onto the distributor plate. This plate, which is an important element in the operation of the stoker, is of cast iron and sets in a casting at the bottom of the firedoor from which it can be easily removed even while the fire is burning brightly. As will be noted from the illustration it consists of a broad flat plate with two curved diverging channels cut into the upper surface. These channels catch a portion of the coal as it is blown over the top of the plate and divert it into the back corners of the firebox along the back sheet.

The cast steel blast chamber is located above and slightly back of the distributor plate. It is provided with two trunnions tapped out for ¾ in. steam pipes, a different pressure being supplied to the two connections. High pressure steam at from 25 lb. to 50 lb. pressure enters through the right-hand trunnion, passes to the upper passage of the chamber from which it is discharged to the firebox through the eight diverging nozzles which are drilled with 5/32 in. holes peened down to ⅛ in. at the orifice. Low pressure steam at from 10 lb. to 25 lb. pressure enters through the left hand trunnion, passes to the lower part of the chamber and is discharged through three nozzles in the plate attached to the bottom of the blast chamber. The combination of the nozzles serves to distribute the coal evenly over the surface of the grates.

The oscillating chutes which deliver the coal to the distributor plate receive their motion from two connecting rods leading to the control box which contains a series of bell-cranks and links. This mechanism receives its reciprocating motion from a crank driven by a worm gear in the main gear case, a rod with universal joints being employed for the connection. On the front of the control box are two levers and handles which are used to adjust the link mechanism and thus regulate the swing of the oscillating chutes. The adjustments for the two chutes are entirely independent and thus provide the maximum flexibility in coal distribution. Should the stoker become inoperative from any cause, the chutes can be disconnected, turned up out of the way and latched; hand firing can then be started immediately. In such a case the coal is simply scattered by shovel on the distributor plate, the stoker blast being used to take the coal from this point and properly distribute it over the surface of the grate.

A duplex gage is also mounted on the front of the control box, the hands showing the steam pressure of the high and low pressure connections of the blast chamber.

By referring to the illustration showing the general rear elevation of the stoker it will be noticed that the main steam pipe leading to the engine is provided with a globe valve and with a ½ in. by-pass pipe having a second globe valve. In ordinary practice the main valve is kept closed, the by-

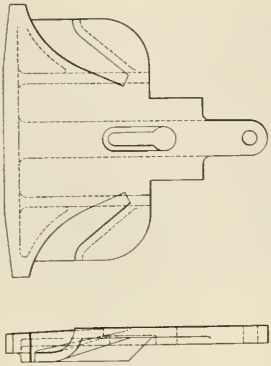


High and Low Pressure Blast Chambers

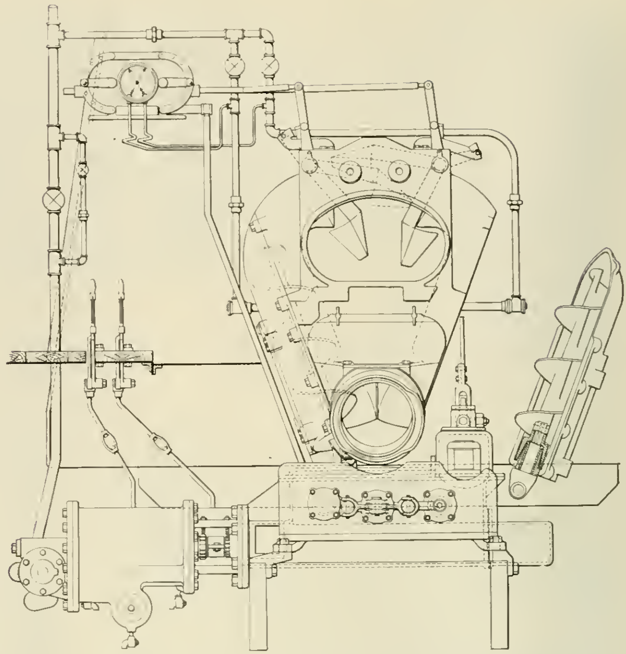
pass pipe furnishing all the steam necessary to operate the engine at the speed required.

Performance on Norfolk & Western

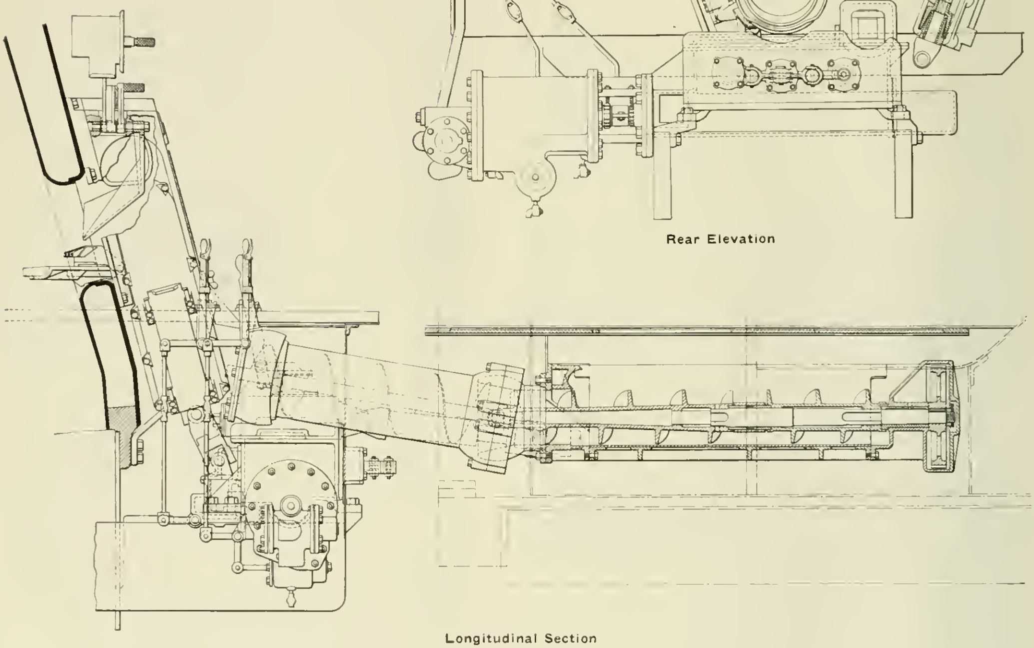
As an example of the performance of the improved Hanna stoker, some notes relative to a recent run on the Norfolk & Western of a locomotive equipped with a stoker of this type will be of interest. The locomotive was of the Mountain type with 29 in. by 28 in. cylinders, 70 in. drivers, 80.3 sq. ft. grate area and a rated tractive effort of 57,200 lb. The run was from Roanoke, Va., to Bristol, a distance of 151 miles and return. On going west from Roanoke the start is over generally rising undulating grades ranging from 0.73 to 0.9 per cent extending for 20 miles to the eastern slope of the Allegheny mountains. Then there is a direct unbroken rise for about 10 miles on a 1.32 per cent grade to the summit, followed by a drop for about 6½ miles on a 1.0 per cent grade to the valley of the New River. Then



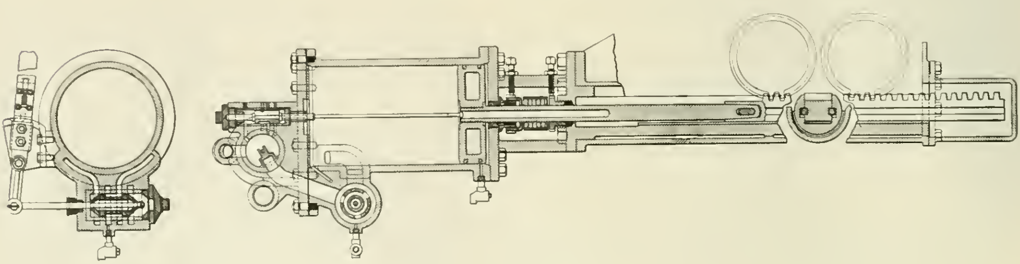
Distributor Plate



Rear Elevation



Longitudinal Section



Section of Engine and Rack Housing

there are four sharp rises on grades running from 1.19 to 1.31 per cent with intermediate drops until the summit is reached at 94 miles from Roanoke, the elevation being 2,591 ft. above sea level. On the western slope there is at first a 10 mile descending grade of 1.125 per cent followed by a series of up and down grades of over one per cent into Bristol, the elevation of which is 1,675 ft., making a net rise of 775 ft. from Roanoke, and a total rise of up grades of 3,540 ft.

On the westbound run, known as the "Memphis Special," the train consisted of a mail car, a combination car, two coaches, three Pullman cars and a dining car, the total weight including the locomotive and the eight cars being about 834 tons. There are no regular station stops but two stops are necessary for water and one for coal. On this particular run there were ten stops including those at flag stations together with those for coal and water; in addition there was one slow-down for track work. The actual elapsed time for the run was 4 hr. 50 min. from which 16.5 min. is to be deducted for stops, leaving an actual running time of 4 hr. 33.5 min., giving an average running speed of 33.1 m.p.h.

On leaving Roanoke there was a brightly burning fire, evenly distributed over the grates, with a depth of about four inches, and a steam pressure of 170 lb. Four minutes after leaving the pressure had risen to 190 lb. and from that time on it swung up and down between 175 lb. and 200 lb. Throughout the run the stoker was controlled by the fireman without having to leave his seat. The rate of feed was governed according to the steam gage and the appearance of the stack. Only immediately after starting there was any appearance of smoke. The fire door was opened by an observer a number of times during the trip when the steam was shut off and in every instance the bed of fire was found to be thin and level.

Occasional adjustments of the steam pressure at the blast nozzles was required but these were slight. Pressure varied from 15 lb. to 20 lb. throughout the run with occasional rises to 25 lb. for the high pressure blast. The oscillating chutes for distributing the coal were untouched except for one adjustment to the right wing. The stoker was stopped 17 times, the total time when it was not in operation being 96.5 min. or about a third of the time. The hook was not taken from its supports, the grates were not shaken and not a shovel full of coal was put into the firebox by hand. On arrival at Bristol the fire was in good condition and was banked without being cleaned.

The return run was a local. There were six cars in the train at the start and one picked up later, the train then being 94 tons lighter than on the trip west. The elapsed time was 5 hr. 43 min. of which 1 hr. 10 min. were occupied at station stops of which there were 33. The actual running time was thus, 4 hr. 33 min. requiring an average running speed of 33.1 m.p.h.

Owing to the frequent stops the stoker required more attention than on the westbound trip. It was stopped 32 times and was idle for a total of 2 hr. 19.5 min. or 41 per cent of the elapsed time. The distributing chutes were adjusted nine times. The pressure at the high pressure nozzles varied from 15 lb. to 30 lb. and at the low pressure from 10 lb. to 30 lb. The steam pressure was maintained between 175 lb. and 200 lb., the average being 192 lb., and the safety valves did not open.

On leaving Bristol the fire bed was rough and humpy as left from burning down over night after being banked, but within 10 min. after the start it was in a smooth even condition. As on the trip west, the fire hook was not used, no coal was fired by hand and the grates were not shaken. On arrival at Roanoke the fire was thin, level and burning evenly.

The coal used was prepared for stoker operation in accordance with the practice on the Norfolk and Western and was of the usual grade which contains about six per cent ash and 36 per cent volatile matter.

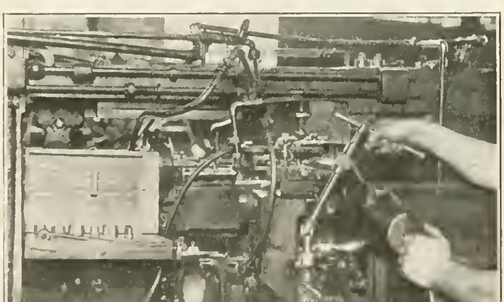
The run was not an unusual one as the records of the locomotive show that for 28 consecutive runs no coal had been fired by hand, the hook had not been used and the grates had not been shaken.

Convenient Socket and Ratchet Wrench Set

THE illustration shows the use on an automatic screw machine of a new socket and ratchet wrench set placed on the market recently by the Eastern Machine Screw Corporation, New Haven, Conn. This wrench set has been designed to meet the demand for a stronger and more durable socket wrench with provision for greater convenience in handling. The set is packed in a strong wooden box in which a place is provided for each part so that the absence of any part is readily noticed.

The most important feature of the set is in the construction of the sockets. The usual practice is to obtain the hexagon hole by drilling the end of the socket to the diameter conforming to the dimensions across the flats and then broach this hole to a hexagon shape. This forces the metal outwards, producing the corners but naturally sets up a strain which is only compensated for by making the walls of the socket thicker. The hexagon hole in the H. & G. socket is made by drilling the hole to the diameter corresponding to the diagonals; that is, the distance across corners at the maximum point, and then the metal is drawn in to form the hexagon during which process the metal is compressed and toughened.

The H. & G. sockets are provided with a strong hexagon head, all of the different wrench parts fitting over this head for turning. All of the sockets are especially heat treated and hardened after being machined to fit the nuts accurately. The set is provided with an adjustable tee handle so that it can be used in a central position for fast work or adjusted for maximum leverage. The ratchet is compact and strongly designed and may be made either right or left hand by simply raising and reversing the position of a ball headed pin.



H. & G. Socket and Ratchet Wrench Reaches Nut in Difficult Place on Automatic Screw Machine

An extension piece is provided to be used between the tee handle and the socket either to turn nuts otherwise difficult to reach or to bring the tee handle to a more favorable position. A universal joint allows for turning nuts located at difficult angles, this joint being milled from bar stock. Two screw drivers which fit any of the other attachments are provided. The box wrench is included in the set primarily to provide a method of getting at nuts in connection with the sockets where the head room over the nut will not permit the use of other tools. This is a drop forging so designed that the sides of the wrench are wide and flat and permit the use of maximum pressure with minimum discomfort. The box wrench is hardened by the cyanide process. Each female part of the wrench attachments has a split screw made from spring steel which provides the proper amount of friction to hold the different parts together while in use.

Semi-Automatic Valve Finishing Machine

As the result of extended and careful experiments under everyday working conditions in the air brake repair department of a large railroad shop, the semi-automatic valve finishing machine, illustrated in Fig. 1, has been developed. It is used mostly in the repair of brake valves and triple valves, the advantages claimed being larger production, more accurate fitting and increased life of wearing surfaces.

The present method of fitting rotary valves, slide valves and graduating valves to their seats is largely by hand scraping and lapping to a flat surface plate, an operation which requires one man to one part until a practically perfect surface is obtained. After this the seat in the valve body is filed and then scraped to the slide valve ieself. The machine, illustrated, is designed to finish mechanically both slide valves and seats in such a manner as to make

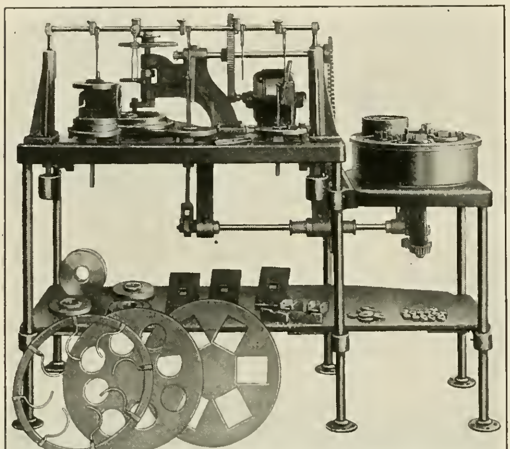


Fig. 1—General View of Semi-Automatic Valve Finishing Machine

them practically interchangeable, thus eliminating to a large extent the human element, since it is generally conceded that only the most expert and careful workmen can scrape and lap the intricate valves at present in use and maintain a flat surface to the edges of all ports and openings.

Capacity and Production

The machine as designed will handle all of the parts of air brake equipment listed below, the carriers or workholders being arranged to receive at one time the number set against each item: Three seats, or 8 rotaries, for engineer's brake valves; 6 seats, or 11 rotaries, for independent brake valves; 18 slide valves, or 24 graduating valves, for triple valves: 18 slide valves for distributing valves. It is also practical to operate on a variety of parts as necessity may require.

The rotary portion of the machine with several air brake parts being lapped is shown in Fig. 2 which illustrates the convenience with which parts can be removed for inspection or new ones applied. The rotary portion, including the lapping plate and the carrier or workholder, are so arranged that they rotate in opposite directions and eccentric to each

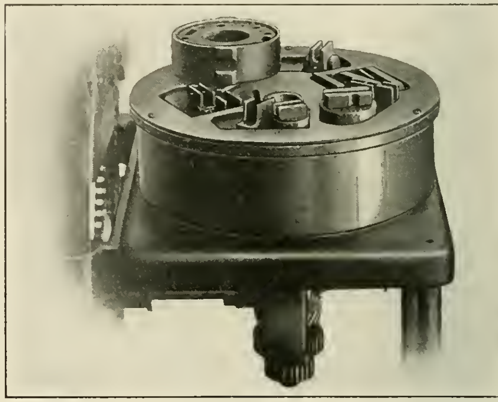


Fig. 2—Close-Up of Rotary Portion with Air Brake Parts Being Lapped

other. The ratio of speeds is such that the work is constantly changing its position on the lapping plate, a condition which results not only in flat surfaces but tends to keep the lapping plate true for the maximum length of time. The

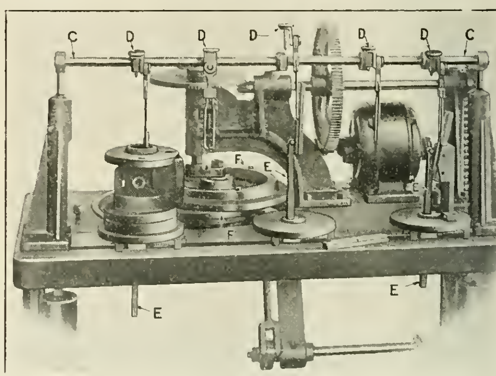


Fig. 3—View Showing Details of Reciprocating Portion

time required with one operator for obtaining a practically flat surface ranges from 5 to 15 min., including the application of abrasive, inspection and keeping the lapping plates in necessary true condition. Twenty complete rotaries and seats of engineer's brake valves, for example, or 25 or more complete triple valves can be handled easily in eight hours.

The reciprocating portion of the machine where the seats in the bodies of the triple valves themselves are finished is shown in greater detail in Fig. 3. Provision is made for five triple valves, or that number of seats in other valves at one time; the lap sticks are mechanically moved about one inch while held at the desired pressure against the surfaces to be finished. One station has a fixture in which the slide valve is placed for finishing the seat for the graduating valve. The lap sticks may be kept in proper condition on the rotary lapping plate in the same manner as the slide valves.

In Fig. 3, the reciprocating bar *C C* carries the lap sticks on which are five members *D* horizontally adjustable for properly locating the lap sticks in relation to whatever type of valve body or graduating valve seat it is desired to finish. The method of removing the lap sticks for changes or the application of abrasive without stopping the machine is shown at the center fixture. The pressure bars for holding the lap sticks against the valve seats are shown at *E*. These are adjustable to give the desired pressure and automatically drop down out of the way when the lap is removed. For keeping the rotary lapping plates in proper condition a mechanism is provided at the back of the machine causing two plates *F F* (Fig. 3) to work against and true each other while the third plate is in actual use. This lapping plate truing mechanism requires practically no attention, the plates being changed not more than twice a day.

During the operation of this valve finishing machine any one part being finished can be removed for inspection, or new pieces applied without stopping or in any way interfering with those already in the machine. By this means it is said that one man operating one machine will produce an amount of repair parts of air brake equipment many times in excess of the possible output by present methods, with the further advantages of a more accurate flat surface throughout and longer service between repairs. The machine is driven by a 1/4-hp. motor or tight and loose pulleys, with two hand-operated clutches allowing each portion to be operated independently. It has been placed on the market by the Walter H. Foster Company, New York.

Safety Locomotive Ash Pan Blow-out Valve

Four distinctive features and important advantages are claimed for the new locomotive ash pan blow-out valve illustrated; namely, safety, elimination of packing troubles, small space occupied and automatic closure. Patents are now pending on the device which has been developed by Arthur Brigham, an employee of the New York, New Haven & Hartford at the Dover street roundhouse, Boston, Mass. Several of the valves have been made and applied and they are recommended with considerable enthusiasm by the men responsible for their maintenance and operation.

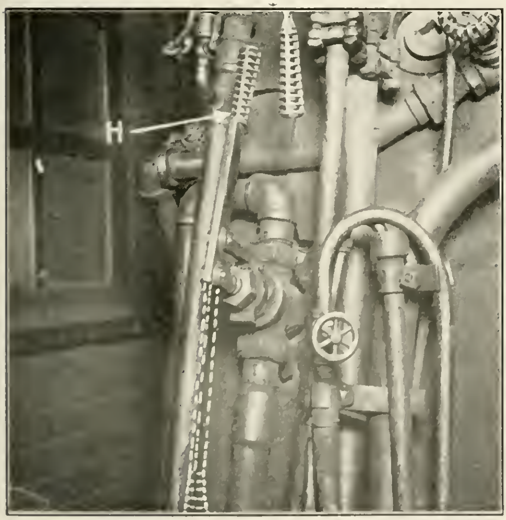


Fig. 1—Brigham Ash Pan Valve Applied to Boiler Head

Referring to Fig. 1 the valve will be seen applied to the back head of a locomotive boiler with handle *H* in the upper position. A direct, steady pull on the handle will admit steam to the body of the valve and direct it to the upper pipe, and connecting pipes to the front ash pan. When the ash pan has been cleared of ashes, handle *H* is released and automatically goes back to the closed position, shutting off the supply of steam. This is an important feature since, should anything happen to the fireman or hostler while operating the valve, it will close automatically. When it is desired to blow out the rear ash pan, handle *H* and its fulcrum lever are revolved parallel with the boiler head to the lower position, shown in dotted lines. A direct pull on the valve handle when in the lower position will admit steam from the boiler to the valve and the lower pipe and then through the connecting pipes and fittings to the rear ash pan. As in the previous case the valve is closed automatically by releasing the handle.

The safety feature of the valve can be more plainly seen by referring to Fig. 2 in which the valve is shown disconnected from the boiler head. It is apparent from the illustration that the valve screws into the boiler head at thread *A*, check valve *B* which controls the flow of steam being inside the boiler sheet. The blow-out valve is grooved internally just to the left of thread *A* so that should the valve receive an accidental heavy blow it will break at this groove, leaving thread *A* and check valve *B* intact. Referring to Fig. 2 the operation of the valve and handle will also be more readily apparent. The movement of handle *H* to the left opens check valve *B*. A one-ported hollow internal sleeve is pro-

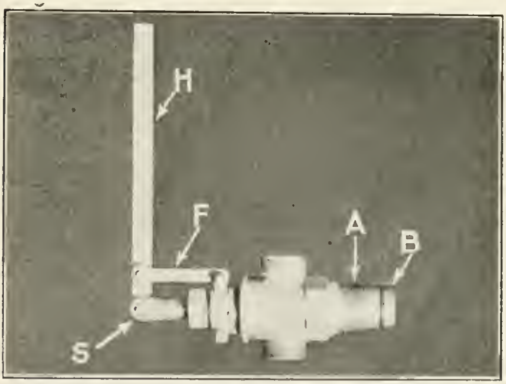


Fig. 2—View Showing Location of Check Valve

vided in the valve and directs the flow of steam into the upper or lower pipes, depending upon the position of handle *H*. Reference to Fig. 1 shows the small amount of room required for the valve and it is stated that owing to the absence of steam from the blow-out valve when not in use no packing is needed.

Semi-Automatic Arc Welding Lead

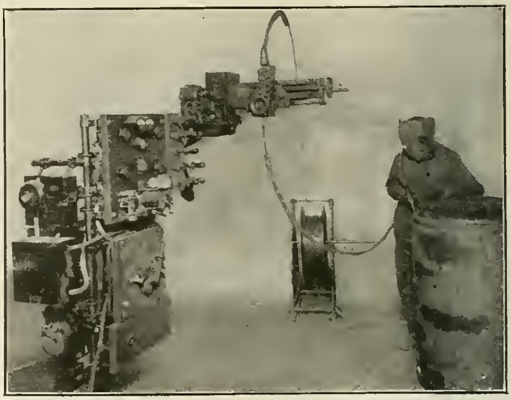
A SEMI-AUTOMATIC arc welding lead has just been developed by the General Electric Company, Schenectady, N. Y., for use in conjunction with its automatic arc welding head, which retains the continuous features of the automatic apparatus, yet allows the operator to direct the arc as required by the conditions of the work.

The apparatus consists of a welding tool to be held by the operator, which acts as a guide for the electrode wire. In the handle of the tool, which greatly resembles an automatic pistol, is a switch for operating the control on the panel of the automatic welder to start and stop the movement of the electrode wire. Attached to the tool is a 10-ft. length of flexible steel tubing, called the "flexible wire guide," with an adapter on the other end for attaching it to the automatic welding head. The wire passes from the feed rolls of the head into the flexible tubing, and thence to the arc through a "guide nozzle" in the welding tool. The automatic welder functions, tending to hold the arc length constant, and the operator merely directs the arc as required.

The field of application of the semi-automatic lead is the welding of products where the seams to be welded are of very irregular contour, or on very large work where the travel mechanism and clamping necessary for the full automatic welder would be complicated and costly. In many cases the edges of the seams are not accurately prepared, making gaps in some places and tight fits in others. The automatic welder with mechanical travel cannot compensate for these conditions by varying the speed, or by manipulation of the electrode, but with the semi-automatic, they are taken care of.

The semi-automatic welder may also be used for building up metal rapidly, as in the case of the filling up of blow holes in castings, or the building up of worn spots, etc. The speed of deposition of the metal varies widely, being somewhere between the ordinary hand speed and that of the automatic, according to the conditions of the particular job. In general it is about twice as fast as hand welding.

The advantages claimed for the semi-automatic welding equipment may be summed up as follows: (1) Saving in time which is ordinarily lost in changing electrodes; (2)

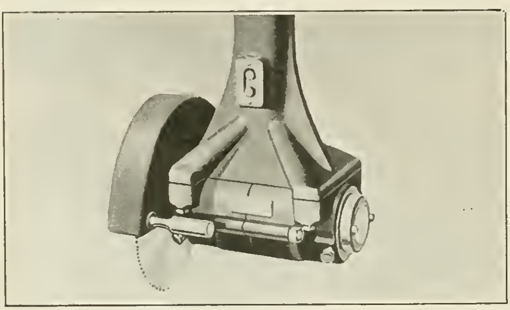


General Electric Semi-Automatic Arc Welder

Saving of from 10 to 20 per cent in electrode material ordinarily thrown away as waste ends; (3) Operators can become proficient in the use of the tool very quickly, as they do not require the muscular training necessary for hand work; (4) Continuous operation results in few interruptions in the welding, each of which is a potential source of defective welds.

Motor Head for Swing Cut-Off Saw

A NEW motor head has been developed for the swing cut-off saw made by the Oliver Machinery Company, Grand Rapids, Mich. The swinging frame of this saw is of the usual Oliver construction, it being made in a cored form with a single arm which is centrally located. This arm is made in three standard lengths, namely 5 ft. 5 in., 7 ft. 5 in., and 9 ft. 5 in. The saw arbor, shown in the illustration, is made of crucible steel and machine ground to an accurate size.



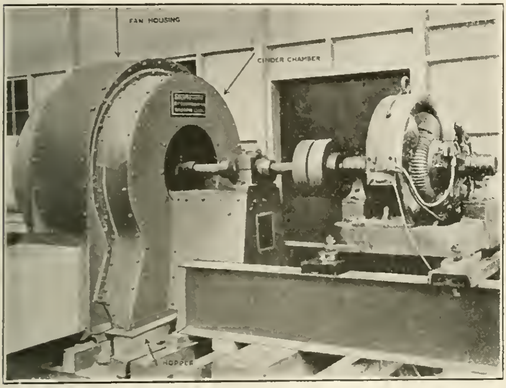
Head Construction of Oliver Motor-on-Arbor Swing Cut-off Saw

Two types of electric drive can be furnished if desired, either belted motor drive or the motor-on-arbor type, illustrated. The belted motor drive consists of mounting a 5-hp., 1800 r.p.m motor on a bracket in the yoke of the machine in place of the countershaft, and belting down to the saw arbor. The motor-on-arbor can be furnished only for two or three phase, 60 cycle, 220 or 440 volt a.c. and consists of a 3-hp., 3600 r.p.m shaftless motor built in directly on the saw arbor, fitted with ball bearings and a 16-in. diameter saw with guard in handle. This motor-on-arbor drive is said to be extremely efficient, dependable, and safe, requiring a minimum of care. The motor is stopped and started by means of two push buttons on the arbor. The entire construction is rugged and the saw can be used effectively with the swing cut-off saw table, described on page 432 of the June 1921 *Railway Mechanical Engineer*.

Cinder Separating Induced Draft Fan

With the idea of separating cinders and dust from exhaust gases and thus greatly reducing the smoke nuisance, the B. F. Sturtevant Company, Boston, Mass., has developed a cinder-separating, induced draft fan, shown in the illustration.

The fan housing is indicated by an arrow, also the cinder chamber and the hopper in which dust and cinders collect by gravity. Buckets are provided at the inlet edges of the blades of the paddle wheel. These buckets catch and separate the dust and cinders which are conducted by means of inclined channels leading out into the special dust chambers in the fan. Several small guiding vanes serve to direct the air and cinders into the inclined channels. Since it is impossible to blow dust with air as this would involve again a separation problem, arrangement is made for the dust to settle and fall by gravity into the dust chambers. These dust chambers lead to the closed hopper at the bottom in which the dust accumulates and from which it can be removed periodically or continuously by means of screw or other conveyors.



Sturtevant Fan Designed To Separate Dust and Cinders from Flue Gases

The cinder-separating fan takes no more room practically and requires no more attention than an ordinary induced draft fan. It is said to be unusually efficient as a fan and to remove 75 per cent of the solid matter in the gases. The fan removes a still larger proportion of the heavy coarse material which drops over the city in the neighborhood of power plants causing complaints from the residents. Two of these fans have been installed in a large power plant in New York City and are reported to operate successfully. They are used in connection with six 500-hp. boilers and when these boilers are operating at 200 per cent rating, it is found that each fan removes 250 lb. of cinders per hour. At higher ratings this would be much greater. The material resembles a fine coke breeze and on an analysis shows about 9,700 B.t.u. per pound.

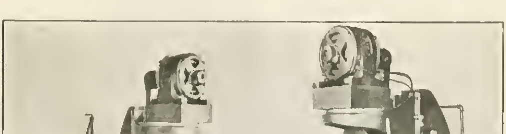
The cinder eliminating induced draft fan is particularly desirable for use with underfed stokers. These do not cause a serious smoke nuisance when boilers are operating at normal ratings. They do, however, when the boilers are being forced above normal ratings. Extremely fine particles in the smoke are not particularly objectionable because they are carried away by the air currents and not deposited over the surrounding neighborhood, but the dust and cinders in the gases are fairly heavy and fall within a comparatively short distance of the stack; hence the need of an efficient cinder-separating fan.

Improved Automatic Hob-Grinding Machine

The automatic hob grinder illustrated is made by the H. E. Harris Engineering Company, Bridgeport, Conn., and combines many important improvements over the original machine of this type described on page 551 of the August, 1920, *Railway Mechanical Engineer*. In the 1920 model, the motor drive for running reciprocating parts of the machine was mounted on rails on the floor instead of on an integral bracket on the back of the machine itself. This arrangement makes the present motor and machine self-contained. The maximum spiral now possible at eight inches diameter is 47 deg. either right or left as against 23 deg., the maximum helix formerly possible to grind. In the new model, ball bearings are used instead of a sliding block to transmit the spiral action from the adjustable angular slide way at the back. Increased life of the spindle bearings is now obtained by using heavy bronze bushings with positive adjustment for wear instead of the ball bearings formerly used.

The machine illustrated is 20 per cent heavier than the 1920 model and the table has less overhang from the bed at the end of its stroke. The column at the back is made heavier and the slides longer. The overhang of the wheel has been decreased to a minimum, making it much stiffer in this respect. The index head has been redesigned, made heavier with larger bearings and the latter placed further apart so that except for the heaviest hobs, it is not necessary to support the outer end of the work arbor with the tail center, thus saving considerable time in changing from one hob to another.

The arrangement for wet grinding has been changed using larger valves and pipes and a deeper pan so that about double



Harris Motor-Driven Automatic Hob Grinder

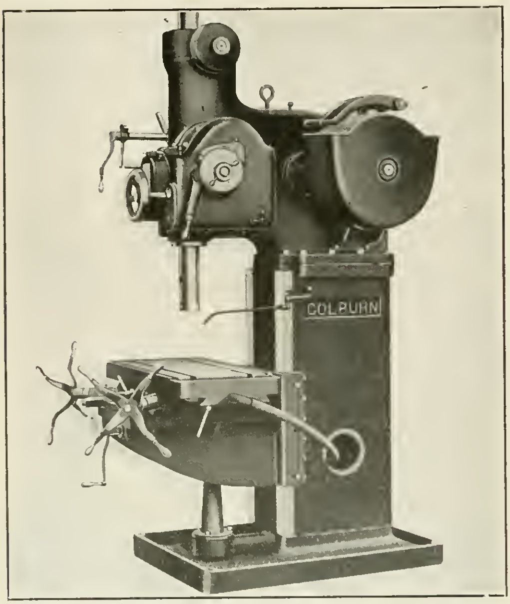
the amount of liquid can be used in cooling as heretofore. This liquid is returned to the settling pan in order to keep it clean. It is said that dry grinding invariably reduces the scleroscope readings on the cutting edges and records show that wet ground hobs stand up longer and produce more work between grindings. The machine may be set to compensate for the wear of the wheel, so that after the wheel has partly ground a hob and is itself partially worn away, it will still grind radially. This is an important feature as is also the adjustment provided so that hobs, where desired, may be ground undercut or with "hook" to the teeth, according to the practice now coming into general use. All adjustments can be made by the operator from the front of the machine and most of these adjustments can be made when the machine is running.

The 1920 machines were made with a fixed table stroke, being driven by a face cam. On the new model the work table is driven by a clutch reverse gear mechanism operating a pinion in a rack, and adjustable stops on the front edge of the table allow adjustments to any length of hob within the capacity of the machine. This eliminates the time lost in the earlier fixed maximum stroke cam-driven machine on grinding short hobs.

A diamond truing device (not shown in the illustration) is built into the head which replaces the old style separate diamond truing device, operated from the work table. While there is no radical change in the general design of the machine, the above represents a number of important improvements and differences between this machine and the 1920 model said to make it at least 50 per cent more effective than the older machines.

Heavy Duty Manufacturing Drill Press

SIMPLICITY of construction and the elimination of all unnecessary running parts are advantages claimed for the new No. 6 heavy duty drill press made by the Colburn Machine Tool Company, Cleveland, Ohio, and shown in the illustration. This tool is designed for the machining of duplicate parts in quantities but can also be adapted to handling a large variety of work inasmuch as a large range of speeds and feeds is possible due to a special transposing gear arrangement. This insures unusual flexibility and provides a means of securing the correct feeds and speeds for the work to be performed.



Colburn No. 6 Heavy Duty Drill Press

Features of design tending to add to the value of the machine as a production tool include the heavy box-type head; rigid table and column; the stub tooth, chrome-nickel steel drive gears, heat treated and hardened, running in a bath of oil; drive shafts of large diameter and short lengths; the use of ball bearings throughout the drive and finally the location of the spindle driving gear at the lowest point of the head and on the large diameter of the spindle.

The machine has a capacity to drive three-inch high speed drills in solid steel, the rated swing of the machine being 28 in. The distance from the center of the spindle to the face of the column is 14 in. and the maximum distance from the nose of the spindle to the standard table is 36 in.; to the compound table, 30 in. The spindle travel regularly provided is 18 in.

All levers and hand wheels are located on the front of the machine and the operator can make speed and feed changes without moving from his regular working position.

Two mechanical speed changes are provided which in conjunction with a special arrangement of change gears makes it possible to obtain 48 different spindle speeds ranging from 30 to 375 r.p.m. Two mechanical feed changes are provided which with different change gears gives 36 speeds ranging from .005 in. to .134 in. per revolution of spindle.

The illustration shows the machine equipped with a plain table of rigid construction but a compound table can be provided if desired. Every mechanical precaution is said to have been taken to safeguard the machine and operator against injury from accidents or carelessness. The feed mechanism is provided with a safety device which shears a pin before damage is done. An interlocking device makes it impossible to change the speeds while the machine is running, also making it impossible to start the machine until the speed sliding gears are fully in mesh.

An automatic tripping mechanism can be set to trip the feed at any desired depth and a final safety trip is also provided for the feed when the spindle has reached its lowest position, thus avoiding possible accident.

When desired, a motor drive can be applied to the machine with a constant speed motor mounted directly on the lower part of the column at the rear and belted to tight and loose pulleys. A 10- to 20-hp. motor is recommended depending upon the work being done.

When desired, a machine of the same general type can be furnished as a two-, three- or four-spindle gang drill.

A Correction

In the description of the Tri-way Universal horizontal boring machine, made by the Universal Boring Machine Company, Hudson, Mass., published on pages 44 and 45 of the January *Railway Mechanical Engineer,* two errors were made. Boring feeds were incorrectly stated to vary from 1 in. to 2-13/16 in. per min. This line should read "Boring feeds vary from 1/8 in. to 2-13/16 in. per min." The weight of the machine crated was given as 2,200 lb. and should have been 22,000 lb.

GENERAL NEWS

The Nashville, Chattanooga & St Louis, on January 9, changed its engine terminals from Lexington, Tenn., to Hollow Rock Junction where new repair shops and other buildings will be provided.

L. A. Downs, vice-president and general manager of the Central of Georgia, and chairman of Division IV of the American Railway Association, has been appointed a delegate of that association to attend the Congress of the International Railway Association at Rome, Italy, in April next.

The National Safety Council, Chicago, is now taking a census of those who are directly charged with the duty of promoting safety through inspection safety investigations, safety education, control of health hazards, or similar work in industries and on the railroads. This is the first time any attempt has been made to obtain a census of the persons engaged professionally in the safety movement.

The enginemen and firemen of the Southern Pacific operating their locomotives with the greatest efficiency in the use of fuel oil, are to be awarded gold badges. The name of the winner with the date of the award is to be inscribed on the back of the medal If a man wins an award a second time, a red enameled star will be inserted in the badge. The award is to be made on a three months' performance basis.

Passenger train punctuality on the Pennsylvania railroad during the year recently ended is reported as 11 per cent better than the previous year. For the period from March to December, inclusive, for the two years, 93.9 per cent of the passenger trains operated were on time in 1921, as against 82.5 per cent on time during the same period in 1920. In 1921 the percentage of trains making schedule time was 96.8, an improvement over 1920 of 4.8 per cent.

The Summary of Wage Statistics, issued by the Interstate Commerce Commission for the month of September, 1921, compared with August, shows an increase of 38,403 in the number of employees of the railroads of the country as of the middle of the month, while their total earnings decreased $3,773,073. The number of employees was 1,718,330, and their total compensation was $223,972,822. The decrease in earnings is said to be due to the fact that there were 27 working days in August, while there were only 25 in September. The statistics do not include the Detroit, Toledo & Ironton, which had not yet filed its report.

Surplus Serviceable Cars

The freight car surplus continued to increase during the weeks ended December 15, 23, January 8 and 15, according to the Car Service Division of the American Railway Association, the totals reported for these periods being 371,221, 404,214, 496,357 and 439,982 cars, respectively

Bad Order Cars

According to reports compiled by the Car Service Division of the American Railway Association, the total of bad order cars showed a decrease during the period ending December 15 to 308,556 or 13.5 per cent, as compared with 14 per cent on December 1

Labor Board Decisions

Wage Increase to Painters.—In a complaint by the United Brotherhood of Maintenance of Way Employees and Railway Shop Laborers against the Delaware, Lackawanna & Western, the Board held that painters were entitled to an increase of 15 cents an hour as specified in decision No. 2 and as covered in paragraph B of decision No. 92, effective March 1, 1920.—*Decision No.* 518.

Carpenters Refuse to Aid in Strike Duty.—Three carpenters on the Pennsylvania Railroad refused to work on bunk cars required by railroad police during the outlaw switchmen's strike in April, 1920. In a case involving the pay of these carpenters for the time not employed during the strike, the Labor Board held that the men were not entitled to it.—*Decision No.* 517.

Examination for Locomotive Inspectors

The United States Civil Service Commission announces an open competitive examination for inspectors of locomotives on March 8 and 9, 1922. Vacancies in the Bureau of Locomotive Inspection of the Interstate Commerce Commission at salaries of $3,000 a year and in positions requiring similar qualifications will be filled from this examination. Applications for the examination should be made on Form 1892 which can be obtained from the Civil Service Commission, Washington, D. C.

American Society of Mechanical Engineers

The Executive Committee of the Railroad Division announces the following action taken at a meeting on December 28: James Partington, former secretary of the division, has been elected to the Executive Committee in place of George W. Rink, who has found it necessary to resign.

A. F. Stuebing has been elected secretary of the division in place of Mr. Partington.

W. H. Winterrowd was elected vice-chairman to succeed Mr. Rink.

William Elmer, of Altoona, Pa., has been added to the Membership Committee of the division.

An invitation from the Metropolitan Section has been accepted to hold a joint meeting with them in the Engineering Societies' building, New York City, on May 16, 1922. The subject of this meeting will be Railroad Refrigeration—Natural and Mechanical.

Reclamation Savings on the Rock Island

The Chicago, Rock Island & Pacific has effected a saving of $1,301,970 through its general reclamation plant at Silvis, Ill., during the three years ending with 1920. From each ton of scrap the company was able in 1918 to reclaim $6.75 worth of useful material, the entire saving for that year amounting to $467,947; in 1919, $8.10 in value was reclaimed from each ton of scrap, and the year's saving was $473,623; in 1920, $6.07 represented the value gained from each ton and $360,398, the total amount saved during that year. The amount and value of the material reclaimed at the general reclamation plant is steadily decreasing, according to C. H. Rost, general storekeeper, because of the work of committees on each division; a large amount of the reclamation work is now done locally. While the savings have thus been increased, no definite figures have been compiled to show the total secured in this manner.

Long Runs of Passenger Locomotives on the M. K. & T.

What is believed to be the longest regularly assigned run in the United States for steam passenger locomotives was inaugurated by the Missouri, Kansas & Texas on November 6, as a result of 11 months' experience in operating its oil burning locomotives in through runs of 400 miles each between Denison and San Antonio, Tex. Oil fuel having recently been adopted on the line between Denison, Tex., and Parsons, Kan., the plan has been adopted of operating trains No. 5 and No. 6, two of the heaviest on the line with a single locomotive each way between San Antonio and Parsons, a distance of 678 miles. These trains regularly handle from 10 to 12 cars and frequently are required to handle extra cars. They have been operated on time since the establishment of the long runs. Formerly, the locomotives were changed on these trains at Denison, Tex., and five locomotives were required to handle the runs. Under these conditions, the locomotives made a daily average of 266 miles each. Under the present plan, three locomotives are required to handle these runs, each making a daily average of 452 miles. Proper care of the locomotives at the terminals is considered the most important factor in insuring the success of the long runs, and in this case each locomotive has a minimum of 12 hours time at each terminal. The locomotives are required to take on fuel only once en route.

Shop Construction

Illinois Central.—This company has awarded a contract for the construction of a car repair shed at McComb, Miss., to Ellington-Miller Company, Chicago. The building will be 600 ft. by 176 ft., with concrete foundation and steel superstructure, and with a cement tile roof. The entire cost is estimated at $140,000.

Missouri, Kansas & Texas.—This company has given a contract to the Graver Corporation, Chicago, for the construction of a type "K" ground operated water treating plant at Parsons, Kan. The plant will have a treating capacity of 50,000 gal. of water each hour and a storage capacity at top of main settling tank capable of holding 200,000 gal. of treated water.

Missouri Pacific.—This company has awarded a contract to T. S. Leake & Co., Chicago, for the construction of a 25-ft. extension to its roundhouse at Hoisington, Kan.

Missouri Pacific.—This company has awarded a contract for the construction of a frame freight and passenger station at Zeigler, Ill., and the remodeling of a brick roundhouse at Coffeyville, Kans., to J. D. Fitzgibbon, St. Louis, Mo.

Virginian.—This company has awarded a contract to the Federal Engineering Company, Chicago, for the installation of a heating plant in its new roundhouse at Elmore, W. Va., to cost $15,000.

Passenger Cars

The Long Island has ordered 40 motor cars for electric service and 10 steel coaches for steam service from the American Car & Foundry Company.

The Chicago & North Western has given an order for 44 steel passenger cars, 3 combination baggage and smoking cars and 3 chair cars, to the American Car & Foundry Company.

The Chicago, Burlington & Quincy has placed orders for 62 passenger cars and 12 dining cars with the Pullman Company and for 53 baggage and mail cars, with the Standard Steel Car Company.

Freight Car Repairs

The Central of Georgia is having a number of steel hopper cars repaired at the shops of the Chickasaw Shipbuilding Company.

Freight Car Orders

The Bangor & Aroostook is applying steel underframes to 250 box cars in its shops at Derby, Me.

The Central of Georgia has ordered 500 box cars from the Mt. Vernon Car Manufacturing Company.

The National Railways of Mexico have ordered 250 tank cars from the General American Tank Car Corporation.

The New York, Chicago & St. Louis has ordered 300 steel underframe stock cars from the Illinois Car & Manufacturing Company.

The Northern Refrigerator Car Company, Milwaukee, Wis., has ordered 500 refrigerator cars from the Haskell & Barker Car Company.

The Atlantic Coast Line will build 50 box cars at its Waycross, Ga., shops and is inquiring for steel superstructures and steel underframes for these cars.

The Illinois Central has placed orders for 2,000 gondola cars as follows: Haskell & Barker Car Company, 700; Western Steel Car Company, 400 and Standard Steel Car Company 400, all these cars to have 8 drop doors, and American Car & Foundry, 500 cars to have 12 drop doors.

The Seaboard Air Line reported as inquiring for prices on 1,500 ventilated box cars of 40 tons capacity; 200 flat cars with steel underframes of 40 tons capacity, and 300 steel phosphate cars of 50 tons capacity, has given an order to the Chickasaw Shipbuilding Company for some of these cars.

The Union Pacific has awarded contracts for 4,500 cars as follows: 1,000 all-steel automobile cars to the Pullman Company; 1,000 steel frame automobile cars to the General American Car Company, and 500 of the same type to the Standard Steel Car Company; 1,000 box cars each to the Mount Vernon Car & Manufacturing Co., and the American Car & Foundry Company.

MEETINGS AND CONVENTIONS

The American Society for Steel Treating will hold a sectional meeting Friday, March 3, at the Engineering Societies' building, New York City.

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

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City. Annual convention May 9, 10, 11 and 12, Hotel Washington, Washington, D. C.

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

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Next annual convention June 14 to 21, 1922, Atlantic City, N. J.

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

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

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

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Annual meeting Chalfonte Hotel, Atlantic City, N. J., beginning June 26, 1922.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, A. F. Stuebing, 2201 Woolworth Building, New York.

American Society for Steel Treating.—W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio. Sectional meeting, March 3, 29 W. 39th St., New York. Annual convention and exposition September 25 to 30, 1922, Detroit, Mich.

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

Canadian Railway Club.—W. A. Booth, 53 Rushbrook St., Montreal, Que. Regular meeting second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal.

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

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

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Meeting second Thursday in January, March, May, August and November, Hotel Iroquois, Buffalo, N. Y.

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

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Next meeting February 13. General discussion, moving pictures and musical entertainment.

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

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill. Next annual meeting Auditorium Hotel, Chicago, May 22 to 25, 1922.

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

Master Boilermakers' Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y. Next annual convention Hotel Sherman, Chicago, May 23 to 26, 1922.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting February 14. Paper on Organization and Modern Handling of Package Freight Through Freight Houses will be presented by G. Marks, assistant general manager, N. Y., N. H. & H.

New York Railroad Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Next meeting March 17. Illustrated talks by F. M. Whyte on Railroad Conditions in Australia.

Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wellner, 64 Pine St., San Francisco, Cal. Next meeting February 9. Papers will be read by women employees detailing their experiences as chief exchange operator, agent, private secretary, welfare worker, etc. Motion pictures showing the manufacture of locomotive boiler tubes will be shown.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Regular meetings fourth Thursday in each month, except June, July and August, at Fort Pitt Hotel, Pittsburgh, Pa.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo.

Traveling Engineers' Association.—W. O. Thompson, Marine Trust building, Buffalo, N. Y.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Regular meetings third Monday in each month, except June, July and August.

PERSONAL MENTION

GENERAL

C. B. Collett, who has been appointed as chief mechanical engineer of the Great Western (England) succeeding G. J. Churchward, C. B. E., who has retired from that position, served his apprenticeship with Maudslay Son & Field, of London, and entered the service of the Great Western Railway in 1893 at Swindon as draughtsman. He subsequently filled the position of chief draughtsman and was appointed in 1900 technical inspector of the Swindon locomotive works. In 1901 Mr. Collett was appointed assistant works manager and in 1913 was promoted locomotive works manager. He has acted as deputy chief mechanical engineer since May, 1919.

Wm. N. Nelson, mechanical engineer of the Minneapolis, St. Paul & Sault Ste. Marie, with headquarters at Minneapolis, Minn., has been appointed mechanical engineer of the Kansas City Southern, with headquarters at Pittsburg, Kan., succeeding E. P. O'Connor, assigned to other duties.

C. T. Ripley, general mechanical inspector of the Atchison, Topeka & Santa Fe, with headquarters at Chicago, has been promoted to the newly created office of chief mechanical engineer, with the same headquarters. H. H. Lanning, assistant mechanical engineer, with headquarters at Topeka, Kan., has been promoted to mechanical engineer with the same headquarters.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

C. H. Creager has been appointed road foreman of engines of the Baltimore & Ohio with headquarters at Washington, Ind., and S. A. Rogers has been appointed to a similar position with the same headquarters.

John J. Herlihy, general foreman at Parkersburg, Ohio, has been appointed division master mechanic of the Baltimore & Ohio with headquarters at Washington, Ind. Mr. Herlihy was born on March 5, 1884, at Shelby, Ohio, and on January 1, 1902, entered the employ of the Baltimore & Ohio as a machinist apprentice at Newark, Ohio. After serving as a machinist at Newark, he was transferred to Cleveland, Ohio, where he first worked as a foreman, then as a machinist. On January 25, 1909, he resigned and became erecting and fitting foreman of the Erie Railroad at Cleveland, being promoted later to general roundhouse foreman at Youngstown. On October 2, 1911, he returned to the B. & O. as assistant roundhouse foreman at Newark, serving subsequently as machine shop foreman at Newark; general foreman at Cleveland; general foreman at Wheeling, W. Va.; acting master mechanic at Benwood, W. Va.; general foreman at Wheeling; general foreman at Benwood; assistant division master mechanic at Pittsburgh, Pa.; master mechanic at Parkersburg, and general foreman at Parkersburg.

W. G. McPherson, master mechanic of the Regina division of the Canadian Pacific, with headquarters at Regina, Sask., has been transferred to Moose Jaw, Sask.

C. H. Norton has been appointed master mechanic of the Susquehanna and Tioga divisions of the Erie.

J. C. Rae, general foreman of the Ann Arbor, with headquarters at Owosso, Mich., has been appointed acting master mechanic, with the same headquarters, assuming charge of the mechanical department, which action was necessitated by the resignation of J. E. Osmer, superintendent of motive power and the car department.

J. E. Stevens has been appointed master mechanic of the Mobile & Ohio, with headquarters at Murphysboro, Ill., succeeding B. A. Orland, assigned to other duties.

F. A. Toates has been appointed assistant road foreman of engines of the Los Angeles division of the Southern Pacific with headquarters at Los Angeles, Cal.

SHOP AND ENGINEHOUSE

Roy Skidmore, erecting foreman of the Kansas City Southern, with headquarters at Pittsburg, Kan., has been promoted to shop superintendent with the same headquarters, succeeding Charles E. Oakes, deceased.

CAR DEPARTMENT

R. N. Dodge, senior inspector car equipment of the Interstate Commerce Commission, Bureau of Valuation, has been appointed car foreman in the heavy freight repair shop of the Chicago & Alton at Bloomington, Ill. Mr. Dodge was born in Champaign County, Ill., on March 19, 1882, and in 1898, after receiving a high school education, entered the employ of the Big Four as a car repairer at Urbana, Ill. In 1900 he moved to Danville, Ill., accepting service with the Chicago & Eastern Illinois. Two years later he was transferred to Dolton, Ill., and after about four years' service in the Chicago district as car inspector, joint inspector and assistant car foreman, he became car foreman of the Chicago, Milwaukee & Gary at Rockford, Ill., being promoted to general car foreman in 1906. Mr. Dodge served with the Interstate Commerce Commission from September, 1914, until October, 1921, during which time he traveled over a great many railroads, including some of the principal lines of the United States, making extensive inspections and studies of general conditions of car equipment, maintenance, construction and all conditions relative to serviceability, for the purpose of the federal valuation of railroads.

R. N. Dodge

PURCHASING AND STORES

G. W. Bichlemeir, purchasing agent of the Union Pacific with headquarters at Omaha, Nebr., has been promoted to general purchasing agent with the same headquarters.

Robert J. Elliott has been appointed purchasing agent of the Northern Pacific, with headquarters at St. Paul, Minn. Mr. Elliott was born at Louisville, Ky. He entered railroad service in March, 1892, as a clerk in the accounting department of the Northern Pacific. Later he was transferred to the general manager's office, and after serving the company in various capacities he was in 1905 promoted to general storekeeper, with headquarters at St. Paul, Minn. In 1907, he was appointed assistant purchasing agent, with the same headquarters, which position he held at the time of his recent promotion.

R. J. Elliott

J. F. McAuley has been appointed division storekeeper of the Portland division of the Southern Pacific, with headquarters at Portland, Ore., succeeding H. J. Smith, who has become chief clerk to the general storekeeper at San Francisco, Cal., succeeding G. M. Betterton, promoted. J. Neph, storekeeper of the San Joaquin division, with headquarters at Bakersfield, Cal., has been transferred to the Los Angeles division, succeeding J. H. Collins, deceased. He will be succeeded by J. F. Brown, storekeeper of the Shasta division, with headquarters at Dunsmuir, Cal., who will be succeeded by F. L. Doss.

I. S. FAIRCHILD has been appointed storekeeper of the New Orleans Terminal division of the Illinois Central with headquarters at New Orleans, La.

E. GARDNER THORPE has been appointed general storekeeper of the Long Island, succeeding Eugene Wright, promoted.

E. GRIFFITHS, division storekeeper of the Chicago, Milwaukee & St. Paul, with headquarters at Perry, Iowa, has been transferred to Mobridge, S. D., succeeding G. L. Juel, who has been transferred to Malden, Wash., succeeding H. R. Meyer, who has been transferred to Perry to succeed Mr. Griffiths.

F. G. PREST, who has been appointed director of purchases of the Northern Pacific, with headquarters at St. Paul, Minn., was born on a farm near Queenston, Ont., on January 5, 1854. He entered railroad service on August 1, 1880, as a clerk in the purchasing department of the Northern Pacific at St. Paul. One year later he was appointed chief clerk of that department, which position he held until 1891, when he was promoted to assistant purchasing agent, with headquarters at St. Paul. In 1896 he was promoted to purchasing agent with the same headquarters and continued in that capacity until his promotion as director of purchases.

F. C. Prest

JOSEPH J BENNETT has been appointed purchasing agent of the Illinois Central, with headquarters at Chicago. Mr. Bennett was born at Centralia, Ill., on July 7, 1885. He entered railroad service in 1902, as an expense clerk in the local freight office of the Illinois Central at Centralia. In 1903 he left to enter the employ of the Centralia Coal Company, for which company he worked in various capacities at the mines, and was later promoted to top superintendent. In July, 1907, he re-entered the service of the Illinois Central as coal inspector at Centralia. He was promoted to traveling coal inspector, Southern lines, with headquarters at Princeton, Ky., in March, 1909, and to fuel agent, with headquarters at Chicago on October 10, 1910. On January 1, 1913, Mr. Bennett was promoted to assistant purchasing agent, with the same headquarters, which position he was holding at the time of his recent promotion.

Joseph J. Bennett

C. B. TOBEY, assistant general storekeeper of the Lehigh Valley, with headquarters at Packerton, Pa., has been promoted to general storekeeper, with the same headquarters, succeeding C. C. Huntington, who has left the service due to ill health.

OBITUARY

J. H. Collins, division storekeeper of the Southern Pacific, with headquarters at Los Angeles, Cal., died of pneumania on December 4, at his home in that city. Mr. Collins had been in the service of the Southern Pacific since 1906.

SUPPLY TRADE NOTES

The Keller Pneumatic Tool Company, Grand Haven, Mich., recently changed its corporate name to William H. Keller, Inc.

The Interstate Car Company, Indianapolis, Ind., is planning the erection of a one-story foundry for the production of iron castings, estimated to cost approximately $25,000.

The Pilliod Company, manufacturer of the Baker locomotive valve gear, has opened a western office at 750 Railway Exchange building, Chicago, in charge of Burton Mudge, vice-president.

S. F. Bowser, founder and president of S. F. Bowser & Co., Fort Wayne, Ind., has retired from the presidency of the company and will be succeeded by S. B. Bechtel, general manager.

William J. Cleary has been appointed assistant general sales manager of the Sharon Pressed Steel Company, Sharon, Pa. Mr. Cleary's headquarters will be in the Dime Bank building, Detroit, Mich.

The Streets Company, Chicago, which has heretofore confined itself largely to the construction and repair of wooden freight cars, has issued an inquiry for certain equipment for the manufacture and repair of steel cars.

William J. Armstrong, assistant treasurer of the Gould Coupler Company, New York City, died suddenly on December 25, at his home in Brooklyn. Mr. Armstrong had been in the service of the Gould Company for the past 25 years.

Albert J. Leonard has been appointed eastern sales representative of the Handlan-Buck Manufacturing Company, St. Louis, Mo. Mr. Leonard's headquarters are at the eastern office of the company, 52 Vanderbilt avenue, New York City.

The firm of Black-Matthews Company, Inc., 25 Church street, New York City, has been organized by Edward J. Matthews and J. Nelson Black to transact business in iron and steel products, together with machinery and railway equipment.

E. R. Mason has been appointed eastern and export representative of Brown & Co., Inc., Wayne Iron & Steel Works, Pittsburgh, Pa. Mr. Mason's headquarters are at the New York City offices of Brown & Co., Inc., room 2038 Grand Central Terminal.

The Youngstown Equipment Company has taken a contract to operate the Kent (Ohio), shops of the Erie Railroad. Webster W. Warner, superintendent of shops, has resigned his position with the railroad to become manager for the equipment company.

B. B. Milner, formerly engineer motive power and rolling stock of the New York Central, who for the past year has been with the Frazar importing-exporting interests, is returning to the Orient where he will establish his own practice as consulting sales engineer.

W. F. Cremean, representative at New York, of the Wine Railway Appliance Company, Toledo, Ohio, has been appointed sales engineer, with headquarters at Toledo, and Peter P. Beck succeeds Mr. Cremean as eastern representative, with office in the Grand Central Terminal, New York City.

Howard J. Charles, formerly with the purchasing and engineering department of the Union Pacific, at New York, who entered the service of the Elvin Mechanical Stoker Company, in June, 1921, has been appointed assistant treasurer of the latter company, with office at 50 Church street, New York City.

O. M. Rau, formerly consulting engineer of the Philadelphia Rapid Transit Company, is now associated with the Hardinge Company, New York City, specializing in the handling of pulverized fuel systems as applied to boilers, and W. O. Renken has been appointed managing engineer of the recently acquired Quigley pulverized fuel department.

The Pressed Steel Car Company and Western Steel Car & Foundry Company have discontinued their Washington, D. C., office L. O. Cameron, who has been a representative of these companies in the Southern territory for many years, has severed his connections with these companies, but will continue his office in the Munsey building to handle other accounts.

E. H. Dewson has retired as district engineer of the Westinghouse Air Brake Company, Wilmerding, Pa., in the Eastern territory with headquarters at New York City and will henceforth serve the company in a consulting or advisory capacity. J. C. McCune, assistant district engineer at New York, has been appointed district engineer to succeed Mr. Dewson. E. H. Dewson has been with the Westinghouse interests since 1901, when the old Standard Brake Company was acquired by Mr. Westinghouse and moved to Wilmerding, Pa., to be known as the Standard Traction Brake Company. Mr. Dewson had been chief engineer of the Standard Brake Company, a position which he retained under the new management. Several years later the engineering departments of the several Westinghouse companies at Wilmerding were consolidated, the Standard Traction Brake Company changing to the Westinghouse Traction Brake Company and Mr. Dewson became assistant chief engineer of the united organization. When the district organizations of the Westinghouse Air Brake Company were created, Mr. Dewson was named resident engineer for the Eastern district, embracing New England, New York, New Jersey, Eastern Pennsylvania, Maryland and Delaware. He has since remained in this position with headquarters in New York City. He has been closely identified with many important improvements in the air brake field during the last quarter of a century and is especially well known for his intimate knowledge of operating problems and traffic conditions in the city of New York. Mr. Dewson now resides at Quincy, Mass., where he plans to spend most of his time while enjoying the greater leisure which his new position will afford. Joseph C. McCune, who succeeds Mr. Dewson as district engineer of the Eastern territory, is his former assistant. Mr. McCune received his early training under the late W. V. Turner, and has held positions of importance in the Westinghouse organization for a number of years. He joined the Westinghouse Air Brake Company after graduation from Cornell University in 1911. He served through the war as an officer of engineers, acting as an instructor in the Third Officers Training Camp at Camp Lee, Va., and later saw service in France as a member of the Expeditionary Forces. He will maintain his present headquarters in New York City.

E. H. Dewson

J. C. McCune

C. W. Johnson, formerly of the Charles W. Johnson Lumber Company, Seattle, Wash., has been elected vice-president of the Duncan Lumber Company, Portland, Ore., and will be in charge of general operations. C. D. McCoy, formerly sales manager of the company, has been elected a vice-president and will be in charge of the eastern sales of the company, with headquarters in the McCormick building, Chicago.

W. H. Graul, department sales manager, and J. J. Hughes, manager of the order department of the American Steel Foundries, Chicago, have organized the firm of Hughes & Graul, manufacturers representatives, with headquarters in the Peoples Gas building, Chicago. The company will represent the Ohio Steel Foundry Company, Lima, Ohio, cast steel manufacturers, and the McConway & Torley Company, Pittsburgh, Pa.

Burton Mudge, president of Mudge & Co., Chicago, dealers in railway specialties, Chicago, has been elected vice-president and a director of the Pilliod Company, New York City, manufacturer of Baker locomotive valve gear, which duties he will assume in addition to those with Mudge & Co., Mr. Mudge was formerly connected with the operating departments of the Atchison, Topeka & Santa Fe, the Chicago & North Western, the Fort Worth & Denver City, and the Rock Island. He resigned as assistant to the general manager of the last named road in 1908, to enter the railway supply business and in September of that year organized the firm of Burton W. Mudge & Bro., representing the Commonwealth Steel Co., this company later becoming Mudge & Co.

Burton Mudge

Harry Barrett Marshall, who for 13 years served as manager of the St. Louis branch of The Electric Storage Battery Company, Philadelphia, Pa., has been placed in charge of all railway sales work of the company. Mr. Marshall, who will be located at Philadelphia, has been associated with the company for the past 16 years. He graduated from the Armour School of Technology in 1905, and a few months afterwards, joined The Electric Storage Battery Company serving in a clerical position at the Chicago branch. In 1909, he was appointed manager of the St. Louis branch, which position he held until his recent appointment in charge of all railway sales work. From the beginning of his association with the company, Mr. Marshall has devoted considerable time to the question of railway sales.

H. B. Marshall

The personnel of the executive staff of the Bridgeport Brass Company, Bridgeport, Connecticut, is now as follows: F. J. Kingsbury, chairman of the board; Carl F. Dietz, president and general manager; W. R. Webster, vice-president; F. J. Kingsbury, treasurer; R. I. Neithercut, secretary; W. D. Blatz, general sales manager; W. R. Clark, general works manager; E. G. Oakley, works manager fabricating division, and Arthur Brewer, works manager mill products division.

R. C Campbell, formerly vice-president of the Duncan Lumber Company, has been appointed manager of the car and railroad material department of the Burton-Beebe Lumber Company, Seattle, Wash., with headquarters at Chicago. Mr. Campbell will also handle long leaf yellow pine for J. H. Burton & Co., Inc., of New York and Mobile, Ala. The Burton-Beebe Lumber Company has moved its Chicago office from 53 West Jackson Boulevard to the Lumber Exchange building.

The Texas Company, New York City, has consolidated its traffic and railway sales departments into one department known as the railway traffic and sales department. The headquarters of G. L. Noble, vice-president; Wm. Jervis, manager, and W. E. Greenwood, assistant manager, is at 17 Battery Place, New York City, which will also be the headquarters of J. E. Symons, superintendent of the lubricating division. W. H. Barrows has been appointed district manager at Houston, Texas.

The Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., announces a number of changes and transfers in personnel in its railway sales department, the organization of which is now as follows: F. H. Shepard, director of heavy traction; M. B. Lambert, manager; E. D. Lynch, office manager; F. F. Rohrer, assistant to manager in charge of contracts; C. H. Long, section manager railway equipment contracts and orders; R. Seybold, manager price section; T. H. Stoffel, electric railway freight haulage export; W. R. Stinemetz, manager, and R. W. Carter, assistant manager of the heavy traction division; K. A. Simmon, manager, light traction division; J. L. Crouse, manager and J. W. Lewis, assistant manager, railway development and supply division; H. A Campe has been appointed manager of the small motor appliance section of the industrial department, succeeding V. M. Beeler, who has been transferred to the Springfield office. H. B. Smith has been appointed manager of the domestic service section of the department, succeeding Mr. Campe and G. L. Washington has been appointed to manager of the Havana, Cuba, office.

John M. Weir has resigned as chief engineer of the Kansas City Southern, to become general superintendent of construction of the National Boiler Washing Company, Chicago. Mr. Weir was born in Ireland on July 31, 1879. He entered railway service with the Illinois Central in June, 1899, as a track apprentice and after occupying various positions, was promoted to resident engineer in charge of construction in March, 1907. Later he was concerned for a time with the construction of a small railway in Canada. After completing this work he returned to this country and entered the service of the St. Louis-San Francisco as assistant engineer at Springfield, Mo. Subsequent to 1908, he was made assistant engineer in the chief engineer's office in charge of construction of the Gainesville & Northwestern in Georgia and not long thereafter he entered the valuation department of the Chicago, Rock Island & Pacific. He served this company as assistant engineer of track of the Chicago terminal and as assistant engineer in charge of terminal valuation. In June, 1916, he was appointed division engineer of the Kansas City Southern, with headquarters at Pittsburg, Kan., and was promoted to chief engineer in March, 1917.

Superheater Company Forms French Connection

Geo. L. Bourne and Fred A. Schaff, president and vice-president, respectively, of the Superheater Company, New York, have recently returned from Paris, where they have formed as a French connection the Compagnie des Surschauffeurs, which has been given full rights for the sale and manufacture of the "Elesco" superheaters and forged return bends controlled by the Superheater Company.

This new French company brings together interests prominently associated with superheating in France, the board of directors being Ad. Seghers, A. Fiedler, S. Magis, Capt. F. R. Fitzpatrick and Geo. L. Bourne. Capt. Fitzpatrick will represent the American interests in the company, and will reside in Paris as a resident director Ad. Seghers, has, for 20 years, been identified with superheating in France. A. Fiedler represents the Basse Loire group, comprising the Usines Métallurgiques de la Basse-Loire, Société des Forges et Aciéries du Nord et de l'Est, Ateliers et Chantiers de Bretagne, etc., and is, himself, managing director of the L'Auxiliaire des Chemins de Fer & de l'Industries, manufacturers of the Caille Potonie feed-water heater, high temperature pumps, etc. A. Magis is a member of the firm of Magis et Dumortier of Brussels, dealers in railway supplies.

The Compagnie des Surchauffeurs is located at 11 Rue Scribe, Paris, France. A plant has been established in the outskirts of Paris for the manufacture of all types of superheaters where the forged return bends will be made.

TRADE PUBLICATIONS

Production Tools.—Three four-page leaflets, describing and illustrating Go & Go types of half side, plain and inserted tooth mills, have recently been issued by the Goddard & Goddard Company, Detroit, Mich.

Locomotive Air Brake Gages.—The Ashton Valve Company, Boston, Mass., has issued Circular No. 66 describing and illustrating its improved 5 in. dial quadruplex air brake gages; also its triplex air brake and train signal gage.

Fuel Systems.—Sectional drawings of Quigley fuel systems and descriptions outlining methods of preparing, transporting and burning pulverized fuels are contained in Bulletin No. 12 recently issued by the Hardinge Company, New York City.

Flexible Couplings.—Specifications, sizes, prices and dimensions, also considerable useful information, are included in Bulletin No. 32 which the Francke Company, Newark, N. J., has recently issued describing and illustrating its flexible couplings for direct connected machines.

Arc Welding.—The Westinghouse Electric & Mfg. Company, East Pittsburgh, Pa., has recently issued Leaflet 1825 describing and illustrating arc welding as applied to repair and reclamation work. General applications of arc welding for manufacturing processes are included.

Hydraulic Valves and Fittings.—Sixty-four pages of illustrations, descriptions, tables and helpful information are contained in Catalogue 43B which the Hydraulic Press Manufacturing Company, Mount Gilead, Ohio, has recently issued covering its line of high pressure valves and fittings.

Air Brake Instruction Pamphlets.—The Westinghouse Air Brake Company, Wilmerding, Pa., has issued new editions of its instruction pamphlets covering the No. 6 ET locomotive brake equipment, the UC passenger car brake equipment and the 3T triple valve test rack and codes of tests.

Wire and Wire Rope.—The development of wire by John A. Roebling and its use in the construction of bridges, especially the Brooklyn bridge, cables and cableways, hoisting devices, aeroplanes, etc., are described in an interesting manner in "Outspinning the Spider," written by John Kimberly Mumford and published in book form by the Robert L. Stillson Company, New York City.

Pumps.—A booklet explaining what is meant by trade pumps, plain fitted pumps, or brass fitted pumps; what is considered standard equipment for a trade pump and what the manufacturer considers as extras, has recently been published by the Hydraulic Society, New York City. Typical sizes of trade pumps are also shown and definitions given of the terms used in the industry, such as static head, total dynamic head, suction lift, static suction lift, dynamic suction lift, etc.

Thermostat Temperature Regulating System.—The Gold Car Heating & Lighting Company, Brooklyn, N. Y., has recently issued its 1921 catalogue describing an electric thermostat temperature regulating system for the automatic control of steam, hot water or hot air heating apparatus. The booklet shows the various types of thermostat control for all kinds of heating equipment. Complete diagrams are given showing the location of the apparatus, as well as the actual connection between the thermostat, motor and furnace.

Chimney Loss.—Two new bulletins of the combustion and the cost of power series have recently been issued by the Uehling Instrument Company, Paterson, N. J. Bulletin No. 220, discussing the magnitude of the power plant's chimney loss, contains diagrams showing the great importance of the chimney loss as compared with other boiler losses, also the possible improvements in efficiency at average boiler plants. Bulletin No. 221, outlining the relation between CO_2 and heat units wasted up the chimney, contains a diagram showing the saving in dollars per year per 100 boiler horsepower by increasing the per cent CO_2 in the flue gases, also tables showing the per cent of losses for solid, liquid and gaseous fuels.

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Conditions Are Improving

The entire country has been pretty hard hit by the depression through which we have been passing. From every side come inquiries as to whether conditions are improving, or as to when we may look for a revival of business. The railroads in particular have suffered severely and are anxiously awaiting a marked improvement in the business situation. The general impression seems to be that there is a steady but hardly perceptible improvement taking place, but that if it keeps on at the same rate we will awaken, not many months hence, to find a near approach to normal conditions.

The best barometer in the railroad field is the record of the revenue freight cars loaded each week; these, of course, are not as accurate as the ton-mile statistics, since they do not take into consideration the size of the load or the distance over which it is transported. In a rough way, however, they reflect the general conditions. It is interesting, therefore, to note that there has been a steady improvement from the week ending January 7, when the total revenue freight loaded was 605,992 cars, to the week ending February 11, when it was 778,412 cars. Every week since January 7 has shown a decided improvement in revenue freight cars loaded this year as compared with the corresponding weeks for 1921. February 11 was the first week for a long time, however, in which the cars loaded exceeded the corresponding week in 1920.

There has not been any great change in the number of bad order cars, but there has been a very considerable decrease in the freight car surplus—it was 296,659 for the week ending February 8. That the increased car loadings indicate a better general business condition is indicated by the fact that the merchandise, l.c.l. and miscellaneous loadings have steadily increased since the first of the year. The increase this year is particularly noteworthy because in both 1920 and 1921 there was a falling off in the loadings for the five weeks following the first week of the year.

One swallow, of course, does not prove that spring is here, but these facts taken in consideration with reports from different industries, as well as a better credit situation generally, point toward a slow but steady improvement in the business situation.

Co-operation With Other Departments

In the organization of American railroads, the mechanical department officer is usually one member of a numerous staff reporting to one of the higher executives. His position is one step removed from the direct operation of the property and too often there is a tendency to segregate the activities of the department, making it a separate plant primarily intended to maintain the motive power and rolling stock, rather than an integral part of the operating machine.

The activities of the mechanical department are so interwoven with the operating and maintenance-of-way departments that the logical organization would seem to be one in which the executive is a clearing house between the operating, mechanical and maintenance-of-way officers. To get a general view of the situation, it may be useful to analyze the extent to which the mechanical department influences the operation of the road. Expenditures for maintenance of equipment form about 27 per cent of the total operating expenses. In addition, the department usually has direct responsibility over fuel which costs nearly half as much as maintenance of equipment. Other large items of expense are controlled indirectly by the mechanical department. The character and condition of the motive power determine the train loads that can be hauled and thus have an important influence on the wages of trainmen and enginemen which form an additional 10 per cent of the total expenses. The effect of the locomotives on roadway maintenance is generally recognized and the mechanical department influences this important division of expenses also.

In the aggregate, the mechanical department controls to a greater or less degree expenses outside that department which are as great as the total cost of maintaining equipment. The influence of the mechanical officer is not limited to locomotives and cars and his interest likewise should extend throughout the entire organization. If he is to measure up to the responsibilities of his position, he must not only know all about his own department, but he should also know something about the other departments and how his department can best co-operate with them.

Decreasing Empty Car Miles

On most of the railroad lines in this country the freight traffic in the two directions is unbalanced. Heavy dead freight usually moves one way, while light, high-class shipments are moved in the other. It is necessary to provide different cars for the various classes of traffic and this results in a large proportion of empty movement. In general, freight cars make about 70 per cent of the total mileage under load and 30 per cent returning empty. As each car makes an average of about 10,000 miles a year and the cost of the empty haul is about five cents a mile, the expense of returning cars for load is about $150 per car per year. This is a serious loss and while it cannot be eliminated, it can often be reduced by adapting cars to carry various classes of lading. This is one of the important questions that should be considered by the car department officers in preparing the designs of freight cars.

Of the various types of cars in common use, the box car is probably suitable for more different classes of lading than any other. In some parts of the country box cars are used extensively for hauling railroad coal. The same equipment is suitable for handling bulk grain, merchandise and l.c.l. freight, so the empty mileage on box cars is often almost negligible. There is another question to be considered in this connection, however. Loading box cars with coal may save considerable by reducing the empty haul, but the economy may be largely offset if the cost of handling the coal at the chutes is increased. In such cases it would be economical to provide hopper bottom box cars. In fact, some roads have developed satisfactory designs of cars of this type.

Another matter requiring careful study is the field for hopper cars and drop bottom gondolas. The drop bottom gondola is more expensive to maintain but it can often be loaded in both directions, whereas the hopper car usually makes about as much mileage empty as it does loaded. Stock cars are another class of equipment which carry loads in one direction only, but the so-called general service stock car is suitable for many classes of lading. Gondola cars with drop ends are another example of equipment that meets the demands of various classes of traffic.

It is doubtful whether the railroads have taken full advantage of the features of design that will reduce the ratio of empty car mileage. This is an attractive field for effecting economies, for in addition to the saving on the empty haul, an increase in the loaded mileage usually results in lower cost on a ton-mile basis for maintenance and fixed charges.

An Old Fallacy

It is surprising how regularly mistaken ideas crop up time and again, no matter how complete and convincing to the average mind is the evidence of their fallacy. Discussion of the grinding of car journals, for example, before the Car Foremen's Association of Chicago recently developed objections to the practice on the ground that car axles are relatively soft, and particles of abrasive are likely to be left in the surfaces and cause hot boxes. That this result does *not* follow has been demonstrated by scientific tests and actual experience with thousands of similar ground bearings on many roads. Neither case-hardened nor soft steel parts, subsequently ground, show any evidence of imbedded grit or abrasive. The facts and arguments in the case have been presented many times and were summed up in an editorial "Does Abrasive Adhere to Ground Surfaces" on page 478 of the August, 1921, *Railway Mechanical Engineer*. Railroad men of the old school favored rolled as against ground bearings on account of the mistaken idea mentioned but most of them were convinced when progressive roads installed and successfully used grinding machines for truing piston rods, valve stems, guides, crank pins, driving axle and trailer axle journals, etc. Literally thousands of these parts, most of which are neither case-hardened nor heat treated in any way save to be annealed, are now in service and no more striking proof of the value of ground bearing surfaces could be conceived.

In the industrial field, also, evidence is not lacking and one example was brought out by another member of the Car Foremen's Association who testified that certain machinery, such as compressors and pumps, furnished to the U. S. government for use on torpedo boats during the war was provided with ground bearing surfaces throughout. These parts also were of soft steel and not case-hardened indicating that this factor has no effect.

Morale Is Being Restored

SPEAKING on the nationalization of railways before a recent meeting of the National Council of the Chamber of Commerce of the United States, Secretary of Commerce Hoover stated that "it undermines the very basis of individualism on which our social structure must rest, and that individualism in itself is something different from that of anywhere else in the world. It has a quality to itself, not participated in by any other civilization, in that it stands staunchly for an equality of opportunity and in that limitation is the justification within the four corners of our social system for the regulation of the railways, but it does not carry us to the point of socialism and the destruction of the whole basic question of initiative and individualism."

It is unfortunate that the average citizen of this country does not realize the truth of Mr. Hoover's statement. We are faced in the railway field, for instance, with a group of labor leaders who are advocating the Plumb Plan and are doing everything they possibly can to discredit railway managements. They keep harping on abuses that have occurred in the past, and fail to recognize the danger which lies ahead if they persist in this sort of thing. We have no sympathy at all for the reactionary railroad executive or officer, be he high or low, and we are equally out of sympathy with the radicals in the ranks of labor whose short-sighted policy is helping to keep the brakes on prosperity in this country today.

The public, and railway officers and employees, cannot intelligently pass upon questions affecting the railroads unless they know the real facts in the situation. They cannot know them if they are not willing to study the situation and take some pains to determine the real facts. It is high time that the so-called "labor economists" and "railroad experts" got down to brass tacks and stopped assuming a thing was so and then developing statistics to prove it. We need to be reminded that, "figures don't lie, but liars figure." No institution can be a success unless its members stop playing the game as individuals and do some real team work. There has been entirely too much knocking and fault-finding in railroad organizations, and everybody concerned, from the head of the department down to the least important man in it, should realize the absolute necessity of team work, if the railroads are to survive and adequately serve the public.

Fortunately, developments during recent months indicate that officers and men are awakening to these facts, and there has been a corresponding improvement in morale on the various roads. In some cases the change has been exceedingly marked; in others, little or no progress has been made. It is time for officers and men alike to look around and take stock, and then get busy. One thing is dead sure and that is, that the public, good-natured as it is, is getting tired of the constant bickerings and recriminations.

Possibilities of the Diesel Locomotive

THE success of the motor car in railroad service raises the question whether the internal combustion engine can be used on a large scale for motive power on the railroads. Apparently the field for the gasoline engine as developed for motor truck service is limited. A single passenger vehicle, even when built as light as practicable, taxes the heaviest motor truck engine to its capacity. Such motors develop a maximum of about 60 or 70 h.p. while modern locomotives range from 2,000 to 3,000 h.p. It is apparent, therefore, that the application of the gasoline engine must be limited to single units, or at least, to very light trains until there is a marked increase in the amount of power developed in a single unit.

While the gasoline engine is limited in power, other types of internal combustion engines are made in very large units. If the internal combustion engine is to be applied to locomotives, it would be necessary to use the Diesel type which is made in sizes up to 3,000 h.p. These engines burn heavy oils and the ignition in the cylinder is not effected by a spark, but by the heat of compression of the gas, or by a hot bulb in the cylinder head. Diesel engines have the advantage of very high efficiency in fuel which would make them particularly desirable for railroad service.

The problem of the application of Diesel engines to railroad service is being studied seriously both in this country and abroad. There are numerous handicaps to be overcome before the Diesel engine can meet the conditions of railroad operation. One of the principal difficulties lies in starting. The internal combustion engine cannot start under load and slipping clutches are not suitable for large power units. It is therefore necessary to interpose some special transmission system between the internal combustion engine and the driving wheels of a locomotive. The most satisfactory drive thus far devised is secured by attaching an electric generator to the engine, and motors on the axles. This, however, increases the weight and the cost of the locomotive to a degree that is almost prohibitive. A method of starting which has frequently been proposed for Diesel locomotives is by means of compressed air stored in tanks on the locomotive. This was the method used by Dr. Diesel on the first experimental Diesel locomotive, built in Germany several years ago. Such an air supply can be used only for a short period and introduces numerous complications.

Aside from the difficulty of starting, the Diesel engine is at a disadvantage because of the great weight per unit of power developed. Diesel engines weigh as much as 450 lb. per horsepower as compared with an average of about 130 lb. for steam locomotives, including the boiler and machinery. This difficulty is overcome by the compound Diesel engine in which the weight per horsepower is only about 40 lb. Reliability is, of course, a prime requisite in any type of locomotive. Modern designs of Diesel engines meet this requirement and have proved satisfactory under the exacting conditions of marine service.

To sum up the whole matter, the principal disadvantage of the Diesel engine for locomotive service is lack of flexibility. The high efficiency of this type would make its use on the railroads very desirable and if a suitable means for transmitting the power from the engine to the driving wheels can be developed, the introduction of internal combustion engines in locomotive service would probably be fairly rapid.

Car Plants Getting Busy

SECRETARY of Commerce Hoover, in his testimony before the Interstate Commerce Commission rate hearing on February 3, suggested that few people seem to realize the amount of expansion which is necessary in our transportation machine to keep pace with the growth of the country. He emphasized the fact also that "unless we can have an immediate resumption of construction and equipment, our commercial community will pay treble the cost of the whole of them in their losses of a single season."

Secretary Hoover stated that the railroads should add at least 120,000 cars and 2,500 locomotives annually to their equipment. "Since we entered the war in 1917," he said, "we have constructed at least 10,000 miles of railways less than our increasing population and economic development called for and we are behind in rolling stock by about 4,000 locomotives and 200,000 cars."

W. W. Colpitts, in testifying before the Interstate Commerce Commission, rate hearing for the Board of Economics and Engineering of the National Association of Owners of Railroad Securities, indicated that the total savings by the retirement of weak cars through a period of five years would be almost $100,000,000 per annum over a 10-year period. The report suggested that 890,000 of the wooden cars in service, ranging in capacity from 30 to 35 tons, should be replaced within five years with 540,000 steel and steel underframe cars of 50 tons capacity.

Obviously, if the railroads are to make good, they must build new freight cars on a considerable scale during the next few years.

Prior to the period of federal control, most railroads had programs for retiring wooden passenger car equipment and replacing it with steel These programs were knocked into a cocked hat under war conditions. The public demand for greater safety and steel passenger equipment, however, will undoubtedly cause their resumption as soon as means can be developed to finance the building of the cars; this, of course, depends to a great extent upon the restoration of public confidence in railroad securities.

It is noteworthy that for the first two months of this year the railroads ordered as many freight cars as they ordered for domestic use during 1921, and that they ordered almost 50 per cent more passenger cars during January and February of this year than they did during the entire 12 months of 1921. This, of course, does not mean very much because during 1921 very little new equipment was built. On the other hand, the orders placed thus far this year were at a time when conditions were at their very worst. With any reasonable improvement in business, the railroads should show increased earnings, and many of them will undoubtedly place orders for equipment which they well realize is vitally necessary if they are to successfully handle the business which is sure to develop.

Mr. Hoover indicated that the American people lose a billion dollars for each of the periodic transportation shortages. The railroads cannot afford to cause another loss of this kind in the future if there is any possible way by which it can be prevented. It is sincerely to be hoped that they will find their way to order during this year at least the 120,000 cars and 2,500 locomotives which Secretary Hoover suggests should be added to their equipment annually under normal conditions.

COMMUNICATIONS

Economy of Hot Water Washout Plant

Chicago, Ill.

To the Editor:

The report of the Travelling Engineer's Association on Operating and Maintaining Oil-Burning Locomotives, published on page 747 of the December issue of the *Railway Mechanical Engineer*, covers the subject very well, but there are certain points that seem to have been overlooked. The influence of hot water boiler washing plants for reducing the consumption of oil fuel in getting up steam around terminals, as well as the influence of hot water in the reduction of the cost of boiler maintenance, should be stressed when touching on the subject of economical operation and maintenance. The writer realizes fully the fact that in the article under discussion nothing in regard to facilities was touched upon, but the terminal savings that can be made in this way are very large and should be considered when there is any discussion of fuel saving.

A series of tests was conducted over a period of several weeks to ascertain the quantity of oil fuel required to get up 100 lb. steam pressure on a number of oil-burning locomotives, with and without hot water facilities.

These tests were carefully made and recorded and the average results given below show conclusively the large saving in fuel made by using hot water for filling locomotive

Type Locomotive	Cold Water	Hot Water	Saving
	Time		
Mikado	1 hr. 49 min.	32 min.	1 hr. 17 min.
	Fuel consumption		
	140 gal.	75 gal.	65 ga.l
	Time		
Pacific	1 hr. 14 min.	30 min.	44 min.
	Fuel consumption		
	140 gal.	75 gal.	65 gal.

boilers as compared with cold water. The locomotives in the tests were Pacific type passenger engines with 25 in. by 28 in. cylinders, 41,000 lb. tractive effort and Mikado type freight engines 28 in. by 30 in. cylinders, 60,000 lb. tractive effort

At one terminal the boilers were filled with cold water from the city mains at an average temperature of not over 50 deg. F. At another, the water from a boiler washing plant was used, the temperature averaging 195 to 205 deg. F. The boilers of all engines were filled to 1½ gages of water and the oil consumption was taken from the oil gage in the tank, readings being taken at the time the fire was lit and as the steam pressure reached 25 lb., 50 lb., 75 lb. and 100 lb.

In addition to the actual saving in fuel through the use of hot water the additional wear and tear on the interior of firebox and the terrible rending effect on account of contraction and expansion when heating cold water by the use of the very hot concentrated oil flame will increase the cost of maintaining boilers and fireboxes at least $250 to $300 per annum.

C. C. Lance,
Engineer, National Boiler Washing Company.

Concerning the Accuracy of Cylinder Packing

Cambridge, Mass.

To the Editor:

Referring to the article on page 95 of the February *Railway Mechanical Engineer* describing the work done on a Blanchard surface grinder, the limits given for one of the jobs described seem unnecessarily large.

Cylinder packing lasts longer and lets less steam leak by if it is a fairly close fit in its groove. It is obvious that if both the groove and the packing are allowed large limits of variation in width, some pistons will have packing that is an extremely loose fit in the groove. This is undesirable as it leads to reduced efficiency and more frequent renewal.

By Blanchard grinding, it is possible to machine the packing to close limits at very small cost. Limits of ± .001 in. are about as easy to maintain as the ± .003 in. limits mentioned in your article. One large railroad shop tells me that they hold their Blanchard ground packing to limits of ± .0005 in. or less. It costs them but little to do this for the grinder is designed for economically producing just such work.

Why not take advantage of this and cut down the looseness of packing fits by holding the variation on one of the two parts involved to practically a negligible amount? Then the variation in fit will be only the variation in width of grooves, and not the sum of this plus a large variation in thickness of packing. This can be done at very small cost by finishing the packing on the Blanchard grinder and this gives the added advantage that the ground surfaces, being smoother and flatter, cause less wear on the sides of the groove and hold steam better.

Henry K. Spencer,
Engineer, The Blanchard Machine Company.

NEW BOOKS

Mechanical World Year Book for 1922. 348 *pages, 4 in. by 6 in., illustrated, bound in cloth. Published by Emmott & Co., Ltd., 65 King street, Manchester, England.*

This is the annual edition of a reference book which has been published for 35 years and is widely known and extensively used not only in England but also in other countries. Some of the subjects treated are: Steam and steam engines including steam tables, indicator work, constructional details, proportion of parts, condensers and turbines; boilers including types, construction, joints, safety valves, chimneys and superheating; gas and oil engines, including the Diesel type; metals and alloys, including composition, properties, weights, structural work, shafting and gearing; machine work, including machine tools, milling, grinding, gages bearings, belting, lubrication, threads; hydraulics and steam heating. Among new material in this edition is a section on boiler construction and a chapter on pipes and tubes of all kinds.

Electric Arc Welding. *B. E. Wanamaker and H. K. Pennington. 254 pages, 167 illustrations. Size 5 in. x 9 in. Bound in cloth. Published by Simmons-Boardman Publishing Company, Woolworth Building, New York.*

The average user of electric arc welding apparatus will find this book suited to his needs, for it treats the subject thoroughly in language that is easy to understand. The authors hold positions as electrical engineer and supervisor of electrical equipment and welding respectively on the Chicago, Rock Island & Pacific. They are men who lead the field in making new and successful applications of the process and have an everyday working knowledge of conditions encountered in actual practice.

The subject matter in the book is confined to autogenous electric arc welding and no attempt has been made to cover electric welding in its broadest sense. The book covers descriptions of welding systems and their installations, phenomena of the metallic and carbon welding arc, training of operators, methods for applying metal to various types of joints and building-up operations, electrode materials used, weldability of various metals, weld composition, thermal disturbances of parts affected by the welding process, physical properties of completed welds, efficiency of welding equipments, welding cost, etc.

This information is that which is most in demand for practical purposes, and the book is one of the unusual books that covers a scientific subject without the aid of mathematics. It should be found useful both as an instruction book for teaching the layman the underlying principles of welding processes and as a convenient reference book for the welding operator.

Principles and Design of Foundation Brake Rigging. 121 *pages, 74 illustrations. Published by the Air Brake Association, F. M. Nellis, Secretary, 165 Broadway, New York.*

This book is unique in that it is the only comprehensive treatise that has ever been issued covering the fundamental underlying principles and their application to the design of foundation brake rigging. The first chapter is devoted to the theory of friction, the factors which affect its amount, the meaning of coefficient of friction and the friction between the brake shoe and the wheel and between the wheel and the rail. Following this is an explanation of what actually stops a railroad train and the sequence of events which then takes place.

The subject next taken up is that of leverage, first simple levers and then levers combined into various systems. The meaning of leverage ratio is explained and rules are given for calculating leverage with examples of their application to various types of foundation brake rigging. The effect of angularity of levers is also shown. Braking power and braking ratios are defined and reasons are given for the commonly accepted braking ratios for passenger and freight cars.

The underlying principles having been explained, the subject of foundation brake rigging is next treated in detail. Some of the points covered are four and six wheel truck brakes, single shoe and clasp brakes, empty and load brakes, hand brakes, locomotive driver brakes, piston travel, efficiency of brake rigging and the design of foundation rigging members.

A chapter on retardation, calculation of train stops and retarding force necessary to control a train on a grade is followed by clear and concise definitions of the terms commonly used in discussions of braking and brake rigging. This completes a book which will be found to be an invaluable reference work to those who are interested in the vital subject of the application and use of air brakes on all types of rolling stock.

Herbert Hoover Discusses the Railroad Situation

Vital Need of Additional Equipment: Tremendous Losses from Lack of Foresight and Antagonism to Railroads

IN RESPONDING to the invitation to discuss some of the problems present in your general railroad investigation, I shall devote myself to three of the railway topics which especially arise from the present economic situation.

I do not need to review at length that we are recovering from the destruction and inflation of the greatest war in history; that we are suffering from the waste, the extravagance, and over-expansion of the post-war boom, and that the war has brought about great shifts in the movement and price levels of commodities between nations.

I would, however, suggest that it might be profitable for our people to get a somewhat clearer perspective of our own, and the world's troubles and problems. Even a superficial survey must bring us out of an atmosphere of gloomy introspection into an assuring realization that, great as our dislocations may seem to be, we relatively are in an enviable position. Our nation is unshaken and as a people we are getting our bearing in a world of perplexing economic adjustments. While there is unemployment and lack of profit taking, we are free of panic. We are comparatively more restless than injured. For instance, as heavy as our tax burden is, it is still less than one-half as great in proportion to our national productivity as the other states in the war.

The violence of our readjustment, however, is without parallel and we sometimes tend to color our measures for the future by the depression we are in. The fact is that we must predicate all plans for the future on the ultimate return of the American people to a normal economic activity, with our annual progress in the expansion of our production, of our plant and equipment, of our skill and our efficiency. There can be no question that this return will take place, and no responsible body will approach our problems on any other basis. Not one of us would submit to the charge that we were not prepared to bet against any odds upon the future of the United States. Our problem is to expedite this recovery—to speed up employment of our workers, and thereby find market for our farmers.

If we look at the national economic situation as a whole, the greatest impulse that can be given to recovery from any source whatever is a reduction of rates on primary commodities combined with the immediate resumption of railway construction and equipment. The first depends upon reduction of operating costs, the second upon restoration of credit.

HERBERT HOOVER
Secretary of Commerce

Increased Facilities and Equipment Necessary

One thing is absolute. Our transportation facilities are below the needs of our country, and unless we have a quick resumption of construction, the whole community—agricultural, commercial, and industrial—will be gasping from a strangulation caused by insufficient transportation the moment that our business activities resume. For the past five years we have had no consequential expansion to our railway transportation machine. With but one interval of nine months in 1918 and 1919 we had a car shortage throughout the whole of the years 1916-17-18-19 and '20. This shortage rose to as high as 160,000 cars with a corresponding shortage of motive power. We paid tremendous sums in commercial losses and unemployment in consequence. We laid it onto the war. We should lay it onto our lack of foresight and antagonism to railroads.

Few people seem to realize the amount of expansion in our transportation machine necessary to keep pace with the growth of the country. And an equal few seem to have any notion of the price we pay for not having it. Our country is more dependent upon railway transport than any other. All others have comparatively great coast lines and internal waterways. The experience of the 20 years before the war has shown that we must build an extension of lines, including terminal facilities, additional sidings, etc., every year equal to the construction of a new railway from New York to San Francisco. We must add at least 120,000 cars and 2,500 locomotives annually to our equipment. Since we entered the war in 1917 we have constructed at least 10,000 miles of railways less than our increasing population and economic development called for and we are behind in rolling stock by about 4,000 locomotives and 200,000 cars.

I wish to emphasize that unless we can have an immediate resumption of construction and equipment, our commercial community will pay treble the cost of the whole of them in their losses for a single season. The very moment that we reach anything like normal business we shall see a repetition of car shortages, followed by an increase in the cost of coal to the consumer from one to three dollars a ton; we shall again see premiums of 20 cents a bushel for the use of cars for moving grain; we shall in fact see a shortage of commodities to the consumer; and we shall see gluts upon the

*Statement before the Interstate Commerce Commission, February 3, 1922.

hands of the producers. We shall see factories filled with orders again closed for lack of cars; we shall see large intermittency in employment; and we shall see the usual profiteering in commodities due to a stricture between the producer and consumer.

There would be no difficulty whatever, by basing such losses on the experiences we have already had, to calculate a loss to the American people of a billion dollars for each one of these periodic transportation shortages.

Furthermore, there is nothing that is so irrecoverable a loss to the nation as idle shops and idle men. To-day we have both. There is nothing that will so quickly start the springs of business and employment as an immediate resumption of construction and equipment of the railways. When business does resume, we shall need all of our capacity for the production of consumable goods. We shall not only find it strangled for lack of transportation, but we shall find ourselves plunging into the manufacture of this very railway equipment and construction in competition with consumable goods for materials and labor. Herein lies the basic cause of destructiove price inflation and booms, with all their waste and over-expansion. In times of depression, we should prepare for the future and by doing so we can cure the depression itself.

If we examine the fundamental reasons for failure to resume equipment, we will find them in the loss of confidence in railways as an investment and the competition of tax free securities. We have passed the period of credit strain in this depression. Surplus capital is pouring by hundreds of millions monthly into tax free securities and foreign loans, and yet our railways are unable to finance the most moderate of construction programs. The confidence of the public in railway investments was at so low an ebb before the war that finance by the issue of common and preferred stocks had become impossible and railway expansion was living on bond issues. The confidence of an assurance and continuity in earning power to cover this burden of bonds has been even lowered since the war began, because of the uncertainties of both rising and falling prices, of rising and falling wages, of rising and falling rates preventing all regularity of earnings upon which an investor could be convinced. even if no other difficult factors entered into the problem. I see no occasion to go into the labyrinth of past railway finance, its propriety, or lack of propriety, its foolishness or its skill. This commision approaches the financial problems of the railways upon the actual value, not upon their issues of securities, and I take it we are living for the future, not the past. We want transportation, and we want it with the values of private initiative and clean public service.

If we look to the immediate future with its complete necessity of paring the railway earnings down to little more than bond interest, until we give relief to the shipper (and thus the primary foundation to business recovery) I can see little likelihood of convincing the investor as to his margins of safety. There is an atmosphere that our railways will never again earn profits, and that they are not as an industry worthy of investment, and that because private investors will not come to their assistance nobody can do anything

Railways Need 4,000 Locomotives and 200,000 Cars

We must add at least 120,000 cars and 2,500 locomotives annually to our equipment. Since we entered the war in 1917 we have constructed at least 10,000 miles of railways less than our increasing population and economic development called for and we are behind in rolling stock by about 4,000 locomotives and 200,000 cars.

Efficiency of Railways

A great deal has been said about the inefficiency of our railway system. I do not sympathize with these statements. Comparison with foreign railways of the fundamental criteria of per ton-mile costs, train loading and so forth, in the light of our cost of living, will demonstrate that our railways are of higher standards, better in methods than others and are growing in efficiency.

Driving Headlong for a Setback

Far from it being impossible for our railways again to return to a profitable footing, I believe it is possible to demonstrate that on an average they will become very profitable. If we assume that the reduction of prices and wage levels will settle at a plane no lower than 50 per cent over pre-war, and if we assume that the present rates are to maintain, and if we assume restored traffic, then the earnings of our railways would exceed 15 per cent on the whole of the commission's tentative valuation. Surely there is room here for safety to investment, as well as relief to the shipper.

But the circumstances being as they are, confidence being at a low ebb, we do not have the equipment necessary for our business. We are driving headlong for a setback to our whole commerce the very moment that we begin to get on our feet.

In these circumstances it seems to me vital that the railways as our greatest industry should propose a courageous program of broad visioned betterments and, if necessary, the government guarantee to equipment trusts upon the primary responsibility of the railways, the proceeds devoted entirely to improvement and equipment. This is no proposal to take money from the taxpayer. It is a proposal to save him from paying treble the amount of his guarantee in profiteering and losses. It will render a reduction of rates earlier, for unless something is done the improvement will have to be paid over years out of increased rates. Nor would we lose a cent upon the guarantee, for if American railways can not earn interest upon their borrowings let us throw up our hands and prepare for a second Russia.

A real program of construction would in its various ramifications give relief to five or six hundred thousand of our unemployed. It would enable even added numbers to increase their standard of living, and thus give increased market to the produce of our farmers. Our farmers who look to foreign markets for their surplus should stop to consider that our home consumption of meat decreased nearly seven pounds per capita in 1921, mostly owing to unemployment and that if this decrease could be overcome it would be worth more than a 35 per cent increase in exports.

We talk glibly of giving billions of credits to foreign countries, to increase our farm exports. I wish to say with all responsibility for the statement that a billion dollars spent upon American railways will give more employment to our people, more advance to our industry, more assistance to our farmers, than twice that sum expended outside the frontiers of the United States—and there will be greater security for the investor.

Railway Rates

Before entering upon the question of readjustment of rates, I wish to set out some factors in the present economic situation that bear upon the entire question.

The following table shows a few commodities and service groups, compared to 1913 as 100. An examination of this table immediately demonstrates:

(1) The inequality in prices and wages between different groups of commodities.

(2) The great increase in spread between "producer's" and "consumer's" goods.

(3) The lag in wage scales.

Farm crops, at the farm	98
All animals, at the farm	92
Retail food stuffs	150
Cotton, at the farm	136
Wool, at the farm	101
Retail clothing	213
Steel billets, Pittsburgh	113
Copper	86
Zinc	90
Pig iron, Pittsburgh	128
Bituminous coal, at the mine (estimated 4 districts)	160
Bituminous coal (retail various localities)	198-220
Yellow Pine Lumber (at the mill)	189
Douglas Fir Lumber (at the mill)	125
Lumber (retail) partly estimated	200
Cost of Living variously estimated from Wage Scales (approximate)	162-180
Farm labor	135
Textile industries	210
Steel industries	150
Railways	200
Metals trades	218
Building trades	190
Coal mining scales	173

As the population engaged in the "deflated" producer's goods—agriculture, and metals, wood, etc.,—comprises one-half the total number of the nation, their power to buy the same ratio of consumer's goods has been reduced to less than 70 per cent of pre-war, and is the consequent cause of a large part of the industrial and commercial unemployment and stagnation in our cities and our transportation.

Spread in Prices

I wish to especially call your attention to the indicated enormous increase in spread between primary producer's and ultimate consumer's goods. In considering it, we must bear in mind that when we use 100 for both consumer's and producer's goods of 1913, we have already included the spread between producer and consumer at that period. I therefore believe that the index numbers indicate an increase of 100 per cent in the actual spread. It is right here where the most of our economic difficulties lie today. Our increased cost of manufacture and distribution bears two relations to the rate question—first, that the increase of rates of from 30 per cent to 100 per cent in different commodities are part of it, and are in turn part caused by it; and second, the increased rates bear very unequally on different groups in the community.

If we search for the cause of this increase of spread we shall find therein a vast complex of increased taxation, increased wages, rents, and a dozen items, all reacting upon each other, and also expressing themselves in increased cost of operating the railways. For instance, the total increase in national, state and municipal taxes since 1913 is approximately $5,640,000,000. At the present purchasing power of the dollar, our total national productivity is probably somewhere around 50 billions of dollars, of which over 10 per cent must now be devoted to increased taxes. This sum of money must be obtained either from the producer or the consumer and in any event a considerable part of the taxes contributes to widen the spread. Because the increase in spread due to taxes necessitates a spiral of increased wages, rents, etc., and before its force expends itself my own opinion is that possibly as much as 20 points in the distorted index number flows from the necessary increase made in taxes.

The increase of railway rates since 1913 in Class 1 railways to 1921, is about $2,600,000,000, of which about $1,400,000,000 are due to wage increases and about $160,000,000 to tax increases. If our traffics were normal the total increase of rates would be more like $3,500,000,000. These sums enter into this increase in the spread and carry with them a further trail of increased living costs and again a spiral of higher wages, rents, etc., in all other branches of manufacture and distribution.

No one can say to what particular table-land of prices and wages we may settle upon, but it is a certainty that the exchange value of producer's goods will not again line up with consumer's goods unless we can decrease the costs and eliminate the wastes of our whole manufacturing and distribution trades. And unless we can secure their nearer proximity we will retard a return of employment and prosperity.

It is a certainty that in order to decrease the spread, railway rates must come down and for rates to come down costs of railway operation in wages and prices of supplies must be reduced. Until this adjustment is secured the economic machine will continue to move slowly. We cannot and should not expect wages to come back to pre-war levels. Many of our wage scales were too low in pre-war times. They can follow down step by step with the cost of living, but there are permanent charges in this spread, such as taxes, which will hold the cost of living above pre-war levels. We must gain our other reductions in the spread by increased national efficiency.

The Method of Readjusting Rates

The involved complex of transportation rates was obviously originally based on some relationship to the value of commodities, mitigated by competition. In other words, the old slogan of "what the traffic will bear" had some economic background. But this entire conception of rate-making was destroyed by horizontal raises. We have rates clearly beyond what the traffic can bear.

The increases in railway rates during the past five years have fallen with extraordinary inequality on different commodities and different groups of people in the community. The country grew up, its industries were distributed under ratios of cost between different commodities, ratios between raw materials and finished goods, ratios between the farm and city. These have all been distorted by the horizontal rises. The increases in rates since 1914, for instance, have added probably less than 1 per cent to the price of cotton goods on the average haul but it has added probably 60 per cent to the price of coal. The increased rates since 1914 have added nearly 100 per cent to the cost of assembling the materials for pig iron.

All this is artificially forcing our industry to move toward their raw materials. This does not alone represent the starting of a new factory; it is a movement of the whole mechanism of the community, labor, homes, schools, railways and whatnot—an enormous duplication of plant and loss of capital. We will ultimately have the rates readjusted and then we will destroy the new industries created under it.

Of equal importance there is a new economic light on

Time to Call Off the Witches

Finally, I want to refer to the veritable witches cauldron being fed constantly with hates distilled from the misdeeds of railway promoters in the past, from the conflicts between the railways and the farmers, between the railways and their workmen. From all the confusion that arises from it we destroy our railways and destroy ourselves. With this commission on one hand assuring honesty in finance, justice to the shipper and the railway investor, with the Railway Labor Board assuring justice to workers and, above all, with a great spirit of public service in our generation of railway managers, it is time to call off the witches and take some vision of our national situation if we are to pull ourselves out of this depression.

this distortion of rates evident under the stress of the last few years. That is, the better realization that some increases of rates come mostly off the producer while others are paid by the consumer. Increases in spread between producer and consumer do not fall equally upon each of them. In primary commodities where the price is fixed by international competition, the increase or decrease in rates is a deduction from the producer. Take wheat, for instance, the point of competition with foreign produce lies at Liverpool. The net to the producer is Liverpool less transportation and other handling charges. Therefore increases of rates are a deduction from the farmer's price. The same thing applies to the producer in certain cases of domestic competition. Also where there is rapid turnover, as in manufacture, and consequent ability to reduce supply, the consumer pays the freight, as processes of productivity will not continue below profit point. In most manufactured commodities the consumer pays the freight, for production quickly shrinks when prices at the factory become unprofitable, and the price to the buyer is the factory price plus the freight. For instance, in hides, the farmer gets the international price less freight. On boots he pays the manufacturer's cost, profit and freight.

It appears to me that with the paralysis induced by the increased spread, we have to take a broader vision of what part of the community is suffering most and direct such concessions through the railway rates as can be given to that group—if we would better equalize the whole economic load.

During the past eight months the railways have made many thousand readjustments of local rates in endeavoring to heal local distortions, but I am convinced that the whole railway rate structure needs a most systematic overhaul in the light of these new economic forces that have been brought into play.

We obviously must maintain the average rate that will support our transportation systems adequately and such an overhauling of rates might quite well mean the advancement of rates in certain commodities in order that compensation can be given to others where there is undue duress.

If I were to discuss the rates charged today I should say at once that a decrease in passenger rates is not nearly so vital to the community as freight rates, for passenger rates do not enter into the "spread" in proportion to the relative volume of earnings. If I were examining the freight rates I should at once say that coal, metals, wood, and agricultural and other producers' goods should be reduced to the bottom before l. c. l. and class rates are touched.

I would be willing to go even farther and say that I am convinced that even if the commission cannot at the present moment justifiably reduce railway incomes a single dollar, it is warranted in investigating the possibility of some relief to the more distressed commodities by a revision of some rates upward. There is perhaps no great field for changes in this direction but it is worth inquiry. As mentioned above, an economic analysis of our industry will show that l. c. l and class rates are far too low compared to the rates on primary commodities.

With the gradual return of the traffic to normal, with decreased operating cost, relief in rates will be available, and it would be an economic crime to apply such relief by horizontal reductions to all rates thus giving relief to higher priced goods and travel, when the vital mainspring of our economic life, our agriculture and fuel and metals are choked.

The Present Rate Situation

Determination of anything in the nature of permanent rate basis is in my own view impossible at present because:

The last five years of changing administration, irregular traffic and wildly fluctuating wages and prices of materials give us but little reliable historical criteria upon which to base the future. We are in the midst of violent economic readjustments, of a profound industrial depression. No one can determine to what plane the reduction in operating costs will settle. No one can estimate the volume of traffics that are probable for any particular period ahead. It appears to me, therefore, that the commission will need to temporize with the situation for some time, and that its conclusions may well fall into three periods: First—The immediate present. Second—During the early period of decreasing costs and increasing efficiency and slowly recovering traffics. Third—Normal operations.

The Immediate Present

If we survey the results of the past year in the application of present costs and rates, we find many railways failing to earn interest upon their borrowed capital; we find some others more fortunately situated who have earned dividends on their share capital.

One or two exceptions of low bonded indebtedness have done extraordinarily well on their share capital. If we survey the situation by districts, in order that single instances do not mislead us, we will find that the whole of the Class I southern roads barely covered bond interest, while the most fortunate group, the western roads, show an earning of only four per cent in 1921 upon their tentative valuation. Moreover, it is obvious that maintenance has been held to a low level and new equipment and extensions practically nil.

The present earnings in their perilous closeness to bond obligations seem to me to dispose of the question of immediate important rate relief, if we do not wish widespread receivership and shocks to our whole commercial fabric.

I believe there are cases where earnings could be increased by lower rates. I know that it is contended that such opportunities do not exist, but no one can review the testimony given here during the past few weeks without concluding that the rates in special instances are stifling business. These directions are perhaps not important in the whole problem of rates, but I am convinced that lower rates would recover lost traffic, such as export coal, substitutions in building materials, gains in water competition, etc.

The Second Period—Near Future

We must assume that those railway wages and supplies which are out of line will at least in part follow down to the levels of decreased cost of living; we must assume that the efficiency that is slowly emerging after the government management will still further increase; we must assume that the volume of traffics will increase toward normal.

I have the feeling that the railways, being our greatest business, will agree that all these savings should be instantly devoted to relief in the rates on primary commodities in order that we should expedite the recovery that can only come through decreased spread between producer's and consumer's goods.

I recognize that the uncertainty and slow reduction of rates in this fashion will itself delay business recovery because of the uncertainty of business as to its future costs. If our railways were in position to stand the temporary shock it would be infinitely better to drop the rates on primary commodities tomorrow—our business recovery would come faster. But we cannot ask the impossible.

The Third Period—Normal Operations

If we look further to normal times, we could make a rough calculation that present wages and costs at say 50 per cent above pre-war would show that the railways can earn somewhere around $1,500,000,000 in excess of the six per cent minimum upon tentative valuation. As I have stated, relief is first more critically needed in the rates on primary commodities.

Some estimates given to me indicate that approximately 35 or 40 per cent of revenues are involved in the groups more urgently needing relief. I think it will also bear calculation that in the income assumed above primary commodities can eventually be reduced to pre-war rates, and still place earnings upon a basis that will inspire such confidence in investors as will secure the free flow of investment capital into construction. It is not to be expected that capital for these purposes will be available at the rate that does not exceed the taxfree securities two per cent to three per cent.

Consolidation and Government Ownership

The consolidation of our railways into larger systems has been contemplated in our legislatures for some years past as a gain in efficiency. Its value can be overestimated—it is not a panacea for all trouble. It does give hope, however, of economies in further efficiency from more complete utilization of rolling stocks and terminals, some small degree of saving in overhead, saving in current inventories; but its probable great saving would be a decreased cost of proper finance, an increased financial stability and a fuller independence from the supply companies.

It is probably unnecessary to refer to the question of government ownership. No one with a week's observation of government railways abroad, or with government operation of industry in the United States, will contend that our railways could ever be operated as intelligently or as efficiently by the government as through the initiative of private individuals. Moreover, the welfare of its multitude of workers will be far worse under government operation.

We are struggling with the great problem of maintaining public control of monoply, at the same time maintaining the initiative of private enterprise. I believe that we are steadily progressing to solution.

Great social and economic problems find their solution slowly and by a process of trial and error. We have tried unregulated monoply, and have tried government operation, and found the error in them. We still have much to solve if we are to maintain our transportation. Much of this solution depends upon the successful initiative of the railways themselves and much of the shaping of these matters lies fortunately in your able hands.

Adhesion and Rack Locomotive for Sumatra

Interesting Design of 0-10-0 Type Superheater Four-Cylinder Compound Locomotive for Dutch State Railways

By S. Abt

THE DUTCH STATE railways on the west coast of Sumatra operate about 152 miles of line of 3 ft. 6 in. gage with about 70 locomotives. From Padang, the terminal of this line, to Fort de Kock and to the coal fields of Ombilia there are some very heavy grades. Portions of this line are provided with a rack bar of the Riggenbach type. The grades on the adhesion track vary from 0.6 per cent to a maximum of 2.3 per cent, and on the rack portion of the line from 5.1 per cent to 6.8 per cent, the total length of the rack line being 22.5 miles. The radius of the sharpest curves on this part of the line is about 500 ft.

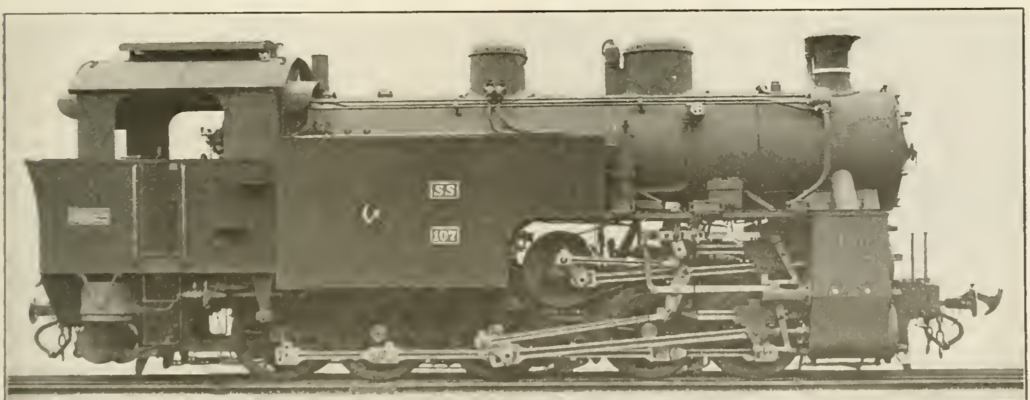


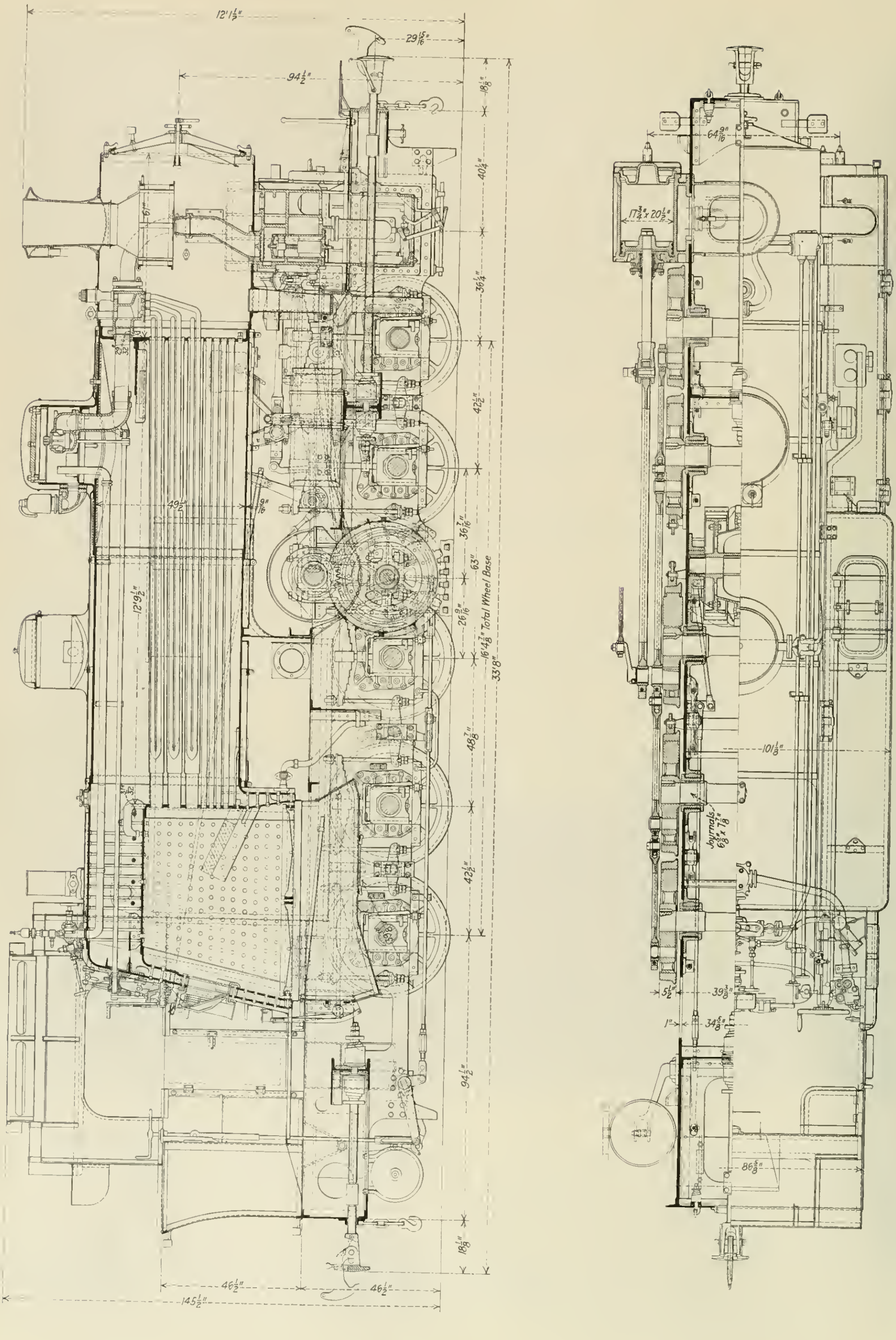
Fig. 1—Adhesion and Rack Locomotive of 0-10-2 Type

Six types of locomotives have been built up to the present time for service on the mixed track. The first four designs were of the four-wheel coupled type and had simple cylinders. The sizes of these locomotives and the year in which they were delivered are shown in the table given below. The bulk of these locomotives were constructed by the Esslingen Machine Works.

The new design of locomotive shown in Fig. 1, is of the 0-10-0 type and was built by the Swiss Locomotive and Machine Works, Winterthur. This type of locomotive was proposed as far back as 1906, when it was found that the four-wheel coupled locomotives were too small, but the first

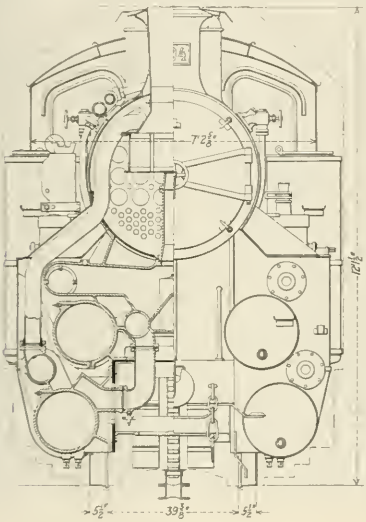
TABLE NO. 1

Year received	1889	1892	1893	1894
Type	0-4-2	0-4-0	0-4-0	2-4-0
Cylinder diameter, in.	13⅜	17	17	17
Cylinder stroke, in.	19⅝	19⅝	19⅝	19⅝
Weight in working order, lb.	57,900	45,200	47,650	64,500
Heating surfaces, sq. ft.	777	550	650	817
Grate area, sq. ft.	15.2	9.6	14.3	13.8
Boiler pressure, lb.	162	162	176	176



Elevation and Plan of Adhesion and Rack Locomotive for Sumatra locomotives of a larger type were only built in 1912, when three 0-8-2 type locomotives were constructed. This design is similar to that built for the Brunig Railway by the same company. Fig. 2 illustrates the manner in which the trains are operated on this line. It shows a train of 360 tons handled by two locomotives of the 0-8-2 type, one in the middle of the train and the second at the rear.

The latest engines which are described herewith were proposed in 1916 and have but recently been completed. Nine of them were built by the Swiss Locomotive and Machine Works, Winterthur, and six by the Esslingen Works, the latter working to the plans furnished by the Winterthur company. Three of these locomotives are equipped with the Caille-Potonie system of feedwater heating and two are equipped with the Titan dumping grate as used on the Hungarian State Railways. These engines will exert a maximum tractive effort of 14,000 kilograms (30,865 lb.); that is, they will handle a train of 200 metric tons on a 5.8 per cent grade.



Front Elevation and Cross Section

The principal features of the new 0-10-0 type locomotive are shown in the drawings. The boiler is the same as that used on the 0-8-2 locomotive with the exception that it is provided with a Schmidt superheater. The barrel of the boiler consists of two courses, has an inside diameter of 1,230 mm. (48.5 in.) and contains 64 tubes, 3,900 mm. (12 ft. 9½ in.) long and 18 flues of the same length for the superheater elements. The tube and flue evaporating surface is 64.5 sq. m. (694 sq. ft.) and the superheater elements have a heating surface of 30.8 sq. m. (331 sq. ft.). The firebox, which is made of copper, has a heating surface of 7.06 sq. m. (76 sq. ft.). The working pressure of the boiler is 14 atmospheres (205 lb. per sq. in.). The firebox has a grate area of 1.85 sq. m. (19.9 sq. ft.). The smoke box is provided with a hopper, operated by a lever on the right hand side of the engine, and is cleaned by a jet of hot water, as is also the ash pan. The two 3 in. safety valves, located on the back of the dome are of the Coale type. The boiler is insulated by white asbestos mattresses and sheet lagging.

The driving wheels are 1,000 mm. (39⅜ in.) in diameter. The leading and trailing drivers have a side play of 22 mm. (about 7 in.). The locomotive frame is suspended by laminated springs with equalizers between the fourth and fifth pair of drivers. The total wheel base is 5,000 mm. (16 ft. 4⅞ in.).

The rack-wheel is driven from a separate set of cylinders, located above the main cylinders, through a jack-shaft located across the top of the locomotive frame. On this jack-shaft is mounted a spur gear which meshes with a gear on the cog-wheel axle. The pitch diameter of the driving rack-wheel is 975 mm. (38⅜ in.). The gearing between the crank axle and the main cog-wheel axle has a ratio of 1 to 2.033 The gear teeth are of the helical type with a pitch angle of 23 deg.


Fig. 2—Train of 360 Tons on a Heavy Grade with Two 0-8-2 Type Locomotives

As will be seen from the illustration, the locomotive is of the four cylinder compound Winterthur type with all four cylinders located outside the frames, two on each side. They are provided with piston valves operated by Walschaert valve gear and controlled by one screw reversing gear. The lower cylinders are the high-pressure cylinders and drive the five coupled adhesion axles. They are cast separately in order to facilitate removal and repairs. The upper or low-pressure cylinders drive the main cog-wheel as mentioned above. These are not placed in operation while the locomotive is running on the adhesion track.

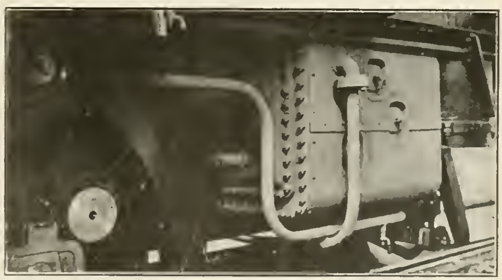


Fig. 3—The Feedwater Heater Is Located Under the Cab

The exhaust steam after leaving the high pressure cylin-

Table N . 2

Gage	3 ft. 6 in.
Tractive effort	30,865 lb.
Weight in working order	114,600 lb.
Weight on driving wheels	114,600 lb.
Wheel base, driving	16 ft. 4⅞ in.
Driving wheels, diameter	39⅜ in.
Cylinders, diameter and stroke	17¼ in. by 20½ in.
Valves	Piston
Boiler	Straight
Steam pressure	205 lb. per sq. in.
Outside diameter of first ring	50⅜ in.
Tubes, number	64
Flues, number	18
Tubes and flues, length	12 ft 9½ in.
Heating surface, tubes and flues	694 sq ft.
Heating surface, firebox	76 sq. ft.
Evaporated heating surface	770 sq. ft.
Superheating surface	331 sq ft
Grate area	19.9 sq. ft.

ders passes direct to the exhaust pipe under ordinary conditions. When it is desired to place the low-pressure cylinders, which operate the rack-wheel, into operation the engineer, by means of a steam operated valve, changes the flow of the exhaust steam from the high-pressure cylinders into the steam chest of the rack or low-pressure cylinders. From these cylinders it passes to the exhaust. In this way the locomotive is propelled both by the five-coupled axles and the rack when ascending the rack grades. In order to ensure starting with a load on the rack portion of the line live steam can be admitted directly to the low-pressure or rack cylinders by means of a special valve, and for a time the locomotive works as a twin engine. The four cylinders are of the same diameter and have the same stroke.

The locomotive is equipped with three kinds of brakes; an air counterpressure or repression brake is used in going down hill and acts on all four cylinders, or independently on either pair of them. For working this brake a valve is fitted under the smoke box which closes the passage from the cylinders to the exhaust and opens a passage to the atmosphere. By reversing the valve gear the cylinders draw in the air which is compressed, the discharge being made through a small pipe leading to a small perforated chamber at the top of the stack. In order to counteract the heat produced by compression, water is sprayed in the exhaust passages of the cylinders, the resulting mixture being driven through the superheater into the header passing out through the discharge pipe mentioned above. By regulating the valve which controls the discharge of the compressed air the locomotive engineer is able to regulate the speed of the train. This is the ordinary way of braking a descending train under normal conditions.

Brake shoes are provided on the second, third and fourth pairs of driving wheels and are operated either by two vacuum cylinders or by hand from the fireman's side of the cab. In addition to this there is a powerful band brake acting on the crank pin disc of the rack engine. This consists of steel bands lined with brass blocks that fit into a

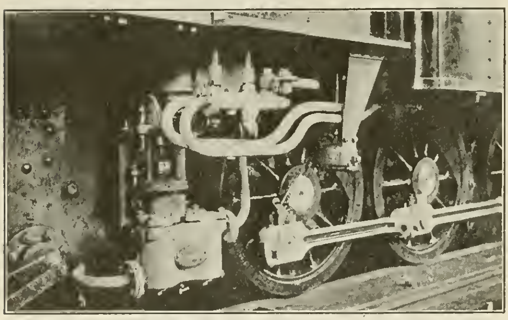


Fig. 4—Double-Acting Caille-Potonie Feedwater Pump

series of grooves cut into the circumference of the discs and are worked by a screw.

The Caille-Potonie feedwater heater and feedwater pump form an important addition to three of these engines as already mentioned. The feedwater heater is shown in Fig. 3, and the double acting feedwater pump shown in Fig. 4. The heater consists of 264 tubes of between ⅝ in. and ¾ in. in diameter. These tubes pass through the water chamber and have a heating surface of 10.8 sq. m. (116 sq. ft.). The steam required for this heater is taken from the exhaust of the cylinders and admitted to the heater through a regulating valve.

Fig. 5 shows the cab arrangement of the 0-10-0 locomotive. The firebox is fitted with the F. Marcotty smoke consuming device. There are two water gage glasses of the Klinger type, two injectors of the Friedmann pattern No. 7 and an Hausshalter speed recorder. The cab is well arranged and has a ventilated double roof.

Two Bosch mechanical feed lubricators, having six feeds form part of the equipment. Gresham and Craven's steam sanding devices are applied to the leading and main driving wheels, sand being delivered from a sand box on top of the boiler.

The coal bunker in the rear of the cab has a capacity of 1,200 kg. (2,425 lb.) and the combined capacity of the water tank is 5,000 litres (1,320 gal.). Tool boxes are provided in the two corners in front of the coal bunkers and their covers serve as seats.

The total weight of the locomotive in working order is

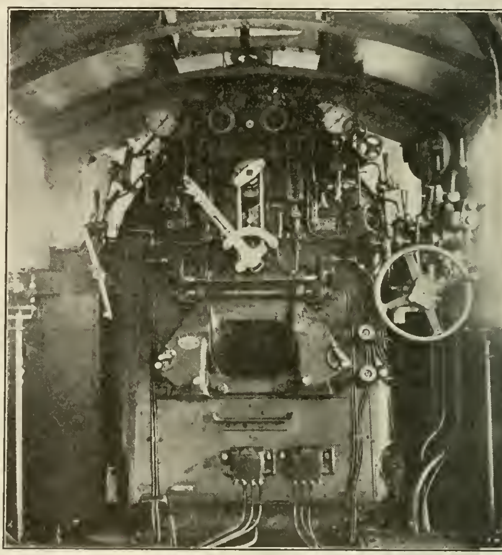


Fig. 5—Cab Arrangement of the Sumatra Adhesion-Rack Locomotive

51.98 metric tons (114,600 lb.) distributed approximately as follows: Leading axle, 10.96 tons (24,200 lb.); second axle, 11 tons (24,250 lb.); main axle, 9.98 tons (22,000 lb.); fourth axle, 10.11 tons (22,300 lb.), and the rear axle, 9.93 tons (21,900 lb.).

The principal dimensions of these locomotives are given in Table No. 2. A comparison between Table No. 2 and Table No. 1 indicates the change which has taken place in operating conditions.

The German State Railway has recently experimented with a new type of third-class sleeping compartment on the Berlin Jena line. The new compartments do not contain beds, but have three sloping shelves placed one above the other, the lowest of which during the day is converted into an ordinary seat, the middle one into a back, while the upper one is used as a rack for parcels. The occupant of the upper shelf climbs into position by means of a folding ladder. The administration intends to place these sleeping compartments on three lines, between Berlin and Cologne, Berlin and Munich, and Berlin and Konigsberg. In view of the low price of the sleeping ticket, 40 marks per person, a great demand for the accommodation thus provided is expected.—The Engineer.

Reducing Locomotive Fire Hazards

Attention to Details of Design and Maintainance Will Eliminate a Large Portion of Fire Losses

AMONG the committee reports submitted at the eighth annual convention of the Railway Fire Protection Association held at Chicago, October 18, was one presented by E. N. Floyd (C. C. C. & St. L.), chairman. This report comprised a comprehensive discussion of the various mechanical features of locomotives with respect to their connection with the fires attributed to locomotives. Some of these constructive suggestions, if followed, would tend materially to the reduction of fires caused by locomotives.

Information procured by the committee from 58 railroads reporting with a total of 144,440 miles and approximately 40,000 locomotives, showed that during the year 1920 there were 6,006 fires attributed to sparks from locomotives. It must be borne in mind, however, that many of the fires along the right-of-way which are blamed to sparks from locomotives may have been due to other causes, such as lighted cigarettes, carelessness of trespassers, careless handling of caboose fires of trainmen, burning of old ties and disposition of waste from journal boxes.

Front Ends

As a safeguard against the throwing of sparks, the committee recommended an inspection of the front end after every trip of a road locomotive and at least every week of yard locomotives. In order that these inspections may be of value, a written and signed record should be kept by the inspector on a printed form embodying the actual conditions found. A written record of repairs made, signed by the foreman, should also be kept. Such inspections must be thorough and must cover loose or missing bolts, rivets or hooks, bent or warped netting, corroded netting, distorted wire, etc., causing openings larger than the standard area. When repairs are necessary the netting should be renewed, no patches should be allowed as they are liable to work loose and make poor joints with the original netting.

Most of the railroads reporting used the Master Mechanic's front end arrangement on coal burning locomotives. This spark arresting device, if properly installed and maintained, appears to give as efficient results as any now on the market. At present, however, there is no uniformity as to the details of installation, maintenance, etc.

It is of prime importance to secure tight fitting joints, especially where the angle iron is fitted around the inside of the smokebox; where the table plates join the smokebox and where they are fitted around the steam pipes and nozzles. A band washer should be placed around the contour of the smokebox over the edge of the netting and securely bolted to the angle iron with a sufficient number of bolts to insure a tight joint. Less than half of the railroads reported using this band washer, but the feature is strongly recommended to insure a tight fit of the netting to the frame and to prevent loosening of the screen.

The manhole opening for permitting access inside of the screen should be framed with bar iron and likewise the manhole door. This door should be tightly fitted to the opening by means of bolts.

Reports indicated a variation in the size of mesh of netting and wire but for railroads using the ordinary grade of bituminous coal, a netting of two and one-half mesh to the inch, No. 11 wire, appears to be most generally used and has been found to be efficient. However, in a few instances where lignite or an exceptionally poor grade of coal is used, it is necessary to install netting as fine as four mesh to the inch with No. 14 wire. A few roads reported the use of perforated plate, but this was not recommended by the committee on account of the gradual enlargement of the perforations and the possibility of this being overlooked in inspections. Following the presentation of the report, there was considerable discussion and difference of opinion expressed in regard to the relative merits of wire netting and perforated plate. There are a number of patented front end netting screens, the outstanding feature of which is an oblongated mesh instead of the old type square mesh. The chief claim for the oblongated mesh is a reduction of the spark volume with the same or greater draft area. The committee believed that the claim was well founded but that the size of opening should be limited to 3/16 in. by ¾ in. The table plates should preferably be of solid sheet metal as the front end netting provides ample draft area. Some roads reported the use of perforated plates and netting instead of solid sheets, but their use was not recommended.

The reason for having in the front end of a locomotive, a number of devices for breaking up cinders that pass through the tubes and limiting the size of the mesh in the screen, is to reduce the size of the spark passing through and out of the stack. In this manner the finer the size of the cinder, the less possibility of it carrying fire as it passes through the stack. A cast iron lining on the front door of the smokebox with horizontal saw-tooth projections is installed in the locomotives of some roads, for further breaking up the cinders.

Ash Pans

The large amount of air necessary for the proper combustion of coal in the locomotive must all come through or above the ash pan and through the grates. As the larger the locomotive, the greater the amount of air required, it has been necessary on modern power to drop the ash pan several inches below the mud ring to provide a sufficient area for the inlet of air. It has been contended by some fire prevention inspectors that this space created a fire hazard as it might permit the dropping of live coals. Fire dropping from ash pans may be due to the door being left open, to improper fitting of ash pan and doors, to a hole burned through the ash pan, to absence of deflectors on shaker bars or to pans being full and overflowing. As it is a standard order that no ash pans are to be dumped when the locomotive is running, providing arrangements for operating the pans from the cab, as used on some roads, is a dangerous practice. No provision should be made for dumping the pans except by a man standing on the ground. Some roads reported two or three ash pan doors operated by one action, but this is not a good practice. As in such cases, it is extremely difficult to secure and maintain the tight closing of all doors on account of the warping of the pans, there should be a special action to each door. A rigid fastening as used on the majority of roads should be provided to keep the doors closed and prevent the vibration of the locomotive causing them to open and allow fire to drop. The ash pan wing should be so arranged that for each inch of space below the mud ring, the ring should extend at least one inch out with an upward flange one or two inches high so that ashes falling from the grates will not be liable to fall out of the sides on account of rocking of the engine. The front of all ash pans should fit tight to the mud ring or to the plate supporting the boiler. Shaker bars should be protected by deflectors supported at the back part of the ash pan about one-half inch above the shaker bars so that clinkers riding the shaker bars will be knocked into the ash pan instead of coming out through the opening and dropping down. Vent holes when they are not winged, should be covered by heavy screen. Solid doors are considered preferable to screen doors.

Fire Doors and Combustion Tubes

Reports show that during 1920, 18 fires resulting in a loss of approximately $9,000 resulted from back fire through fire doors. Such back fires occur when the boiler is being fired up and may be the result of the blower being too weak to support the combustion in igniting the fire or to careless handling of oil in starting the fire. This is something that can be prevented only by proper care on the part of the man starting the fire.

A number of fires have been caused from flames coming out of combustion tubes through the side sheets, the trouble generally occurring when the engine is being fired up. The flame may set fire to the cab floor and if not discovered in time, may result in serious damage. As a precaution, all pipes passing through the cab floor should be fitted with metal collars flanged on the inside so that there will be no temptation for the engineer to close the openings by waste. The irregular opening between the cab floor and the side of the boiler also should be covered with metal or other fire resisting material.

Oil Burning Locomotives

In connection with oil burning locomotives, there are a number of precautions which should be taken to reduce the danger of fires. When filling oil tanks, care should be taken to see that sufficient room is left for the expansion of the oil when it is heated. Tanks should never be filled to within more than two inches of the top. Flame or an open light should never be brought nearer than 10 ft. from the oil tank, manhole or vent. The arrangement of flash walls and side walls in the firebox and the adjustment of the burner should be such that soot does not collect in bunches and, when dislodged, pass through the stack. Great precaution should be taken in starting fires, particularly where there is no external source of steam to operate the oil burning apparatus and the blower. When sanding flues on the road, a place should be chosen where the burning soot will not start fires. The sand used should be free from all particles of charcoal, wood or waste. When putting the engine in the roundhouse, fires in all burners should be put out by closing the tank oil outlet valve and allowing the oil in the pipe to burn out. The burners should then be blown out and the oil regulator valve closed.

Handling Locomotives on Descending Grades

Drifting and By-pass Valves Important; Effect of Reverse Lever Position and Use of Throttle

By A. G. Newell

Road Foreman of Engines, El Paso & Southwestern

THERE has been considerable discussion in regard to the proper manner in which to operate a locomotive when drifting, in order to obtain the best results as to lubrication and the reduction of wear and tear on machinery, but the writer has failed to find a case where the statements were backed up with the proof.

It is the practice on some roads to drift at a short cut-off; others advocate half stroke, while in one case, it was claimed that the best results could be obtained by drifting with the reverse lever on the center. Nearly all roads recommend the use of the drifting throttle, which, in my opinion, is one of the most effective ways to help use up our already limited coal supply. The manually operated drifting throttle may be economical on roads in a level district, but on mountain roads where engines are drifted long distances, investigation will show that its effect in reducing the coal pile are surprising.

Drifting Throttle Uses Considerable Steam

By actual tests made on a 27 in. by 32 in. Mikado type freight locomotive, which was equipped with a manually operated drifting throttle, it was found that with the throttle set to furnish sufficient steam to prevent the intake of air into the cylinders through the relief valves at a speed of 35 miles per hour and bringing the train to a slow speed without changing the throttle, a very noticeable exhaust could be heard at the stack. By bringing the train to a standstill, sufficient steam was admitted to the cylinders to move a 2,000-ton train on level track. Why furnish this much steam to perform a certain service when a much smaller amount, if admitted to the right place, will produce the same results?

Furthermore, with any manually operated device such as a drifting throttle, it is necessary to depend on human judgment, which, as we all know, is unreliable. Granting that the manually operated throttle will be used at all times, the results are uncertain; where one engineman would be prone to use too much steam, the next man would very likely go to the oposite extreme.

Carbonization, So-Called, Is Mostly Dirt

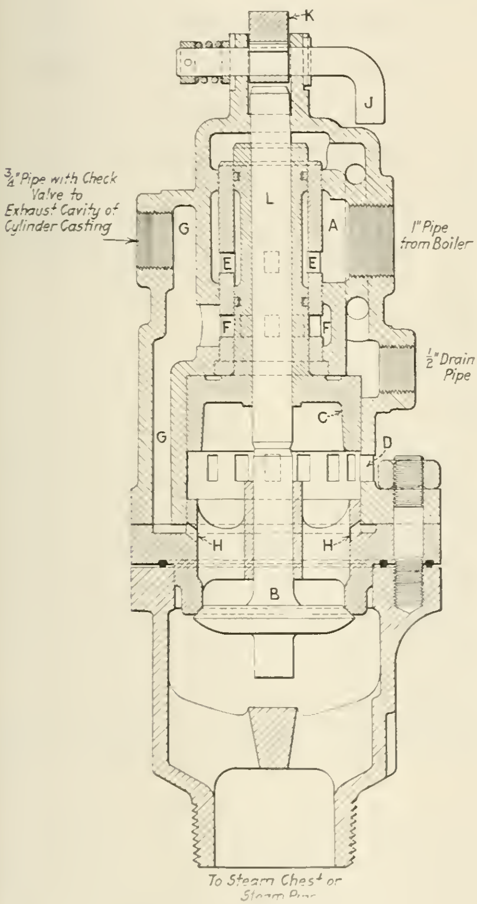
It has been demonstrated that the greater part of the so-called carbonized oil, which adheres to the walls of steam passages, valve spools and cylinder heads, and which was formerly believed to be caused by air being admitted to the valve and cylinder chambers while they are at a temperature of nearly 700 deg., is nothing more nor less than small particles of carbon, silicious matter and deposits from front end gases. When the throttle is closed suddenly while running at a high rate of speed, the gases are drawn into the nozzle stand, and thence to the valves and cylinders where the suspended matter adheres to the oily surfaces and bakes or forms the so-called carbonized oil.

The condition may be almost entirely eliminated by admitting a limited amount of live steam to the exhaust and admission channels on each side of the engine, equipping the engine with a suitable by-pass valve and drifting at a full cut-off or with the reverse lever in the corner. The admission of a small amount of steam to the exhaust passages, prevents the front end gases being drawn into the valve and cylinder chambers, while the steam admitted to the steam pipe or passages distributes the oil and provides a steam vapor.

Automatic Drifting Valves Only Remedy

A reliable automatic drifting valve is the only means whereby we may hope to economically eliminate the so-called carbonization and increase the mileage per pint of valve oil. There are several drifting valves on the market but none of them seems to have been fully perfected; until there is more interest and support given to the development and maintenance of this device by the railroads, it is doubtful if any great advancement will be made.

The writer recently assisted in a series of tests made in a mountain district on a Mikado type freight locomotive having 29 in. by 30 in. cylinders and 63 in. drivers and equipped with an automatic drifting valve, known as the Miller valve, in addition to relief valves and American Locomotive type by-pass valves. The test was conducted to determine just what takes place in the cylinders when drifting at various speeds and cut-offs and with the devices alternately working and cut out.



Section of Miller Drifting Valve

Each of the relief valves had an opening area equal to 3.54 sq. in. The by-pass valves each had an opening equal to three per cent of the area of one cylinder. When the drifting valves were applied they were fitted to the relief valve bodies so that it will be understood that when they were used, no air was admitted through the relief valves. The drifting valves each had an opening equal to 0.47 sq. in. and the live steam line leading to them from the fountain was 1¼-in. pipe which was split at the front end to 1-in. pipe and again reduced at the valves to ¾ in. pipe, so it can readily be seen that very little live steam is used in connection with this type valve.

The Miller Drifting Valve

The Miller drifting valve is a combined relief and drifting valve. It can be tapped into the steam channel at the steam chest by a direct connection, or into the side of the steam pipe by means of an elbow connection.

The operation of the valve is as follows: Live steam from the boiler enters the valve at the upper connection, *A*. When the locomotive is shut off the relief valve *B* drops, forming a partial vacuum under the drifting valve piston *C*. Atmospheric pressure on the top of this piston brings it down, closing the air ports *D* in the relief valve body and opening a communication from the steam admission port *E* to the valve chamber of the locomotive port *F*, exhaust cavity *G*, and ports *H*, so that steam can flow direct from the boiler into the locomotive valve chambers from which as the valve moves, it is admitted into the cylinder. At the same time steam through the exhaust cavity *G* flows to the exhaust cavity in the cylinder casting to prevent front end gases being drawn in through the exhaust nozzle should the reverse lever be carried too high.

In other words, with this valve, both exhaust and admission ends of the cylinder are kept filled with live steam at a low pressure. When the throttle is again opened the pressure of steam underneath the relief valve forces it upward to closed position. Some of the steam entering the drifting valve is trapped between the top of the relief valve *B* and the bottom of the drifting valve piston *C* and forces the piston up, closing the port *F* to the admission of live steam, and at the same time opening the air ports *D* in the relief valve body.

The construction of the valve is such that it is impossible for sufficient pressure to accumulate in the cylinders to cause the locomotive to move off, as the relief valve is always wide open except when the locomotive is drifting; consequently any steam accumulating in the cylinders can flow out through the relief valve in the usual manner. Should the locomotive have a leaky throttle which would permit sufficient pressure to accumulate in the cylinders to close the relief valve, the safety feature on the drifting valve, which consists of a small lever *J* attached to the cam *K* on top of the drifting valve, can be brought into operation. Turning this lever causes the cam to force down the long stem *L* passing through the drifting valve *C* and hold open the relief valve *B* thereby permitting the escape of steam from the cylinders.

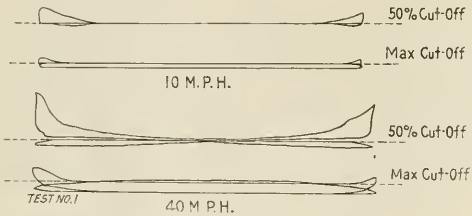
Tests of By-Pass, Relief and Drifting Valves

The tests referred to included five trips, all with the same locomotive, on the same run, with practically the same weight of train and under uniformly good weather conditions. Indicators were attached to each cylinder and a number of cards taken at both 50 per cent and at maximum cut off for speeds of 10, 20, 30 and 40 m. p. h. A comparison of the various indicator cards demonstrated clearly the relative importance at various speeds of relief, by-pass and drifting valves, singly or in combination, as well as the effect of the position in which the reverse lever was carried. A few of the typical cards are reproduced and some of the data taken from the cards are given in the table.

On the first test trip the relief and by-pass valves were blocked shut and neither drifting valves nor throttle were used while descending grades. The indicator cards showed considerable compression and a relatively high mean effective pressure at 50 per cent cut-off. With the reverse lever in the full forward position the vacuum averaged higher than under any of the other conditions. The locomotive pounded badly at any speed above 20 m. p. h. with 50 per cent cut-off.

This test run demonstrated the fact that on roads where considerable drifting is done it is essential that some form of drifting, by-pass or relief valve be provided, or else the engineer must be depended upon to operate with a drifting throttle.

On the second test trip the relief valves were in operation but by-pass valve remained blocked shut and neither drifting valve nor throttle were used while descending grades. The compression was high, averaging nearly the same as on the previous run. There was still considerable mean effective pressure while the vacuum was slightly improved, more so at maximum cut-off than at 50 per cent. The improvements were so small, however, that it was clearly demonstrated that relief valves alone are of very little value. Moreover, the

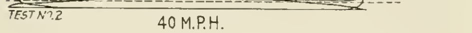


Test No. 1—Neither By-pass, Relief nor Drifting Valve Used

probability is that the cold air admitted through the relief valves would do much more damage than could be offset by the small reductions in vacuum and compression.

By-Pass and Relief Valves Show Good Results at Low Speed

On the third test trip both relief and by-pass valves were in operation, but drifting valves or throttle were not used. As stated, the areas of the by-pass valves were three per cent of the cylinder areas. The indicator cards showed that very good results were obtained at speeds of 10 m.p.h. and 20 m.p.h., but at 30 m.p.h. and over, both vacuum and compression were in evidence. During this trip the locomotive drifted at the various speeds with the reverse lever

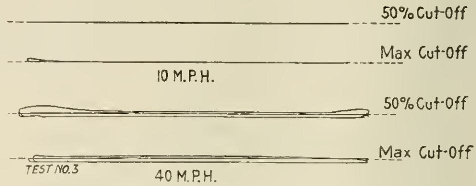


Test No. 2—Only Relief Valve in Operation

at half stroke or greater with little pounding. By increasing the area of the by-pass valves the vacuum could, no doubt, be eliminated even at the higher speeds.

By-Pass Necessary Even When Drifting Valve Is Used

On the fourth test trip the by-pass valves were again used and the Miller drifting valve was added. As the drifting valves were screwed into the relief valves, the latter became inoperative insofar as admission of air was concerned. With the exception of the 10 m.p.h. and 20 m.p.h. cards at 50 per cent cut-off ideal conditions were obtained under this combination. The slight compression shown on the 10 m.p.h. and 20 m.p.h. cards at 50 per cent cut-off was no doubt caused by a small amount of steam from the drifting valves being trapped in the cylinders. However, it was so small that no pounding was observed. The results showed that a by-pass valve of sufficient capacity to permit a free passage of pressure from one end of the cylinder to the other was necessary to prevent front end gases being drawn into the cylinder by the creation of a vacuum and that in addition a small amount of steam should be admitted to the exhaust and



Test No. 3—Both Relief and By-pass Valves Used

live steam passages. The indicator cards further bore out the theory that better results are obtained by drifting at full stroke.

On the fifth test trip the Miller drifting valve was again used, but the by-pass valves were blocked shut. Relief valves

DATA FROM INDICATOR CARDS

Speed	10 m.p.h.		20 m.p.h.		30 m.p.h.		40 m.p.h.	
Cut off, per cent...	50	Max.	50	Max.	50	Max.	50	Max.
Mean effective pressure—								
Test 1..........	1.8	0.5	4.2	0.9	3.6	0.9	5.2	1.1
Test 2..........	1.8	0.5	3.5	1.0	3.6	1.0	5.5	1.5
Test 3..........	0.0	0.2	0.0	0.0	0.4	0.1	2.7	1.5
Test 4..........	1.5	0.0	0.8	0.0	0.0	0.0	0.0	0.0
Test 5..........	2.75	0.4	4.0	0.9	4.0	0.9	4.8	2.4
Mean vacuum—								
Test 1..........	0.5	5.6	2.6	8.4	3.0	9.2	2.0	10.2
Test 2..........	1.2	2.0	2.0	5.3	3.4	5.7	2.0	7.3
Test 3..........	0.0	0.0	0.0	0.0	1.8	0.0	3.8	3.9
Test 4..........	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Test 5..........	2.4	0.2	2.4	4.7	0.3	5.7	3.6	8.0
Av. max. comp.—								
Test 1..........	17	5	36	9	38	9	54	12
Test 2..........	18	7	27	13	40	14	42	16
Test 3..........	0	1	0	0	2	0	8	1
Test 4..........	6	0	10	0	0	0	0	0
Test 5..........	24	5	32	8	38	10	41	14

Note—All pressures are in pounds per square inch.

Test 1—Relief and by-pass valves blocked shut, drifting valves closed, drifting throttle not used.

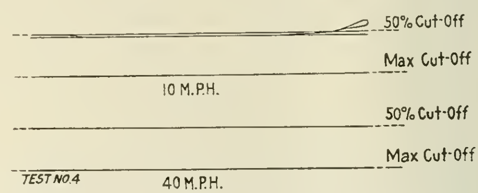
Test 2—Relief valves operative, by-pass valves blocked shut, drifting throttle not used.

Test 3—Relief valves and by-pass valves operative, drifting valve shut off, drifting throttle not used.

Test 4—By-pass valves operative, relief valves inoperative, Miller drifting valve used.

Test 5—By-pass valves blocked shut, relief valves inoperative. Miller drifting valve used.

were inoperative and throttle was not used while drifting. The results were decidedly inferior to those obtained during the preceding trip and indicated that it would not be economical or practical to design a drifting valve large



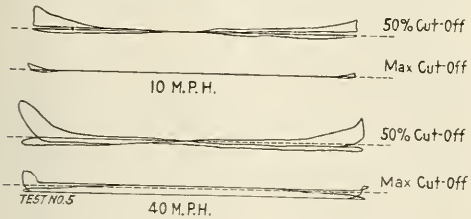
Test No. 4—Both By-pass and Drifting Valves Used

enough to provide sufficient steam to destroy the vacuum unless a by-pass valve was also employed.

Pyrometer records showed that when the locomotive was equipped with both by-pass and drifting valves the cylinder pressures dropped much lower when the main throttle was closed than when these devices are not used. This has an important bearing on the life of cylinder packing as sudden changes of temperature together with excessive compression and vacuum will in a short time result in broken packing rings.

Conclusions

The conclusions arrived at as a result of these tests may be summed up as follows: The modern locomotive operating in



Test No. 5—Only Drifting Valve in Operation

a district where more or less drifting is done, should be equipped with a by-pass valve of sufficient size to allow the pressure in the cylinders to float back and forth, without creating vacuum or compression as the piston moves from one end to the other at its maximum speed. In addition, a reliable automatic drifting valve that will admit a limited amount of steam to the exhaust and live steam channels should be applied. In the absence of the automatic drifting valve, good results may be obtained by the careful manipulation of the main throttle at the top of descending grades or approaching a stopping place. The pyrometer shows that cylinder temperatures may be lowered sufficiently by working a very light throttle for a mile or so after tipping a summit, prior to shutting off completely. To make a success of this method requires close supervision and co-operation of the enginemen as the careless engineer is apt to either forget entirely or close the throttle too much, or not enough, to obtain the desired results. Another point that was proved beyond a doubt during these tests is that the least compression and, therefore, the least pounding is obtained with the reverse lever at full stroke when drifting. With the modern power reverse gear the above method can and should be practiced.

Factors in the Business of Owning Locomotives*

Motive Power and Operating Departments Must Work Together in Design and Operation to Secure Economy

By C. B. Peck

Western Mechanical Editor, *Railway Age*

IN SETTING before you tonight what I conceive to be a few of the important business angles of locomotive policy, my purpose is not that of an exhaustive treatment but merely to suggest something of the relationships which matters within widely different jurisdictions bear to each other in their final effect on the well being of the railroad.

In discussing the ownership and operation of locomotives as a business proposition rather than from the technical viewpoint, it may be pertinent to consider for a moment who owns the locomotives. "The railroad, of course," you say. But the railroad is sharply restricted in its enjoyment of its property by public regulation and if we consider the locomotive as a producer of gross ton miles rather than as an end in itself, a part of the responsibility for expensive service should be placed squarely on the shoulders of the public. Indeed the burden is there now, but there is not a realization of its cause.

Purchasing Policy

The first business relating to the ownership of locomotives is their purchase. The question of what policy should be adopted by railway managements with respect to the acquisition of motive power is an exceedingly difficult one to discuss. Simple as the fundamental principles may appear to be, their application is affected by many variables the relative weight of which must at best be determined on the basis of very meager knowledge. For instance, if a heavy investment in equipment is to be made during a period of heavy traffic in order that the public demand for transportation may be met, just what assurance has the management that the crest of the wave of heavy business may not have passed before the equipment is delivered? If such be the case, what effect is the burden of the added fixed charges likely to have on the financial safety of the corporation until the next period in which the new investment has an opportunity to develop its full earning capacity? Again, with public regulation limiting the maximum return on railway capital to 6 per cent, and then taking care to see that on the average the maximum shall not be reached, what likelihood is there that the credit of the roads will more than meet the need for the additional facilities constantly demanded by the steady industrial and commercial expansion of the country?

With these reservations, then, it may not be out of place to suggest that the ideal purchasing policy is one in which, not locomotives, but locomotive service is the objective. In other words not the lowest price but the least cost per 1,000 gross ton miles or per passenger car mile during the life of the locomotive should be the aim of the management.

The five items of direct cost of freight train operation per 1,000 gross ton miles for the Class I roads during the first 11 months of 1921 averaged $1,254. Interest on investment and depreciation charges for the same unit of service approximated a total of 7½ cents. The relative importance of locomotive price and operating costs is clearly indicated by these figures. The direct items of unit cost of train operation are given in detail in the table.

Economics and Design

In preparing for the purchase of new motive power the mechanical department has one of the best opportunities that could possibly be offered to go into the whole vast field of the economics of railway operation. Even the detail mechanical design cannot be settled on the basis of sound judgment until the designer has at his command a thorough knowledge of the limitations of operating and maintenance facilities and a sound appreciation of the relation of the cost of maintaining each group of the details to the total cost of locomotive maintenance. How many roads know the relative cost of maintenance per locomotive mile of locomotives of different classes now in service, and can tell whether the differences are due to the boiler, the rods, cylinder conditions, valve motion, frames or driving boxes? Also whether the differences de-

*A paper presented before the Western Railway Club, February 20, 1922.

velop in the back shop or in running repairs? The results of a study of this nature would be tremendously valuable to the designer in his selection of details. One year's saving in maintenance on an order of 50 locomotives, after they had begun to come through for classified repairs would probably defray the entire cost of the study and a sound basis would be established for the rapid elimination from the standards of the road of the undesirable designs. Serious defects of design, tending to cause failures or leading to marked inconvenience in the roundhouse or shop are readily caught. But there are still big possibilities for the exercise of judgment within the range of safe and apparently satisfactory designs. Judgment is nothing but guess work unless founded on fact.

Elements of the Unit Cost of Freight Train Operation

	Cost per 1,000 gross ton-miles
Fuel	$0.405
Crew wages	.378
Locomotive repairs	.312
Train and engine supplies	.083
Engine house expense	.076
Total	$1.254
Investment charges (estimated)—	
Interest on investment	$0.050
Depreciation and retirements	.025
	$0.075

But at the outset the designer has even a broader survey to make—one involving almost every item of direct train operating cost, as well as the investment charges. The limits of weight and tractive effort are generally fixed by conditions outside of the locomotive itself, such as strength of bridges, standards of track maintenance, etc. Within these limits, of course, increasing the capacity of the locomotive decreases the unit cost of crew wages and to a less extent the fuel bill. The cost of maintenance is almost as large as crew wages and increasing the size of the locomotive may materially increase this item of expense if the working loads on the running gear become excessive, or if the size of the locomotive outgrows the facilities for its maintenance. Unit investment charges may also be adversely affected if outgrown shop and terminal facilities lead to a marked reduction in the yearly mileage of the motive power.

The big problem, however, is to determine how much shall be added to the pound price of the bare locomotive for those items of equipment that will increase its capacity without materially increased weight, or will decrease one or more of the important items of unit operating cost.

It is not the purpose of this paper to enter into a detail discussion of the possibilities of this growing group of devices; they are known to be large by executives as well as by mechanical department officers. Suffice it is to say that no road need be without reasonably accurate knowledge of the relative importance of each of the factors in its direct train operating costs, and that the final decision as to the selection of such devices should be based on their probable effect on the sum of the cost of fuel, crew wages, locomotive repairs and the investment charges. Of this sum the latter form a very small part, but I fear that they are too frequently the sole factor considered.

Utilization and Maintenance

An analysis of the operating statistics compiled by the Interstate Commerce Commission for the period from 1903 to 1913 inclusive, has developed the fact although there was a marked improvement during that period in the extent to which the potential hauling capacity of freight locomotives was utilized, there was actually a steady decline in the total yearly traffic movement obtained from each unit of hauling capacity. The average train load had increased more than the tractive effort of the average freight locomotive, but the average number of train miles made by each locomotive in a year showed a marked decline. Continuing the comparison, the tremendous increase in traffic which reached its maximum in 1918, led to a big increase in the actual volume of traffic moved by each unit of tractive effort. But this was obtained entirely by increasing the train load, the average train mileage per locomotive per year remaining practically the same as in 1913. In 1920, the record year for volume of traffic, the same conditions continued.

What does this mean? In the first place it shows that the extent of utilization of the capacity of the locomotive when it actually moved, has been greatly increased, with large decreases in the crew time, fuel consumption, cost of train and engine supplies and the enginehouse expense per unit of traffic moved. But the average number of train miles per locomotive has declined from about 22,000 in 1903 to about 18,000 in the high years 1917 and 1920. This decline is equivalent to a loss of two months a year of the kind of service rendered in 1903. To restore the former conditions would mean that 1/6 of the present investment in locomotives could be released for productive use in providing other much needed facilities.

There are several causes for this marked decline in locomotive mileage, not all of which are under the control of the managements. One of the latter, for instance, is the effect of the locomotive inspection law. But it is pertinent to note that the number of locomotives has increased more than 50 per cent during the 17 years under consideration, and the average hauling capacity has increased between 65 to 70 per cent. In other words, there is at least 2½ times as much locomotive hauling capacity to be maintained as there was in 1903, and some of this capacity probably requires more attention per tractive effort unit than did the average unit of the earlier period. The meager expansion of shop and engine terminal facilities which has taken place during the same period certainly has been far from adequate to care for this great increase in motive power and it seems probable that this is one of the largest, if not the largest single cause of the decrease in train miles per locomotive.

Longer Runs

The distribution of locomotive hours published by the Railroad Administration indicates that the average serviceable locomotive spends not more than 40 per cent of its time on the road, and a little over 50 per cent at the roundhouse. These figures reflect the effect of the short operating district, averaging approximately 100 miles in length, which is so strongly entrenched in American railroad practice.

There are instances where it has long been the practice to operate passenger locomotives over two freight engine districts, with or without a change of crews, and in several cases increased passenger engine runs have recently been established. On the Missouri, Kansas and Texas, after several months' experience with passenger locomotives operated continuously a distance of 400 miles, the distance was increased on one run to 672 miles, with the result that three locomotives were doing the work which five were formerly required to do. In this case the locomotives are operating in oil burning territory, which, of course, eliminates one of the greatest difficulties in the way of long engine runs, i. e., the maintenance of a good fire without detaching the locomotive and running it over a cinder pit to clean the fire en route. Some experimenting has also been done in increasing the length of freight locomotive runs with very promising results, but this work has not yet reached the point where any general conclusions can safely be drawn from it.

What are the possibilities of long runs? Taking the country as a whole about 10.5 hours are spent on the road and 13.5 hours either in the terminal or at the roundhouse out of each 24 serviceable locomotive hours. Doubling the length of the run would probably have little effect on the average number of terminal hours per trip, but would double the hours on the road. Then instead of 10.5 hours out of each 24 serviceable hours an average of 14.6 hours of actual service would be obtained. This is an increase of about 40 per cent. Putting it differently, for each 10.5 locomotive hours actually required in moving trains there would be 6.75 hours in terminals instead of 13.5 hours, a reduction from a total of 24 to 17.25, or 28 per cent. Eventually, but not immediately, this would mean a 28 per cent reduction in investment charges per unit of service. If the fires do not require cleaning enroute it would reduce the engine house expense per unit of service by 50 per cent. The cost of repairs would not necessarily increase: indeed the closer attention to running repairs required to insure against engine failures would tend to prolong the mileage of the locomotive between classified repairs.

Where locomotives are now operating in assigned service, increasing the length of runs may lead to much less satisfactory maintenance conditions, since it will tend to create pooling conditions with a loss of interest in the upkeep of the locomotives by the crews. This will have to be paid for at the terminals in increased inspection or the plan is likely to prove a failure at the outset.

Wherever a general extension of locomotive runs proves to be practicable an opportunity is offered for the concentration of work at the better equipped terminals. On the development of these terminals future appropriations may be concentrated, with much more effective results than would follow the wider distribution of the same amount of capital over the additional number of intermediate terminals.

Dispatching

The locomotive, like any other machine, has its limitations. Failure to respect these limitations inevitably leads to increased operating costs. Any machine gives the best results when subjected to steady and constant use, following as nearly as possible a fixed routine. In the case of the locomotive this would require dispatching after a fixed minimum period in the hands of the mechanical department with a full tonnage train movement over the division without delay on a regular schedule of running time, followed by the delivery of the train and the return to the mechanical department without terminal delay at the terminal. It is, of course, unnecessary to call attention to the effect of delays, either road or terminal, in increasing crew overtime, and fuel consumption. Nor does it need much argument to convince any mechanical department officer that excessive delays greatly increase the amount of boiler work. Here, the business of locomotive operation comes in vital contact with transportation yard facilities and passing tracks, on the adequacy or inadequacy of which depends the possibility of obtaining ideal locomotive operating conditions.

But there is another possibility for stabilizing locomotive operation, that does not involve the question of capital expenditure for other facilities. That is the possibility for organizing freight train movement on the basis of regularly scheduled dispatchings, so fixed as to smooth out the load on tracks, yards and engine terminals. The common practice of fleeting trains over the road overloads the passing track facilities on single track lines, thus causing excessive road delays. It chokes terminal yards, which are excessively busy for comparatively short periods followed by longer periods of idleness, and throws a load on the engine terminal that results in long delays to locomotives under steam, short time for repairs, delay in dispatching and engine failures. These overloads increase the unit cost of yard operation, train crew wages, engine house expense and, through neglect of defects in the early stages of their development, inevitably lead to increased maintenance expenditures. Of course certain classes of traffic demand a service that leaves no choice as to how or when the trains shall be moved. But the great bulk of traffic on American railroads can be started on its way at 10, 12 or 2 o'clock as well as at 6 o'clock.

Maintenance

For the first 11 months of 1921 the combined cost of locomotive repairs and engine house expense per 1,000 gross ton miles on the Class I railways slightly exceeded the cost of train and engine crew time, and was only a little less than the cost of fuel. These two accounts, the sum of which is tremendously influenced by the character of shop and engine terminal facilities, are therefore among the three principal items of direct cost of train operation.

Two railroads operating in the same region, through country of much the same nature, handle practically the same character of traffic in about the same average train loads, both passenger and freight. With the exception of enginehouse expense and locomotive maintenance, the unit costs of train operation on the two roads differ but slightly. Over a period of four years' enginehouse expense on Road A averaged 5.5 cents a train mile, and on Road B, 7.3 cents a train mile. Locomotive repairs cost Road A 17 cents a train mile and Road B 26.9 cents a train mile. Road A gets about 40 per cent more train miles a year from each locomotive owned than does Road B. Shop and engine terminal facilities on Road A are considerably above the average; those on Road B, particularly its back shop facilities, are much below the average.

On the business handled during the four years the above difference in the rate of expenditure on these two accounts cost Road B an average of about $2,300,000 a year. Assuming that half of this difference is brought about by causes which increased and improved facilities could not remove, the saving of the remainder would justify a capital expenditure of over $9,000,000 on the basis of a 12½ per cent return—certainly liberal enough to be attractive even in these days of high interest rates. The book value of this road is approximately $400,000,000, and it is doubtful whether the value of all shops, engine terminals and shop facilities for the care of both the cars and the locomotives exceeds $16,000,000.

Capital Expenditure

But before passing final judgment on the managements of these two roads one other comparison should be made. Road A has a history of extremely conservative financing which places its present management in a position of security; the sheriff has his eye on Road B. Road A is considerably above the average in its ability to accumulate a surplus; Road B's situation is fairly typical of the situation with which the greater part of the railroads in the United States are confronted today.

With these facts in mind let us try to answer the question, "Where would Road B get $9,000,000, or half of that amount, to provide additional shop and terminal facilities?" "But," you say, "the prospect of a saving in operating expenses equal to a return of 12½ per cent, possibly even larger, ought to be attractive enough?" Undoubtedly it is attractive enough to the management of Road B, but put yourself in the place of the investor a moment and remember that your bonds will not alone enjoy the security of the high earning capacity of the capital you furnish, but that they will have to share it with most of the securities already outstanding. Furthermore, how confident would you feel that the public would not relieve the railroad of its 3 or 4 per cent of the return, with which it hopes to build up its surplus, long before the maturity of your bonds, leaving you with a depreciated security on your hands? Under these conditions would you take the risk?

It is not difficult to understand why the credit of the railroads narrowly restricts the amount of new capital they are able to raise. And generally speaking, the managements have little choice as to how they shall spend it. Daniel Willard, president of the Baltimore & Ohio, in his testimony before the Interstate Commerce Committee of the United State

Senate during the railroad inquiry last May, clearly defined this problem as follows:

"Is it desirable to spend at this time for new shops $2,000,000, which sum is available and which sum would enable it to repair its locomotives at a lesser cost, or should the money be used for the purchase of new steel coaches which will mean no economy in operation, but on the contrary mean an increased cost of transportation because of the greater weight of the steel equipment?

"It was decided," said Mr. Willard, "that the public in this instance would be better served by spending the money available for steel coaches rather than for new shops, inasmuch as it was possible to maintain the motive power in the existing shops."

The demands of the public for increased service require a constant expansion of certain facilities such as industrial tracks, cars and locomotives. Unless funds are still available after these demands have been met how can the management make the much needed investments in facilities such as new shops and enginehouses, which offer opportunities for tremendous economies in operating costs, but which will not take the place of cars and locomotive in actually moving the business?

The public is in control of the railroads' revenues. It controls over half of their expenses. The greatest field for economy beyond the scope of public regulation requires capital expenditure. But the ability of the roads to raise capital depends on their credit, and their credit is largely determined by the relation between their revenues and expenses. Who, then, is responsible for the waste resulting from the use of obsolete and outgrown facilities? The railroads or the public? In my opinion, in the long run the public will pay dearly for its covetous attitude toward its railroads.

The question of back shop expansion is somewhat different from that of engine terminal expansion. In the latter case the necessities of location and service leave little question as to who shall provide the capital. The need for additional back shop space may, however, be met outside of the railroad. While the opportunities for contracting locomotive repairs are not as numerous as in the case of cars the possibilities of utilizing shop space in certain industries during slack times, for locomotive repairs might be developed to very great advantage, thus postponing the time when back shop extensions would become compulsory. If sufficient capacity were available in outside shops, the railroads might be money ahead by depending on them for future growth, thus conserving their credit and at the same time getting the benefit of real business management in the cost of part of their work. Competition of this kind between the railroad and the contract shop might have a wholesome influence in the development of more businesslike methods of control in the management of the railroad shops.

This statement is not a reflection on the ability of railroad shop managements. The methods of accounting for maintenance expenditures leave them little opportunity for the exercise of good business judgment, and any real improvement in this situation will have to originate with, or have the active support of, the chief operating officer or the executive.

Locomotive Rehabilitation

At the present time we are in an era of intensive locomotive development which has progressed so rapidly that the original construction of probably more than half of the locomotives in service is obsolete. Many of these locomotives already have been through one or more rehabilitation processes to restore them to a status of usefulness comparable with that of the new locomotive of modern construction. What should be done with the remainder?

In answering this question, consideration should be given to the question of capital turnover. The maintenance of equipment accounts include a depreciation and a retirement account for each class of equipment, which I am inclined to believe are not taken seriously enough.

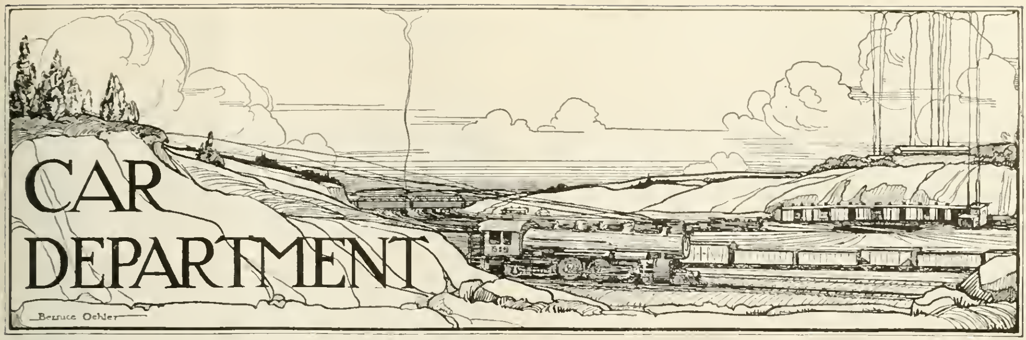
There is no doubt but that a locomotive could be maintained forever in a physical condition averaging say about 60 per cent of its condition when received from the builders. But improvements in the efficiency and effectiveness of locomotives, as well as in the other parts of the railroad machine with which it must function have in the past and probably always will in the future, limit its usefulness to a comparatively short period. In considering the advisability of rehabilitating the old locomotive, which has accumulated a large part of the fund necessary to replace its original value, through the depreciation account, this fact should be kept clearly in mind. Furthermore, the cost of the process of rehabilitation cannot all be capitalized but may involve an abnormally heavy charge to the repair account at the time the work is done and the locomotive, being old, and of small capacity will probably continue to run up heavier unit repair charges than would a new locomotive, modern in design and capacity. It becomes a question, then, whether it would not be cheaper to save the heavy charge to repairs, make the necessary retirement charge and raise new capital for the difference between the book value of the old locomotive and a new one, thereby getting at least a year's service with only nominal repair costs, as well as all the advantages of a modern locomotive in reducing the other train operating costs. With these facts in mind it becomes a matter for serious consideration just how large the depreciation rate should be. Too small it tends to perpetuate obsolete and inefficient power. Too large it may increase the average of the sum of all operating costs. Its correct establishment to best fit the probable future development of each road, is not a matter of mere bookkeeping but a question directly affecting future operating costs.

Conclusion

The few business factors which have been here touched on are, I believe, sufficient to establish the fact that a railroad is an entirety which cannot function as a group of walled-in departments, each sufficient unto itself. Probably each one of the points suggested is better understood by some of you than by me, but if, in attempting to bring them together some phase of the subject not in his immediate view may have become a little more concrete to any one present, I shall have accomplished my purpose. Let no one forget that railroading is a business and that the yard stick of business principles should be applied to every problem, no matter how technical it apparently may be.

Photo by Kadel & Herbert

Canadian Tank Cars Being Loaded for Shipment to Soviet Russia



Motor Cars Used on New Haven Branch Lines

Important Advantages of New Passenger Equipment Are Flexibility and Low Operating Cost

THE economical handling of branch line passenger traffic is a vital question today on many railroad lines. Two or three car trains hauled by a steam locomotive are expensive to operate and moreover frequently constitute a larger operating unit than the situation demands. Due to the fact that branch line traffic has failed to produce a net operating revenue, it is often customary to operate only one or two trains a day. As a result of this practice the railroad is obliged not only to face the competition of the interurban trolley, but also that of the automobile and motor bus running on parallel highways.

In order that the railroads may continue to serve the people living along their branch lines, it will be necessary for them to furnish frequent service in the shape of small flexible units which can be operated at a sufficiently low cost to show a net operating revenue. To meet these conditions railroad officers are very naturally turning to the small gasoline-driven passenger car, somewhat similar to the motor bus now in use in many cities, retaining the gasoline engine and transmission which have already been brought to a high degree of perfection, and adapting the running gear to use on tracks.

The question of self-propelled motor cars for branch line service is by no means new, as several designs of such cars were tried out a number of years ago. The fundamental

Mack Rail Car, Used in Local Passenger Service on the New Haven reason for their failure to meet expectations was due to their large size and heavy weight which required the use of engines of high capacity and resulted in high first cost and large operating expenses.

The New York, New Haven & Hartford, situated in a heavily populated section of southern New England, has a large number of short branch lines which are valuable as feeders for the main lines, but which are not earning a profit on passenger traffic as at present operated with steam locomotives. After a thorough investigation of the problem it was decided to try gasoline-driven cars. Three cars of this type have now been received; one of them is in service between New Haven, Conn., and Derby; one between Tremont, Mass., and Fairhaven, and the third will soon be assigned.

The cars combine many of the characteristics of automotive and railroad equipment as will be noted by reference to the illustrations. The motive power is furnished by the Mack truck engine, made by the International Motor Company, New York. This motor has four cylinders, each of 5 in. diameter and 6 in. stroke. The power rating according to N. A. C. rules is 40 h.p., but the motor actually develops a maximum of about 60 h.p. The motor is located under a hood placed ahead of the car body and power is transmitted by a gear drive to the rear axle which is of the bevel gear type, the gear ratio being 4.29 to 1. The axle has no differential, and drives two 40 in. wheels with cast steel centers and rolled steel tires. The transmission of the selective type gives four speeds forward and four in reverse with direct drive in high speed.

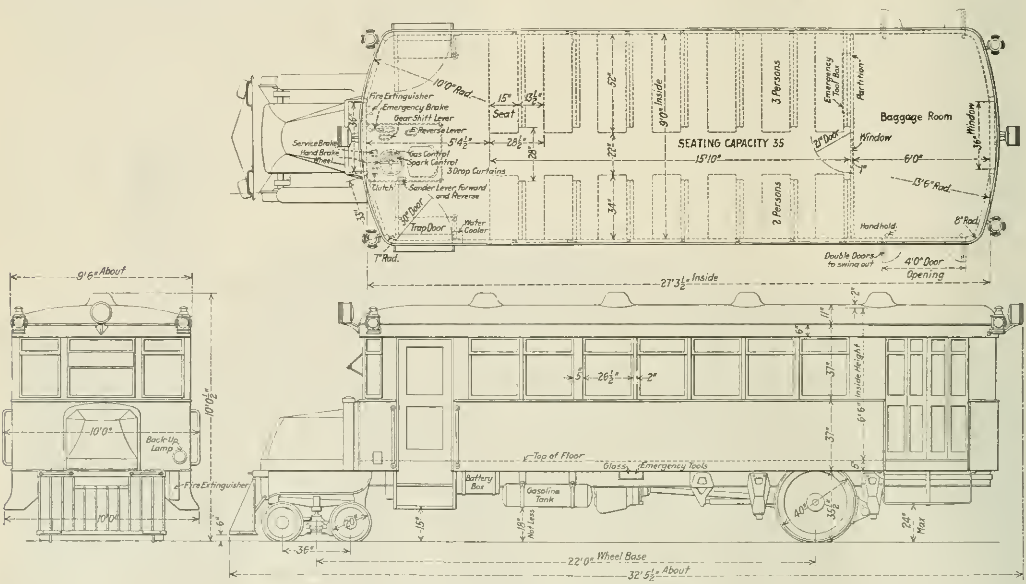
The leading truck is of the four-wheel type with 20 in. diameter wheels. The axles, like those of the driving wheels, run in Timken roller bearings. The truck has a swing bolster supporting leaf springs which in turn carry the underframe. At the rear the frame is also supported on leaf

A brake valve mounted in front of the driver's seat controls the application directly and the release through a quick release valve installed close to the brake chamber. The braking force is obtained through two dished plates between which is placed a heavy rubber diaphragm. The diaphragm is con-

Front End of Body, Showing Driver's Seat and Controls

nected to a push rod which transmits the pressure to the brake shoes. In addition a hand brake is provided, which acts on the rear wheels only and is operated by means of a wheels which corresponds to the steering wheel on motor cars.

The car has seating capacity for 35 passengers and baggage capacity of 1,000 lb. The body is 27 ft. 10 in. long and 9 ft. wide inside the window sills, with a height of 6 ft.



Plan and Elevations of New Haven Motor Car

springs which are slung under the rear axle. In order to reduce vibration and deaden sound, rubber blocks are interposed between the ends of the springs and the car frame.

The cars are braked by the Westinghouse Air Brake Company's motor vehicle brake. The pressure for this device is taken from the compression in two of the engine cylinders and is stored in two small chambers on either side of the car.

6 in. from floor to ceiling. The maximum width at the steps is 9 ft. 8 in.; the width at the eaves, 9 ft. 7 in., and the maximum height above the rail, 10 ft. 5 in. The car weighs 23,400 lb. equipped, or about 30,000 lb. when filled.

The body of the car was built by the Osgood-Bradley Company, Worcester, Mass. The frame is of wood and steel covered with No. 18 openhearth steel plates. The flooring in the passenger compartment is 13/16 in. yellow pine, with maple floor mat strips extending down the aisle and to the front entrance steps on both sides. In the baggage compartment the floor is 1⅛ in. thick. Under the flooring is a layer of hair felt insulation which is held in place by corrugated steel plates, No. 24 gage. The sides of the car also have a layer of hair felt which is covered with agasote. The roof is of tongued and grooved sheathing covered with canvas.

The inside width of the body is sufficient to provide space for five passengers across the car. For this reason two-capacity seats have been placed on the left side and three-capacity seats on the right side of the aisle. This reduces the length of the body, which is very desirable because it reduces the overhang beyond the rear wheels and cuts down the dead weight. The seats, which are made by Heywood-Wakefield Company, Wakefield, Mass., have pressed steel wall plates and pedestals and fabrikoid upholstery. The car body is heated by the exhaust from the engine which is connected to a special exhaust heating control valve on the muffler pipe. There are no heating pipes in the baggage compartment. The interior lighting is controlled by a Newbold 12-volt miniature train-lighting system, 12 lights of 15 candle-power each furnishing illumination for the body. The exterior light consists of golden glow 9 in. headlights of 32 candlepower at front and rear with classification and marker lamps of 4 candlepower. Klaxon and Strombose horns are provided for warning devices; the Strombose horn being used for railroad crossing signals in order that the autoists will not confuse the sound with that of automobiles.

In service the car maintains a speed of about 35 miles an hour on level track and has made 40 miles an hour. It maintains 20 miles an hour on ¾ mile grades of 2 per cent.

One of the items of greatest interest in connection with the gasoline rail car is the cost of operation, but the limited experience with these cars does not make it possible to give a close estimate of costs. However, it seems certain that this type of vehicle will effect remarkable economies in wages, fuel, maintenance and fixed charges. The crew required to operate the New Haven car consists of two men, an engineer and a conductor. Gasoline consumption averages about ⅕ gal. per mile. Cost of maintenance is yet to be determined.

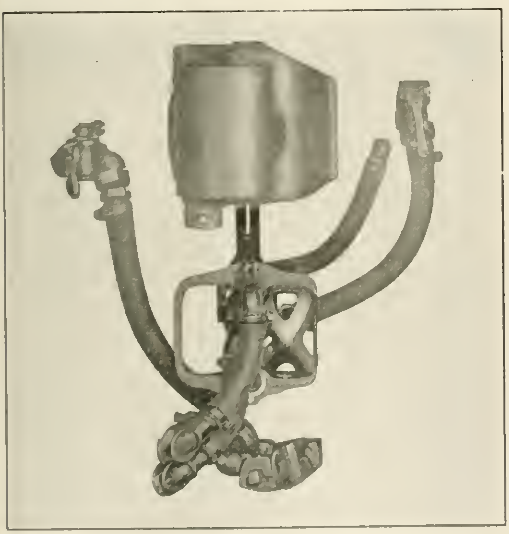
The popularity of road motor buses augurs well for the success of the rail motor car, which operates far more smoothly and can safely maintain higher speeds. There is every indication that the service will be popular with passengers. From the railroad standpoint the advantages are many. Operating costs are reduced; the necessity for extensive terminal facilities are eliminated; in short, the car provides a flexible, economical unit that is just what the railroads need for handling branch line traffic.

Recent Changes in American Hose Connectors

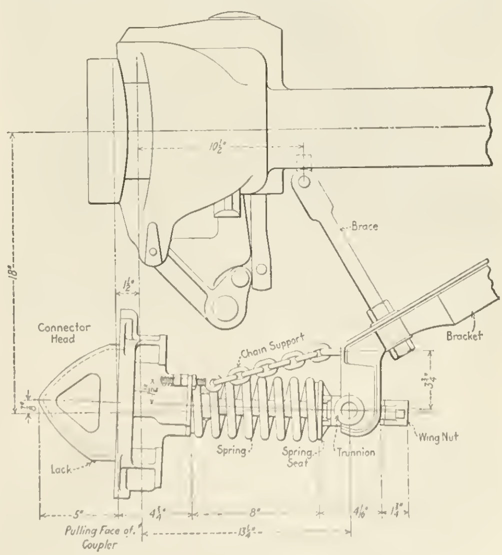
Passenger Heads Interlocked Under Pressure—Permanently Attached Freight Interchange Adapter

The American automatic hose connector is one of the few connector devices placed on trial during the past seven years, the practicability and reliability of which has been indicated by an extensive period of service. It is now in service on the equipment of eight steam railroads and two industrial roads in the United States and installations are now under way on several other steam railroads.

The American connector is manufactured by the American Automatic Connector Company, Cleveland, Ohio. It is of the butting joint type with a so-called pin and funnel type gathering and registering device, and the head is designed



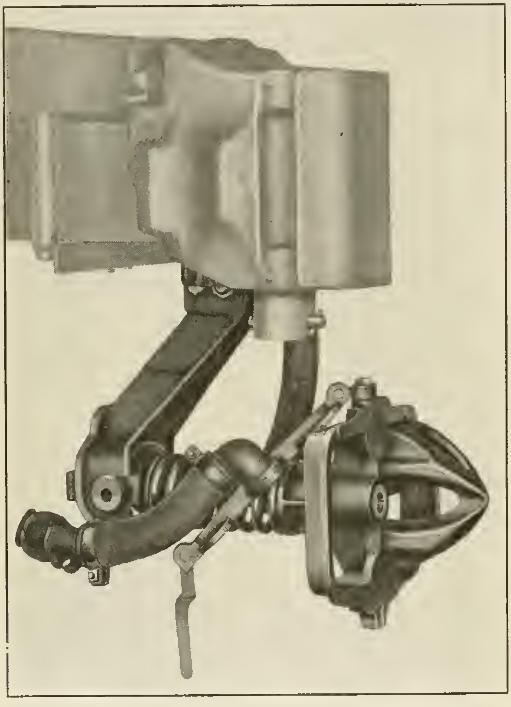
Face of Passenger Connector Head; Brake Pipe and Signal Adapter Is Attached Direct to the Head, Steam Heat



Application of Passenger Connector with Chain Support and Automatic Pressure Lock to provide a gathering range of 7½ in. vertically by 7 in. horizontally, a range materially greater than that of the standard coupler. Each connector complete consists of six parts and weighs 50 lb. As shown in the illustrations, the brake pipe is in the center of the bearing face of the connector head; on passenger heads the center of the signal port is located 3½ in. above and the center of the steam heat port 4 in. below the center of the brake pipe port. The ports normally lie in the same vertical plane as the center line of the drawbar, with the pyramidal or projecting guide at the right and the receiving guide at the left when facing the car.

When two connectors are joined the gaskets are slightly compressed and the contact between the heads is made at four points. These points are 11 in. apart horizontally and 15 in. apart vertically, a spread of bearing that assures freedom from leakage in going around sharp curves or over rough track with frozen hose.

The connector is suspended from a malleable iron bracket which is either bolted to a lug on the coupler head or directly to the coupler shank. For installations on existing equipment the lugs may readily be welded on, while new couplers



American Freight Connector with Permanent Interchange Adapter

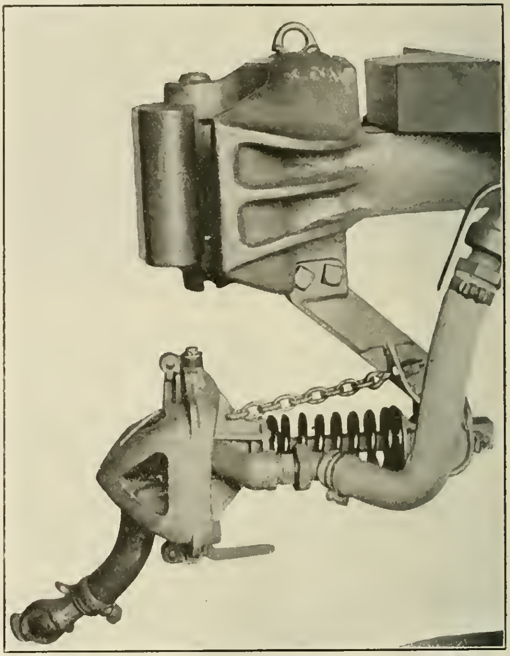
may be secured with the lugs cast on. The standard arrangement of hose connections remains undisturbed.

The first extensive installation of American connectors,* comprising 100 freight cars, 18 locomotives and 24 passenger cars, was made on the Copper Range Railroad at Houghton, Michigan, early in 1919. These connectors have been thoroughly tested under severe conditions as to climate and curvature and are still in service.

Since that installation a number of improvements, either in the head itself or its attachments, have been made to insure positive maintenance of vertical alinement, the automatic locking of the heads under high steam pressure in passenger service and to provide a convenient freight interchange adapter.

*The connectors applied to this equipment were briefly described in the *Daily Railway Age*, June 18, 1919, page 1477.

The application of the chain suspension to both passenger and freight connector heads, by which accurate vertical alinement of the head is assured while in its free position, is shown in the drawing and in one of the photographs. By referring to the drawing it will be seen that the length of



Application of Freight Connector with Chain Suspension; Interchange Adapter in Service Position

the chain is so adjusted that when the head is free the center line of the connector is raised at an angle such that the nose of the projecting guide is held ⅞ in. above the horizontal line through the pivot center. In this position the bearing face of the connector head projects 1½ in. beyond the inside face of the coupler knuckle. The angle of the chain is such that when connector equipped cars are coupled the slack produced by the 1½ in. compression gives the heads complete freedom of angular movement within the full range of movement of the car couplers, both angular and vertical.

In passenger service the use of high steam pressure on the steam heat line, particularly between the locomotive and a baggage car equipped with head end lighting equipment, produces a severe reaction tending to separate the heads unless springs of higher capacity than those used in freight service are included in the equipment. As the steam heat connection is at the lower port in the face of the connector, the tendency is to open up the connectors at the bottom around the top bearing surfaces as a pivot. This tendency has been utilized to produce a positive lock which holds the connectors tightly engaged, irrespective of spring tension, so long as the heads are under pressure.

By referring to the drawing it will be seen that the lower gathering surface of the projecting guide has been extended to form a slight shoulder or permanent latch. On the corresponding surface of the receiving guide is a similar shoulder, the two being in such relation to each other that when adjoining heads are brought together they interlock. Any tendency of the heads to open at the bottom therefore automatically brings together the faces of these two projections and effectively prevents further opening. When the cars are uncoupled, however, the first separation of the connectors is at the top; this is insured by the slight elevation of the connector heads effected by the chain adjustment. This angularity of the heads disengages the interlocked lugs so that they cause no interference with normal operation.

One of the problems of connector service is the convenient adaptation of connector cars to operate with cars equipped with standard hose connections. An interchange adapter for freight connectors has been developed by the American Automatic Connector Company, which is permanently attached to the connector head and can be placed in or removed from the interchange position in a few seconds without tools. In one of the illustrations the adapter is shown clamped in operation position and in another it is swung back out of the way. The adapter is locked in service position by means of a lever at the bottom which is engaged in a slot between two lugs at the bottom of the connector head. Laterally projecting shoulders on the lever engage the rear surfaces of the lugs. In closing the lever these projections, in passing the corners of the lugs, compress the gaskets in the face of the connector, the pressure being slightly relieved when the lever has been fully raised. The lever is thus held in the locking position without the use of mechanical fastenings which materially simplifies the operation of applying or removing.

The American connector has been thoroughly tested on the Copper Range Railroad under particularly severe climatic conditions, in both freight and passenger service. While the connector may be considered primarily a safety device, the results of these tests indicate that its application was fully justified as an economy measure. Air hose renewals on the 100 Copper Range freight cars equipped with the connectors were reduced from $80.50 in 1918 to $1.15 in 1919 and gasket renewals were reduced from $4.80 in 1918 to $.32 in 1919. On 20 passenger cars no air hose renewals were made in 1919, while in 1918 they cost $16.10. Steam hose renewals were similarly reduced from $154.00 to $6.60. On the average it is conservatively estimated that the connectors may be expected to effect a reduction of 60 per cent in hose and gasket renewals. The total cost of maintaining connector service on 100 freight cars and 20 passenger cars for a period of 8 months was $40.63. This included hose and gasket renewals as well as damage to connector heads caused by striking bumpers at mills, and other obstructions, before proper clearances were established for the connectors.

The connectors greatly reduce brake pipe leakage. This improves the operation of the brakes, saves fuel and air pump maintenance and materially decreases the damage to equipment from undesired slack action. Air pumps maintenance was reduced 50 per cent on engines regularly handling connector equipped cars.

On the Copper Range, ore cars move between the mines and mills and are uncoupled twice each day, once at the mine and once at the mill. Some of these cuts require coupling on curves as sharp as 19 deg. and the gathering range of the connectors has been found to exceed that of the car couplers. In this service the connectors effect a saving in crew time of one-half hour a day for each 40 car train.

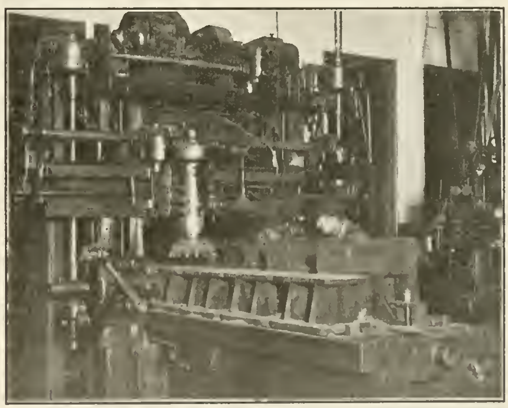
During the tests conducted in 1919 on the Copper Range by the Bureau of Safety of the Interstate Commerce Commission, the ability of the American connector head to withstand abusive treatment was clearly demonstrated. In a number of coupling tests with connector equipped cars on sharp curves and with abnormal conditions of vertical alinement artificially created to place the connectors beyond their gathering range, the only damage suffered by the connectors was the bending of the shafts. Following each of these tests the heads were allowed to return to their normal position and the cars again coupled. In all cases the connectors then performed their intended functions of gathering, registering and maintaining tight brake pipe joints. The gasket faces are completely protected from injury by an adjoining head under conditions which prevent the heads from gathering and registering, and the form of the projection guide is such that it is not susceptible to injury unless from a cause serious enough to destroy the entire connector.

Since the first trial installation of American connectors on the New York Central at Chicago late in 1918, trial installations have been placed in service on the Copper Range Railroad; the Erie; Baltimore & Ohio; Detroit, Toledo & Ironton; Nashville, Chattanooga & St. Louis; the Chicago Great Western and the Monon. A number of industrial cars of the American Steel and Wire and the Carnegie Steel Companies have also been equipped. All of these installations are still in service, except that the original installation on the New York Central was removed and substituted by improved connectors which are now in service.

Machining Fulcrum Supports

It is incorrectly supposed that the planer-type milling machine is more adapted to machining cast iron than steel. While heavier cuts can undoubtedly be taken in the cast-iron the modern, powerful milling machine equipped with high speed cutters can be used to machine tough steel castings and remove the metal quickly and economically.

The illustration shows a three-head planer-type milling machine installed in a large car shop and used for machining many parts entering into the construction of passenger and freight cars. The particular job on the machine at the time



Track Scale Fulcrum Supports Machined on 3-Head Planer-Type Miller

the photograph was taken was sent to the shop from an outside point and consisted of the fulcrum supports for track scales. Ten of these supports which are heavy steel castings were clamped to the bed of the machine as indicated and the three traveling cutter heads adjusted to work simultaneously. The cutters are built up with inserted high speed steel teeth, the outside diameters being $17\frac{1}{2}$ in. A cutter speed of 50 ft. per min. was used, the feed being from $1\frac{1}{2}$ in. to $1\frac{3}{4}$ in per min. While not many car shops possibly would have enough work to warrant the installation of a planer type milling machine the above is but a single instance of the many unexpected uses which develop after a modern productive machine is installed in a railroad shop.

The Care and Protection of Lumber in Storage

Sanitary Precautions to Prevent Decay—The Building of Piles and Protection Against Fire

By H. A. Sackett
Assistant Purchasing Agent, Chicago, Milwaukee & St. Paul

MUCH of the dissatisfaction with timber, particularly car lumber, is wrongly charged to assumed inherent weaknesses of wood in general, or certain species, where in fact carelessness in handling is responsible. The cause quite frequently is poor storage facilities, which lead to checking, warping, decay, casehardening, etc. Finished metal products and even raw material is given adequate protection against the elements and natural deteriorating influences. If similar precautions were taken with lumber, which often is a very highly finished product, not only would its use give better results but considerable waste could be stopped.

Failures that are mostly traceable to incipient or advanced decay before use are generally attributed to inferior quality of lumber. It is true that the constantly widening use of wood has resulted in the cutting of smaller timber than was the practice a generation ago, and that many mills now utilize practically every stick of timber available which naturally results in a larger volume of inferior grades. If greater care had been exercised in wood utilization in the past, which includes handling from the mill to ultimate consumption, the actual loss would probably have been reduced 30 per cent. It behooves everyone responsible for lumber stocks to practice such diligence as will minimize the deterioration and loss occasioned by careless handling in storage.

Storage Yard Improvements

Most roads have established concentration and storage yards for lumber and wood products. Some are admirably laid out and maintained; others resemble more a typical junk yard, selected not because of their suitability for the purpose but apparently because they happened to be in the way. The suggestions that follow are conservation measures designed to protect the very considerable investment represented by the average stock of timber and lumber carried day in and day out by the average road.

The first step is to rid the yard of all refuse, particularly odds and ends of old rotten wood, to remove all grass, weeds and vegetation of every sort. Then the site should be graded as nearly level as possible with at least six inches of cinders, gravel or slag to insure prompt seepage of such moisture as may collect from heavy rains, rapid thaws or overflow. In some localities drainage ditches, at required intervals, would greatly aid maintaining a reasonably dry yard.

Fungi Infections

Several years ago the United States Department of Agriculture investigated timber storage conditions throughout the country for the purpose of making available data that would assist in controlling the enormous waste due to deterioration of lumber in storage, which it found chiefly to be caused by decay, communicated from infected material to originally sound stock. To quote from the report, * "There are two general methods by which wood destroying fungi spread from infected to sound lumber: (1) by a direct outgrowth of mycelium from an infected stick to adjoining or nearby timber and (2) by the blowing about of spores produced by the fruiting bodies or by the mycelium.

A Horrible Example: Vines Permitted to Grow Over Lumber Piles—Courtesy U. S. Department of Agriculture

"In wholly or partially enclosed moist spaces, such as are often found in poorly ventilated lumber piles, the mycelium finds sufficient moisture in the air to allow it to develop on the surface of timbers and in this way may progress along the timber for considerable distances. Such may be the case, also, where timber is closely piled; the writer has records where severe infections have thus passed during rainy weather from the bottom upward through piles 12 to 15 ft. high. In lumber storage sheds, or in the base of close piles the mycelium of several species of fungi has frequently been observed developing in great abundance, not alone on the moist foundations and lower layers of lumber, but also spreading profusely on the soil.

"The chief purpose of spore formation in fungi just as in seed formation in ordinary green plants, is a perpetuation of the species through reproduction. Spores serve the twofold purpose of tiding the fungus over unfavorable periods and allowing their rapid spread under favorable growth conditions. Nature is lavish in her methods and the number of spores produced is often enormous. For instance, Buller computed from partial counts that each pore of the underside of *Polyporus squamosus* produced in the course of a few hours an average of 1,700,000 spores, or a total of over eleven billion for the entire under surface of a fruit body having an area of 250 square centimeters (38.75 sq. in.)."

Courtesy of U. S. Department of Agriculture

Partially Rotted Hardwood Will Infect the Adjoining Stock by Contact

A lumber yard should be systemized, and arranged as carefully as a store house, where castings of various types

*See Bulletin 510, United States Department of Agriculture.

and sizes, nails, screws, bolts, nuts, etc., are placed each in its designated bin, drawer or shelf. Lumber should be piled according to size, first by cross-section and then by length. Each species should be separated, and each class of material be assigned a section of the yard. Maintenance of way material should be in one group, including bridge timbers, switch ties, bridge ties, piling, rough lumber, etc., car lumber in another group, and so on. Finished and kiln-dried stock should always be stored under cover in sheds with at least three sides as protection against driving rains and snow

Courtesy of U. S. Department of Agriculture

Fruiting Body of Fungus Growing on Hardwood Lumber in Position to Spread Infection to Sound Stock Above

as well as intense heat. Proper ventilation is also important. Every pile of lumber should be plainly marked to indicate contents and purpose for which it is to be used. Such identification cards can be arranged to act as a stock record upon which withdrawals and additions can be noted, thus giving a clear record of stock on hand at all times. This suggests that a special lumber storekeeper may be required. And when the value represented by an average railroad lumber yard is considered, what objection can be offered to this suggestion? If the issuance of lumber and its maintenance in proper condition during storage were given as much attention as is devoted to practically all other materials used on a railroad, many thousands of dollars now dwindling away in small leaks of waste and deterioration could be saved.

The site for a lumber storage yard should be carefully chosen. Low ground or "made land" should be avoided. It is practically impossible to keep such a yard reasonably dry and free from collecting bogs and pools of water, and in localities where overflow is to be expected standing water may reach to the pile bottoms, or even beyond, for weeks at a time.

Another desirable feature is reduction of the communicable fire hazard by isolating the yard as much as practicable from other industries or localities where such a condition may be expected to develop within the immediate future.

High ground is unquestionably an ideal location, not only because this provides the best drainage, but also because a better circulation of air is obtained which aids seasoning and will keep lumber in better condition.

Trackage

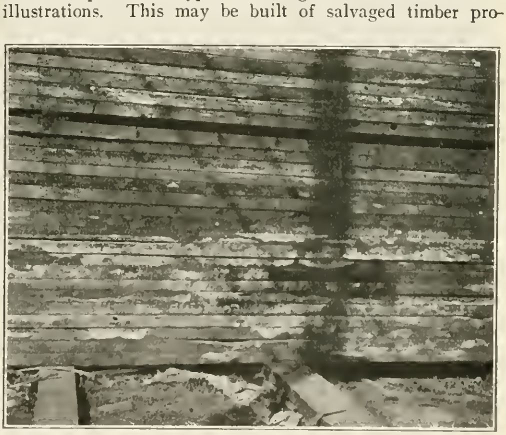
The service tracks should be so laid out that handling is reduced to a minimum. The yard should be platted in blocks, each block facing standard gage tracks on which lumber is delivered in the original cars direct from the mills and automatically unloaded onto the pile. In addition there should be narrow gage tracks for small lumber trucks on which the stock when issued is moved from the pile to the shop. When transshipped to some other point on the system it can again be loaded directly on the work cars which, without rehandling the lumber, are switched to the work train. In the alleys and at required intervals between piles, at right angles to the main tracks narrow gage tracks should be laid for the lumber trucks. Wherever possible the grade of the yard should be in one direction so that the loaded lumber trucks, which are usually moved by manual labor, will have the aid of gravity when being moved with loads toward the shop.

An arrangement as outlined would permit the use of locomotive cranes for handling timbers, and gasoline or electric motors for hauling the lumber trucks. In fact, careful planning of a new lumber yard will so reduce the amount of manual labor required that the cost of handling can be more than cut in two, which will not only pay for the extra mechanical equipment needed, but will solve the problem presented by a scarcity or poor quality of labor.

Spacing of stock piles and proper clearance for tracks are details that must be adapted to the conditions that are individual to the yard. In every case care should be taken that ample space is provided to allow for the use of either gravity, or automatic loading and unloading devices, as well as the handling of lumber and timber by manual labor.

Foundations for Lumber Piles

Whether the yard is old or new there can be but one suggestion for bearings; they must conform to modern sanitary requirements. The ideal foundation for lumber piles consists of concrete piers and creosoted timber sills. The tops of the piers should be at least 18 in. above the ground and the treated bearing sills about 6 in. by 8 in. in sections. Another less permanent type of bearing is shown in one of the illustrations. This may be built of salvaged timber pro-



Courtesy of U. S. Department of Agriculture

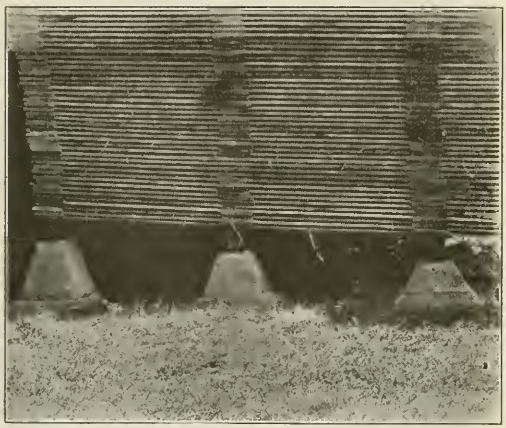
Badly Infected Pile of Three-Inch Hard Pine

viding it is absolutely sound, and after framing should be treated with at least two coats of heated creosote oil. Where better methods of treatment are available these should be used but in any event some such protection must be given all lumber used in pile foundations. This bearing consists of ground pieces *A* which may be plank 2 in. to 3 in. thick, from 6 in. to 12 in. wide and about 2 ft. in length; risers *B* which should be at least 6 in. in height, or more as required, and may be of one piece or several as is most convenient; bearing *C* which may be made of almost any available material but should not be less than 4 in. by 6 in. in section, and should rest on at least three foundations. Almost any sound lumber may be used, but it must be preserved with creosote.

Numerous types of bearings can be made suitable. The important point with each, however, is that it must itself be proof against infection by decay if it is to prevent the communication of such infection to the lumber piled upon it. It must, of course, also be of sufficient strength and rigidity to carry the required load without sagging, and to provide the proper pitch to the pile so that it will freely shed water, and resist wind pressures. The slope of all lumber piles should be in one direction, preferably towards the "face" side of the alley.

The piling strips should be sound lumber and such as are used for timber and rough lumber should be creosoted. Piling strips should never be allowed to accumulate between lumber piles or in the alleys. Likewise, damaged sticks or waste lumber should be removed immediately and disposed of; otherwise the best planned yard will fail to meet the chief requirement, i. e., maximum sanitation.

Properly built sheds with ample room to allow for the necessary working space should always be provided for kiln-dried stock such as car siding, car lining, car roofing, car flooring, building siding, ceiling and flooring, dry poplar, ash, mahogany and quartered oak. The shed foundation should be either of concrete or creosoted timber, substantial and so constructed as to keep the lumber well off the ground. The roof must be tight and the siding should not run down below the bottom of the foundation sills or bearing pieces so that a free circulation of air is permitted from all sides beneath the enclosure. If fungus outbreaks occur in the shed the soil and timber immediately adjoining the infected



Courtesy of U. S. Department of Agriculture

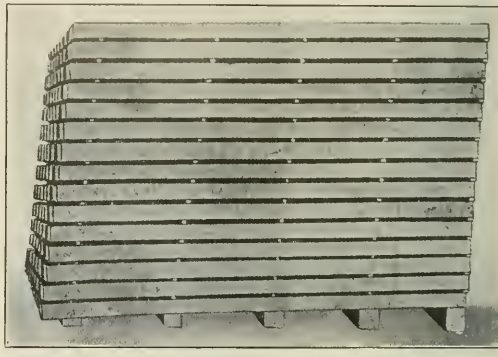
Concrete Foundation Piers and Timber Sills

area should be sprayed or painted with an antiseptic solution of a water soluble salt like sodium fluoride, mercuric chloride, zinc chloride or copper sulphate.

Method of Piling

In the piling of all lumber, care must be used to have the piles substantially constructed to prevent them from falling apart or being blown over by wind storms. The sides or edges of the piles should be straight and parallel, both horizontally and vertically. Piles of boards and 2 in. plank should not be built wider than the length of the lumber in the pile, and in no case should the width of the pile exceed 16 ft. Plank over 2 in. in thickness and all timbers should be piled in narrow piles from 6 ft. to 10 ft. wide, although piles of the same kind of material may be placed upon the same bearings closely adjoining each other. This arrangement permits the complete removal of a pile without waiting to exhaust the entire stock of one size and provides space for piling receipts of new stock without piling it on older or seasoned lumber.

In piling dressed boards and kiln-dried 2-in. plank in

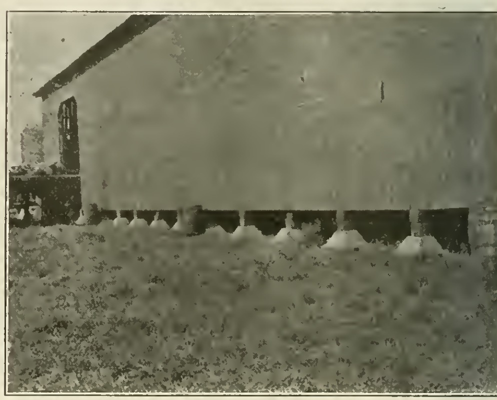


Courtesy of U. S. Department of Agriculture

Method of Piling Timbers. Showing Stripping and Overlapping of Ends

sheds it is permissible to strip only between each five layers. In piling out of doors similar material which has not been kiln-dried, as well as all heavier lumber, strips must be used under each layer in all cases.

In piling 1-in. and 2-in. lumber, pieces of the stock itself should be used for piling strips, but in larger sizes strips



Courtesy of U. S. Department of Agriculture

Ideal Storage Shed. Built on Concrete Piers and Set High Off the Ground for Ventilation

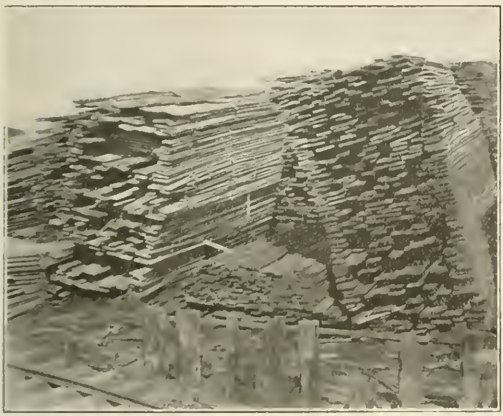
1 in. thick and not over 1 in. wide should be used over each bearing, except the one strip on the face of the pile, which should be 1 in. thick and 2 in. wide.

The piling strips should be no longer than the width of the pile. No strips should be allowed to run through from one pile to another. One piling strip should be used over each bearing piece upon which the lumber rests and should be placed directly over the bearing piece or the strip previously applied. The edge of the trips used on the front of the pile should be allowed to project over the ends of the lumber upon which it rests at least 1/8 in. This will act as a drip cap and assist in preventing the ends of the lumber from checking or splitting. The ends of each course of lumber applied to the pile should be brought flush with the edge of the piling strip at the front of the pile. By following this method the pile will have a forward pitch of about 1 1/2 in. per ft., which together with the slope of the pile, will prevent the accumulation of moisture from rains or snows.

Except where piled in a shed all lumber should be separated in the layers so that a space of approximately 3/4 in. is left between pieces to allow of free circulation of air on all four sides of the pieces. This permits of rapid and thorough drying of the lumber and prevents sap staining and rot. Lumber so piled may be allowed to remain in stock for a long period without damage. This space may be easily regulated by instructing the workmen to allow the width of a finger between the edges of pieces.

All boards and planks dressed on one side which are stored out of doors, should be piled with the dressed side down. When similar lumber is rough on all sides the side of the piece nearest the heart of the log should be down. This will retard checking of the lumber and opening of shakes in the course of seasoning.

In piling lumber 2 in. and under and of miscellaneous lengths the entire pile should be of the length from front to rear of the longest piece of material in the pile. Thus, if 1-in. lumber 8 ft. to 16 ft. in length is being included in the same pile that pile should be 16 ft. long and should



Courtesy of U. S. Department of Agriculture

Conditions Caused by Failure of Decayed Foundations, Creating Fire Hazard and Waste

be even at both ends. This is accomplished by bringing the ends of the shorter lengths alternately to the front and the rear of the pile.

By this method a ragged appearance of the rear of the pile is avoided and there is no waste due to warping and checking of the ends of the longer pieces projecting unprotected from the rear of the pile.

If the quantity of such stock will warrant having two or more piles it would be desirable to pile the 14-ft. and 16-ft. lengths together and the 8-ft., 10-ft. and 12-ft. lengths together.

All rectangular sizes 5 in. in thickness or over, whether rough or dressed, should be piled on edge. This includes car sills, car framing, guard rails, caps, stringers, bridge and switch ties, heavy joints, etc.

All piles of 1-in. boards, poplar and hardwoods of all thicknesses, dressed car flooring and 2-in. plank not under roof should be protected from sun and rain by a covering of rough boards laid in two courses with the cracks in the lower courses lapped by the boards in the upper course. This cover should be laid on strips so that it will be about 6 in. above the top of the pile at the front and 2 in. at the rear. Care should be used to have this cover always in place when the pile is not being worked.

In removing lumber from piles in the yard, that which has been on hand for the greatest length of time should invariably be taken first. Lumber should always be taken

Lumber Bearing Built of Sound Salvaged Material

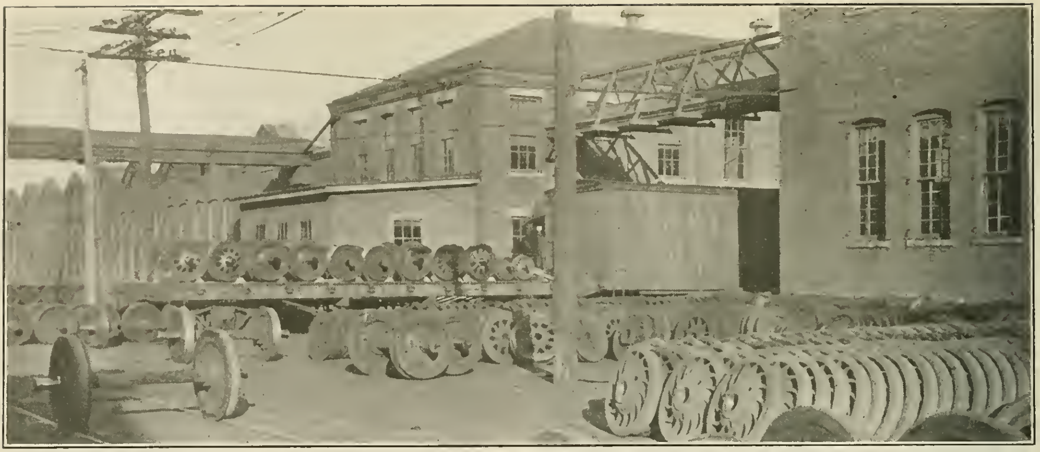
from the top of the pile and in no case should workmen be allowed to break into the side of the pile to avoid the effort of going to the top and removing and replacing the cover.

Fire Protection

Adequate protection against fire is merely common sense. In addition to keeping the yard clean of accumulation of debris, which provides the greatest fire hazard, water should be always and everywhere available. New yards should always be equipped with high pressure water mains, hydrants and sufficient hose so that practically every foot of the yard can be immediately flooded. In addition to keeping this equipment in perfect working order the workmen in the yard should receive thorough training in its use by fire drills which are ordered by the regular fire alarm, previously unannounced.

Where such apparatus is not available water barrels should be distributed throughout the yard at convenient points and strategically disposed so as to be most effective in an emergency. A fire pail should be kept at each barrel and additional pails, ready for instant use, at suitable points. It is obvious that the barrels must be kept full of water, and that they must be inspected frequently. The water in the barrels can be kept from becoming stagnant or from freezing by dissolving in each barrel from 100 lb. to 150 lb. of calcium chloride (common salt). Barrels should be kept covered with well fitting but readily removable covers to prevent excessive evaporation of the water. The most suitable barrels for this purpose are those in which creosote oil is shipped. Tarring the tops will keep the salt from creeping. Barrels should be painted a bright red as identification.

All of these precautionary measures are summed up in the old and well worn but, alas, only too little applied adage, "a stitch in time saves nine." Not alone does the proper handling and protection of lumber before utilization provide real, tangible economy; it is likewise effective conservation which from the standpoint of the greatest good to the largest number is far more important than individual profit. The workmen who must carry out these details is as much profited as the employer who may derive the immediate benefit, because every stick wasted decreases the available supply just that much, which means greater scarcity and higher prices; and high priced lumber always touches every pocket.



Machining and Mounting Wheels and Axles*

Smooth Wheel Fits Advocated: Gaging Worn Axles and Rolled Steel Wheels; Welding Cast Steel Wheels

By Charles Petran

Machine Shop Foreman, Chicago, Milwaukee & St. Paul

CAST iron wheels to be properly machined and for the safety of the railroad should be carefully fabricated at the foundry. The iron should be of the best material, so that the wheels come out perfect both in shape and in composition. A wheel coming to the wheel shops which has a hard hub invariably comes in a low tape measurement, and the hub is usually full of blow holes. This is a dangerous wheel to apply and it is money in the company's pocket immediately to place it in the scrap pile. We have had hard wheels of this description burst at 20 tons pressure; we have had the same kind of wheel broken in two in service.

If the wheel has a high tape measurement, the hub is soft, and it is perfectly safe in every respect.

Boring and Mounting Cast Iron Wheels

All wheel shop foremen should check up the chucks of their boring mills at least once a month to satisfy themselves that the jaws of the chuck are perfectly safe.

In placing the wheels in the machine, the operator should, after closing the chucks, see that he has a five-point contact to the flange of the wheel, and if not, that is the time to investigate for a warped flange.

If the wheels come from the foundry properly fabricated, the mills should be operated for boring wheels at 30 ft. per minute. In starting the cut the operator should use hand feed until the cutter gets a start. This prevents the cutters from following the bore of the wheel, if it is out of center. While it will not insure a perfectly central cut, it helps to bring it much more nearly central than if the cutters are jammed into the wheel and the feed thrown in. What little the wheel is out of true with this first cut is removed with the second cut. It is absolutely essential that all wheels be bored with two cuts, for the above reason.

While the second cut is primarily to bring the bore of the wheel central, it is also intended that the operator fit the bore of the wheel to an axle, if there be any. An allowance of 0.006 in. will give the fit the proper tonnage. After boring the wheel for the second cut, the bore should always be chamfered to give the operator an opportunity to start the wheel on the axle fit. All wheels should be bored in pairs so that two wheels with the same tape may be applied to the axle.

All axles, whether new or second-hand, should be carefully machined on the journal. The machining must consist of a roughing cut, a finishing cut with water and rolling the journal. The journal should be smooth, perfectly round, should not be tapered, and the fillets should be smooth.

A great many operators feel that the fit of an axle should be rough. I disagree with them. The best fit that we can give an axle is to have it as smooth as possible. This gives a long, perfect wheel fit, and a most reliable one. When the fit is made with a coarse feed, in mounting the wheel an accurate tonnage is not shown on the gage, as the wheel plows down the threads formed by the tool. Dismount this same pair of wheels and you would find a loss of tonnage at the second mounting.

A pair of cast iron wheels should be mounted at a pressure of eight tons for every inch of wheel fit diameter. This works out as follows:

Capacity	Wheel fit dia.	Pressure
100,000 lb.	7 in.	56 tons
80,000 lb.	6½ in.	52 tons
60,000 lb.	5¾ in.	46 tons
40,000 lb.	5⅛ in.	41 tons

For all-steel wheels the rule is 10 tons to every inch of wheel fit diameter, plus ten tons, as shown below:

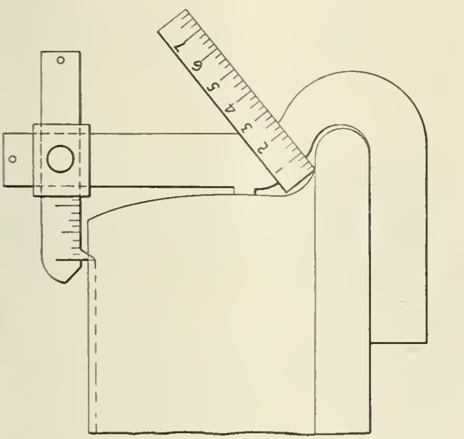
Capacity	Wheel fit dia.	Pressure
100,000 lb.	7 in.	80 tons
80,000 lb.	6½ in.	75 tons
60,000 lb.	5¾ in.	67 tons
40,000 lb.	5⅛ in.	62½ tons

*Abstracted from a paper presented before the Car Foremen's Association of Chicago, December 12, 1921.

We should have recording gages at all wheel shops as these gages not only give the correct pressures but also show any defects in the wheel fits. For a perfect wheel fit, the recording gage would show a perfectly straight line moving upwards and continuing as long as the pressure is on, but with wheels mounted without a recording gage we have to rely on the honesty of the operator, and you all know that would not hold good in a court of law.

A pair of wheels should be mounted perfectly central to prevent the wheels from climbing frogs and wearing flanges thin. This is so important that the wheel shop foreman should check the wheel mounting operator daily to see that this is properly done. It is also essential that a good coating of white lead and oil be painted on the inside of wheel fit and the axle fit prior to mounting. Otherwise there is a liability of the wheel dragging on the axle fit, piling up metal in front of it and thus falsifying the mounting pressure and causing a loose wheel.

After a pair of wheels is mounted the operator should test the wheels to see that they are not mounted crooked on the axle. This is done by tramming on the top and two sides of the wheels before removing them from the wheel press. A heavy coat of grease should then be applied to the journals to prevent them from rusting, and when the store department loads up these wheels for shipment they should again be touched up on the journals with this grease.



Gage Used to Measure Vertical Flange to Determine Service Metal to be Removed from Rolled Steel Wheels

Wheels should be loaded on cars so that the inside journal of each pair is inside of the wheels of the adjoining pairs. This prevents the journals from being cut or bruised while in transit.

Instructions for the Inspection of Axles

1—Caliper the wheel fit.

2—Caliper the center.

3—Caliper the journal in the center and at both ends.

4—Gage the collar of the journal. If the collar is close to the limit, the inspector must examine the inside of the collar and see if the collar is cut, making allowance for turning it up. If, in his judgment, there is not enough metal after truing up, mark the axle scrap.

5—The same rule will apply to a journal. Let us take a 60,000 lb. capacity axle. The limit is 8½ in. long, but a journal 8¼ in. long with a badly-worn fillet would be a scrap axle, so the inspector must use good judgment and not look for the 8½ in. journal nor the ¼ in. collar as laid down by the rule, but rather the 8¼ in. journal and the 3/8 in. collar, and then see what these sizes and lengths would be after being machined at the shops. The same is true of the diameter of a journal. A 3¾ in. journal on a 60,000 lb. capacity axle should be condemned, but I believe the condition of the journal should always be considered—whether it is cut or tapered and if in your judgment it would require a journal 4 in. in diameter to true up to 3⅞ diameter. If a 4 in. journal would have to be turned to less than 3⅞ in. charge it out as scrap. If you do not, it will be done at the machine shop, and the railroad will be the loser.

Thin flanges, small wheel fits and long journals have been passed by our inspectors too much, and in consequence we have to carry a big loss which, with proper inspection, would have been money in the pockets of the company. The money involved in wheels and axles runs up to such a high figure that I believe every supervisor should give this his personal attention. Train your inspectors to the fact that the machine shop is going to remove metal from the axles and they will, in consequence, be smaller in diameter, the journals longer and the collars thinner than when they are examined by the car inspectors.

Rolled Steel Wheels

The Eastern railroads have quite a number of their freight cars equipped with rolled steel wheels, and as the charges for turning are very high, our inspectors should be given very explicit instructions as to how to determine a change of steel wheels on a car without losing any money.

The first move of an inspector is to determine whether the witness groove on a 33 in. steel wheel is correct. The correct measurement is 29½ in. but we have found many wheels with the groove 28½ in. and we have found some 30 in., so it is absolutely essential that the inspector make this his first check. You will appreciate that if the witness groove should only measure 28½ in. that we would be giving the foreign road ½ in. of metal, on the replacement wheel, which he would not be entitled to. This amounts to $17.68 at the price of $2.21 per 1/16 in. In other words, we would be giving him a replacement wheel ½ in. larger in diameter for the wheel removed.

We have a gage that shows the service metal by measurement and gives an accurate measurement of the amount of metal to be removed. The gage is set on the wheel with the heel on the tread. The indicator is then dropped so that the point meets the witness groove in the side of the wheel. The distance from the flange contour of the gage at about ⅜ in. above the throat of the wheel is measured to the flange of the wheel. This would be the amount of metal necessary to remove. This amount is then deducted from the distance shown on the indicator of the gage. For example, if the indicator shows that there is 1¼ in. of service metal on the wheel and the measurement from the gage to the flange ⅜ in. this would indicate that when the wheel is turned and a full contour flange again appears, there will be ⅞ in. of service metal left, just enough to place the wheel again in service.

If a pair of wheels of this description is removed from a freight car, the inspector should apply a pair of wheels with ⅞ in. of service metal. In our passenger wheels, we do not take out all the metal in the flange of the wheel, to make a full contour. We make the throat of the wheel full size and allow this full size to run ⅜ in. above the tread. Should a spot appear above ⅜ in. from the tread of the wheel, we do not remove any more metal on this flange, thereby saving possibly two turnings of metal for further service. Of course the top of the flange is again full size, the worn spot appearing in the center of the flange. I believe the American Railway Association should investigate this matter and allow the same rule to apply to freight wheels. When the throat of the wheel has a full contour ⅜ in. up there can be no danger of any description as a result of allowing a proof mark to appear.

Cast Steel Wheels

Do not scrap a cast steel wheel because it has a slid flat spot and is considered a one-run wheel. We have a very simple method of reclaiming these wheels at the Milwaukee shops. We take a piece of the flange of a cast steel wheel and draw it out for welding sticks about ⅜ in. in diameter. As these wheels come in on account of being slid flat, we weld in this metal on the flat spot, flatten it down with a hammer, and again place the wheel in service. We have watched these welded spots and find them to be equally as sound as the balance of the wheel. The cost of welding in a flat spot is about 70 cents. The wheels with worn flanges are held until we have a carload, and the manufacturer grinds them for us without charge, the only expense being for transportation and loading.

Discussion

In answer to a number of questions relative to the welding of cast steel wheels, it was explained that the hard metal, which is deposited in the surface of the tread and flange in the casting process, has a thickness of about ⅝ in. in the flange. This hard metal, reclaimed from scrap wheels and drawn out into welding rods, makes a sufficiently hard weld to wear well with the hard tread metal. It lacks the water treatment by which the wearing surfaces are hardened in manufacture, but this is made up in a measure by the hammering which the weld receives. No one reported any success in attempts to turn cast steel wheels.

The possibility of finishing journals by grinding was suggested by several speakers. Although no direct experience with this process was brought out, its successful use in other industries, on bearings of similar material was mentioned. The use of emery on car journals was objected to because of the possibility that abrasive material might remain imbedded in the unhardened surface of the journal and cause trouble.

Considerable objection was raised to the practice of determining the service metal in rolled steel wheels, outlined by the author. The general practise of those who discussed this subject, is to leave the determination of this dimension to the wheel shop, where it can be made by actual measurement after the wheels have been turned. It was pointed out that, with the exception of metal removed on account of flat spots, the allowance for which is specified, the interchange rules call for actual measurements and not for an estimate by the inspector on the basis of a gage measurement at the time the wheels are removed from service. This point was referred to the M. C. B. Committee of the association with the suggestion that it be taken up with the A. R. A. Arbitration Committee.

Angle Cock Holder Blocks

By E. A. Miller

THE dismantling and reassembling of angle cocks is quite an important item in air brake maintenance work. In many shops, it is the custom to hold the cock in a vise while taking off the handle and while unscrewing the cap for the removal of the plug. The cock must be gripped by the hexagon brake pipe end and as it has to be turned over, it must be taken out of the vise and regripped for the second operation. As the points gripped are at only one end and as considerable force often is required to start the cap, the vise must be tightened with considerable force to avoid pulling the cock out of the vise. The vise jaws must not press on the body of the cock as this would tend to distort the bushing and the plug.

A device which eliminates the use of a vise will materially reduce the time required for dismantling and reassembling air brake angle cocks and at the same time considerably reduce the physical effort required. The blocks shown in the illustration have been used for some time by one of the large railroad systems and with excellent results. These blocks are made of cast iron and fastened to the bench by

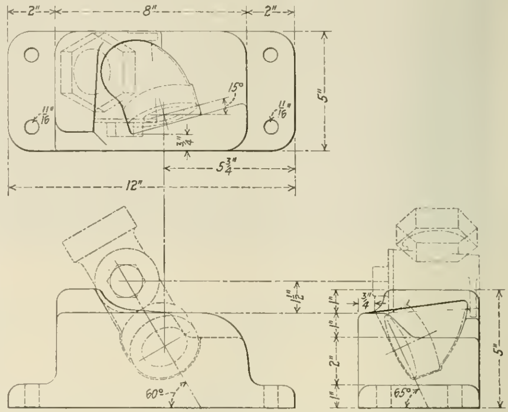


Fig. 1. Block for Holding Angle Cock When Removing and Applying Handle

four ⅝-in. bolts. Two blocks are required, the one shown in Fig. 1 being used for holding the cock while removing the handle pin and handle and the one shown in Fig. 2, while unscrewing the cap and taking out the plug. The same blocks used for taking the cocks apart are, of course, also used for putting them together again after the plugs have been ground.

Blocks of similar design are used for handling cut-out cocks. A wrench for removing the cap is shown at the right-

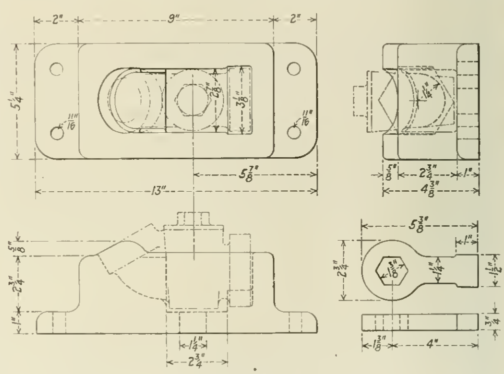


Fig. 2. Block for Holding Angle Cock When Removing and Applying Cap, Also Cap Wrench

hand side of Fig. 2. This is forged of steel and fitted to the cap. A short wrench of this type used with a hammer, is preferable to a long handled wrench and is equally effective for removing the caps from cocks and for tightening them up again when reassembling.

The New Dining Car Train

Electric Cooking on English Dining Car Train*

Articulated Train on Great Northern Forms Unit of Novel Design: All Cooking Done by Electricity

THE Great Northern Railway of Great Britain has recently placed in service a dining car train in which all cooking is done by electricity. The train operates between King's Cross, London, and Leeds, leaving the former station at 10:10 a. m., and arriving at the latter at 2:10 p. m. The return trip is made in the evening.

Aside from the electric cooking, the mechanical construction of the train is quite different from the usual type, as may be seen from the photograph. The train is built on the articulated principle, five coaches being carried on six trucks. This construction considerably improves the riding qualities as the oscillations are reduced to a minimum. The weight also is materially reduced. The train being constructed as it is with the ends of two cars upon one set of trucks, makes it possible to reduce the distance between the two adjacent coaches to much less than usual. Moreover, since the connection is permanent, the vestibule can be made waterproof and draftproof. The middle car is the kitchen, the end cars coaches and the intermediate cars diners.

View of the Kitchen, Showing Ovens

*Abstract from a description in the Railway Gazette, London.

The Electric Kitchen

The outstanding feature of the train, which marks a radical departure, is the electric kitchen. Although certain electric cooking utensils have been used in railway coaches heretofore, it is believed that this is the first dining car train in which the cooking is done exclusively by electricity. H. N. Gresley, chief engineer of the Great Northern, is responsible for the idea and all development work was carried out under his supervision.

The main cooking range is located at one end of the kitchen, a roasting oven and a steam oven being placed above it. Above the steaming oven is a grill and hot water tank. At the right of these ovens is a boiling range with four hot plates for boiling, frying, heating, etc. Two 10-gallon boiling pans for cooking vegetables also form a part of the equipment. An electric fish fryer is also provided.

On the side, between the serving windows, is a hot cupboard for warming plates, the top of this cupboard forming a convenient table. Warm water is carried in a 40-gallon electrically heated tank in the roof of the corridor alongside the kitchen, and forms the main supply for the boilers over the ovens. The demand for adequate supplies of hot water is a very appreciable factor in the current consumption.

Power Supply and Wiring Equipment

The energy for cooking during the time the train is on the road is derived from two 6-kw. belt driven generators and a storage battery composed of 80 cells. As the run is comparatively short, it is necessary to serve lunch soon after the train is under way, and in order that preliminary operations may be begun before the train leaves, the wiring arrangement is such that power may be drawn from the station supply, so that generators and batteries are of minimum capacity.

The changeover switch from the station or terminal supply to the battery and generator supply is located within convenient reach of the cook. Small boards contain the switches and regulating equipment for each group of apparatus. When these switches are closed, pilot lamps illuminate red glass lenses upon which are inscribed the names of the apparatus in use. This indication serves to prevent the attendant leaving equipment in circuit that is not being used.

An automatic switch connects the generator to the battery and cooking appliances as soon as the train has reached a predetermined speed and disconnects the generators when the e. m. f. of the latter falls below that of the battery. Another switch is so arranged as to divert a part of the current from the battery after it has been fully charged, the current thus diverted being used for heating the water.

An overload circuit breaker prevents excessive load being thrown upon the generators or batteries, and should this open it is necessary to reduce the current by turning off some of the cooking elements before the breaker can be made to hold in.

The storage battery equipment consists of 80 cells with a capacity of approximately 120 ampere hours. These cells are arranged 10 in a crate, and the total weight of the battery is 1,880 lbs. All apparatus is designed to operate on a variable voltage of from 150 to 220 volts. The 150-volt operation is derived from the generators and storage batteries on the car while the train is in transit, and the 220-volt supply from alternating current circuits at terminal stations.

The wiring is carried in enamel conduit which is grounded, as are also the frames and casings of the various cooking equipment. To prevent the train being started while the connecting plug is in its receptacle, it is located in such a position relative to a valve in the train pipe that it is impossible to release the brakes without first removing the plug. Provision has been made to charge the storage battery in case exceptionally heavy demands have been made upon them during the journey. If the ampere-hour meter shows that the cells are in a discharged condition when the train arrives, the battery is immediately put on charge, the direct current being derived from a mercury arc rectifier.

Interior of the First-Class Dining Car

The plug which connects the kitchen apparatus to the supply mains at terminals is so designed that the contact never makes or breaks the circuit. This plug consists of five contact pins; two long pins carry the main current, while two shorter pins serve to energize a contactor switch located in an iron box between the station tracks. This contact switch closes or breaks the current in the main circuit. When the plug is inserted in the receptacle the long pin contacts are made first, after which the shorter pin contacts actuate the contactor switch. In the same way, when the plug is withdrawn, the short contact pins cause the contact switch to open before the long pins break their connection. As soon as the plug is withdrawn, the cable is no longer alive. The fifth wire serves as a ground connection.

Illumination of Coaches

Illumination of the dining coaches is by semi-indirect fittings. The fixtures in the first class saloon have alabaster bowls 12 in. in diameter, while those in the third class saloon have obscured glass bowls. Each of the bowls contains four 25-candle power lamps. In addition to the ceiling lighting the first class coaches are equipped with table lamps which brings up the total candle power of these coaches to 750. The third class coach lighting is approximately 600-candle power. All lights throughout the train can be controlled either from the guard van or by the dining car conductor.

View of Kitchen, Showing Change-Over Switch and Cupboard

Interior Design of Coaches

The keynote of the interior design is extreme simplicity, the coaches being practically without decoration. No moldings are used in the first class dining car. The car walls are lined with plain natural mahogany panels made as large as possible to reduce the number of joints. The roof and ends of the dining saloon are absolutely plain and painted a dead white. In the first class coaches the tables are arranged to accommodate six persons in each section. On one side of the aisle is provided a table and four seats, while on the other side is provided a smaller table and two seats. In the third class coaches two tables and four seats are provided on either side of the aisle.

The seats in the first class compartments are of the arm chair variety, upholstered in green tapestry. Polished mahogany tables are used with covers of green morocco leather. The floor covering is of Wilton crimson pile carpet, while the lobby at either end of the car is covered with green and white India rubber tiling.

The seats of the third class coaches are also of the arm chair type, the unholstering being in crimson and black pile.. In these coaches cork linoleum is used for floor covering.

Car Inspectors Discuss New Rules of Interchange

Continuation of Consideration of Rules by Chief Interchange Car Inspector's and Car Foremen's Associations

At a joint meeting of the Chief Interchange Car Inspector's Association and the Car Foremen's Association held in Chicago, January 9, there was a general discussion of the new code of interchange rules of the American Railway Association. An abstract of the discussion up to and including that of Rule 87 was given in the February issue of the *Railway Mechanical Engineer.*

Rule 101.

(This rule covers billing prices for material, and has been completely revised.)

Mr. Jameson: Item 105 reads:

Box lids, malleable iron (manufactured), including bolt and spring, if any, all sizes, each, net, $1.20.

while item 112 reads:

Castings, rough, malleable, per pound, $0.145; credit $0.005.

Now we would price a journal box according to item 112, at 14 cents per lb. net. Would that include the lid or would the lid be extra? I take it the lid is extra.

M. E. Fitzgerald (C. & E. I.): It seems to me that the charge for a journal box net, including its lid, would be confined to the price per pound. The box lid price as quoted in item 105 would cover the application of a box lid only, labor and material

L. Martin (Baltimore & Ohio): I believe the application of the journal box new would cover the lid.

J. T. Morrison (C. R. I. & P.): We consider each item separately. If you have a journal box applied there is no reason why you should put on a new lid; therefore you charge the net price for the lid if you do renew it, in addition to the price per pound for the journal box. I think you will find that that interpretation is borne out by the rules throughout.

A. S. Sternberg: It is my opinion when you apply a journal box the lid is included in the pound price.

Mr. Jameson: You have a pressed steel lid, including bolt, cotter, washer and spring, all sizes, each, net forty-four cents. Many malleable boxes have this pressed steel lid. Now, if I am going to apply a new malleable box with a pressed steel lid shall I charge 14 cents a pound for the whole thing; or if the lid is a patent malleable lid with a spring, shall I charge fourteen cents for the whole thing? I cannot consider lid as "castings, rough, malleable."

Mr. Morrison: Cost price on all box lids is not the same; consequently you cannot very fairly include that in the price per pound for a malleable oil box. You have to charge them separately.

R. J. McGrail (C. & A.): I believe that they should be separate; I agree with Mr. Morrison.

Mr. Fitzgerald: Suppose we take off a box broken with a good lid and apply a new box with the lid complete; we would have no labor there for applying the lid. How would you arrive at a credit for the good lid that was on the broken box? There is no credit allowance for scrap in item 105.

Mr. Martin: I would like to ask those who are charging for the lids separately how they weigh the new box in the first place. Are they weighing the box without the lid on it?

Mr. Morrison: We are charging for the journal box on the basis of what the box weighs and that does not include the weight of the lid. If the lid on the box removed is a good one we assume that it is of as much value to us as the one we applied. Consequently no charge is made for the lid in that case.

A. Armstrong (Atlanta, Ga.): If I was applying a new malleable journal box with a malleable lid attached, I understand that both being the same material I would charge the total weight of box and lid combined, but in the event that I applied the new malleable journal box with a pressed steel lid I would use the two prices.

Mr. Sternberg: I move that it is the consensus of opinion of this body that the journal box and lid when applied at the same time shall be charged at the pound price of 14½ cents.

Mr. O'Donnell: The lid is a manufactured item. The spring and the bolt go with it.

Mr. Martin: If we separate these two items it means that we have got to keep our records to show in what condition the lid came off the car. We must give the owner credit for a good piece of material that we take off and one comes pretty nearly to offsetting the other.

Mr. Overton (Southern): Item 104 has reference to pressed steel lids and item 105 has reference to the malleable lids. We all know that there are plenty of cars running every day without box lids, some possibly of pressed steel, some malleable. In case you apply the pressed steel use the pressed steel price. If you apply malleable, use that price. In item 112 we have rough castings, malleable, which applies to the oil box. If there was no lid applied and the lid was intact and good, I do not see how you could charge for it.

Mr. Jameson: Neither the price of $1.20 nor the pound price given in Rule 101, includes the labor of applying the lid. The labor is a separate item and comes under rule 107.

The motion was lost

Mr. Cheadle: Item 46 reads:

Release valve, R. & R. or R., includes straightening its rods when necessary.

Item 47 allows a credit of 65 cents regardless of condition of release valve. Rule 101 does not refer to Rule 107, so all work necessary to complete these repairs is covered by this price. There are prices in Rule 101 to which you add labor. Should we charge for the cotter keys plus the labor?

Joseph Lennertz (B. & O. C. T.): It covers the price of the valve, the application and the straightening of the rod, but it does not cover the cotter key when a new cotter key is added.

Mr. Jameson: Item 184 reads:

Spring cotter or split key, 1, renewed, when used in connection with other parts repaired or renewed, net one cent.

You have a right to charge one cent for renewing the cotter keys in that case.

G. J. Kreeppen (Chicago): Item 61 reads:

Nipples 12 inches or less in length, threaded, 1¼ in., 12 cents.

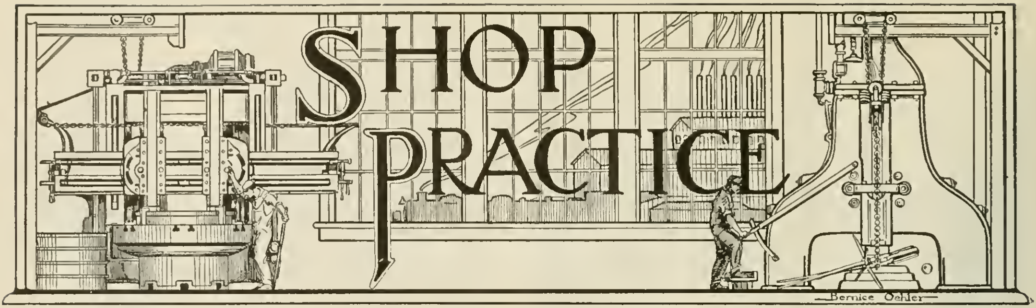
Item 180 reads:

Pipe, black or galvanized, 1¼ inch, per foot, 18 cents, credit one cent.

A pipe with threads on both ends is only 12 cents and a foot of pipe is worth eighteen cents, while in Rule 111, Item 28, says that you can charge 18 cents for brazing a nipple. There are three different charges on that nipple. What is the proper charge?

Mr. Morrison: Nipples are a manufactured article and they can be furnished to you at less than the price given you, while it is supposed that if a pipe is over 12 in. long, perhaps it will have to be threaded on the ground and as a result a higher charge is allowed on a longer piece. All these small nipples are supposed to be purchased threaded, the threading being done on a machine, and consequently it is a good deal cheaper than the hand process that is employed where the work is done on the ground.

[The remainder of the proceedings, a discussion of prices in Rule 107, will appear in the next issue.—Editor.]



Electrically Safe Ending Boiler Tubes

Summary of Results in Safe Ending Boiler Tubes and Flues with the Thomson Electric Butt Welder at Nashville, Tenn.

By J. J. Sullivan

Superintendent of Machinery, Nashville, Chattanooga & St. Louis, Nashville, Tenn.

THE recent revival of interest in the application of safe ends to boiler tubes and flues by the electric butt welding process is indicated by the published report of the Master Boiler Makers' Association Committee on Welding Safe Ends. According to that report the Norfolk & Western now has in service about 280,960 tubes welded by this method, 152,000 of which were welded in 1919 with no failures reported. The Union Pacific was reported to be able to weld about 60 tubes per hour and to have more than 700,000 electric welded tubes in service with only two failures.

The practice on the Nashville, Chattanooga & St. Louis at the Nashville shops is summarized in the following article which includes two illustrations, Fig. 1 showing the welding machine and flue roller and Fig. 2 being a plan of the flue shop with the movement of tubes and flues through the shop.

The process of electrically butt welding safe ends to all sizes of boiler tubes and flues has been used at Nashville since August, 1916, so that the results given were secured over an extended test period during which the electrically welded tubes and flues gave excellent service without failures. The type 40-A electric welding machine used is made by the Thomson Electric Welding Company, Lynn, Mass., and has a capacity of welding up to and including 5½ in. flues. The general principle of the machine is that heat is induced by passing a large volume of electric current at a low voltage through the butting tube and safe end to be welded, the heat-

Fig. 1—Rolling a Boiler Tube After It Has Been Safe Ended in Thomson Electric Butt Welder

ing effect being caused by the resistance of the metal to the flow of current. The greatest resistance to the flow of current is between the butting ends which therefore become hot first and when they reach the proper welding temperature, the current is turned off and pressure applied mechanically to force the molten ends together, thereby producing a weld.

The machine, shown in Fig. 1, was developed especially for welding boiler tubes and flues and its general construction is evident from the illustration. In the operation of welding, the tube is held in the clamp jaws or dies *A* which are forced together mechanically, clamping the tube and serving as one electrical contact. The safe end is similarly gripped in dies *B*. The electric current is turned on by means of a switch and the butting ends of the tube and safe end instantly begin to heat. The operator learns to judge by experience when the welding temperature is reached and when the metal is hot enough, dies *A* and *B* are moved mechanically towards each other which forces the two molten ends of the tube and safe end together. At the same time the operator turns off the current, and the weld is made. The pressure on the dies is released, allowing the tube to be pushed through to rolls *C*.

The weld is in the full view of the operator all the time and no smoked glass or goggles are needed, as there are no flying sparks. Another advantage is due to the method of heating which prevents oxidation as would occur with an

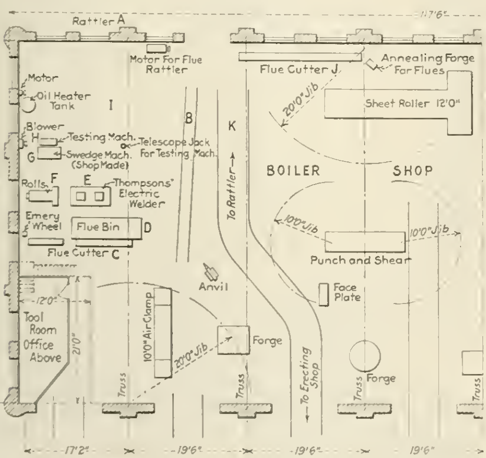


Fig. 2—Plan of Flue Shop and Course of Fules Through the Shop

open fire. Consequently no welding compound is necessary. The operator has complete control of the electric current by means of a current regulator and switch and can quickly obtain any heat desired from a dull red to the melting point of the metal. As soon as the weld is made, the current is switched off and expense for power stops. Another advantage is the low voltage characteristics of the machine and consequent elimination of danger from this source.

Cost of Electric Welding

Extended experience has shown that the cost of electrically butt welding safe ends on 2-in. boiler tubes at Nashville is 3½ cents each, the time averaging about 1.12 min. each. This is the labor cost, and the cost for power, as determined by meter readings for a large number of welds is .224 cents for each 2-in. tube. The labor cost for safe ending a 5½-in. boiler flue is 15 cents, the time required 4 min. and the power cost 2.016 cents for each flue. One welder and one helper are necessary for the most efficient operation.

Referring to Fig. 1, the device for rolling the tube immediately after being welded is shown at *C*. The tube is pushed along on two supporting rolls as soon as the weld has been made and the welding dies release their grip on the tube. This arrangement saves practically one handling of the tubes and with a helper to facilitate handling tubes into the welder a considerable increase in production is obtained.

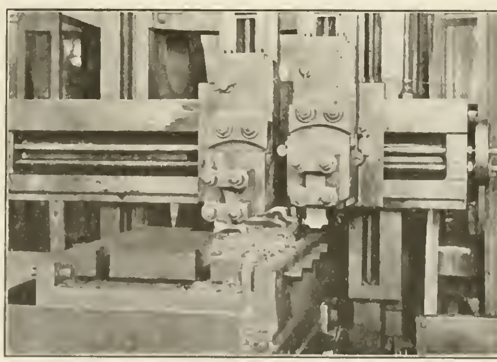
The method of handling tubes and flues through the shop at Nashville will probably be of interest and referring to Fig. 2 this movement will be readily understood. The tubes are cut from the boiler in the erecting shop loaded on a truck and moved to the rattler *A* outside the shop. After being rattled a sufficient length of time to loosen and clean off the scale, the rack of tubes is moved into the shop by means of the flue rattler motor and stored on track *B*. When opportunity offers the tubes are then placed conveniently to the flue cutter *C* and the firebox ends cut smooth and square. An emery wheel is provided as shown for removing burrs. From bin *D* the set of tubes is moved to the electric butt welder *E* where they are welded and rolled quickly with the expenditure of a minimum amount of time and effort.

The next operation is to swedge the tubes which is performed on a shop made machine. The tubes are tested and moved to *J* where they are cut for length and have the front ends annealed in the forge shown. The tubes are then ready for application to the boiler, being sent to the erecting shop along passageway *K*. The only back movement is from the rattler back to the first flue cutter, a condition which cannot be prevented in this case owing to the local shop lay out.

Machining Wedges for Wide Driving Boxes

An evidence of the great size and weight of locomotive parts as called for by modern design is provided in the illustration which shows the planing of an extended driving box wedge on a crank planer. The wedge in the illustration is 14 in. wide and this type of wedge in some cases is made as wide as 16 in. whereas even ten years ago it was uncommon to find these parts more than five or possibly six inches wide.

A special jig is shown fastened to the planer table and



Fourteen-Inch Wedge Being Machined on Crank Planer

provided with set screws for holding the wedge or shoe as the case may be in the proper position after being lined up. In the case of the wedge, taper shims are placed between the wedge and the jig and by tightening or loosening these shims the wedge can be raised or lowered until it is at the desired elevation. The left-hand planer head with a round nose tool in the tool post takes a roughing cut across the wedge and is followed closely by the finishing tool which removes the tool marks and leaves a smooth accurate finish on the wedge. The finishing tool is designed as shown to cut a fillet on each side of the wedge.

Atmospheric Aftercooler

By E. A. Miller

In railroad shop practice considerable difficulty is often experienced owing to water accumulating in the air lines and thus interfering with the operation of pneumatic tools. The trouble is accentuated in winter due to the freezing of this water and consequent bursting of pipes and general delay of the work. One way to reduce greatly the chance of trouble of this kind is by the use of some form of after cooler and separator, an example of which is illustrated.

Reference to Fig. 1 shows that the cooling is done not by water but by air, consequently the term atmospheric aftercooler. The total area of the cooling surface is slightly less than 1,400 sq. ft., and this is adequate for compressors up to a capacity of 4,000 or 4,500 cu. ft. of free air per min. There are 262 three-quarter inch tubes in three rows on each side of the device making a total of 524 tubes through which the compressed air is compelled to pass on its way to the shop. Referring to Fig. 1, air from the compressor enters at inlet *A* passes through tee *B*, valve 1 and through a long radius tee *C* to the upper section of 6-in. heavy pipe. As shown by the arrows, the air is then conducted down through the 3/4-in. tubes to the lower 6-in. pipe from which it passes through a 6-in. special Cochrane air separator *L*.

The water is separated from the air at this point after

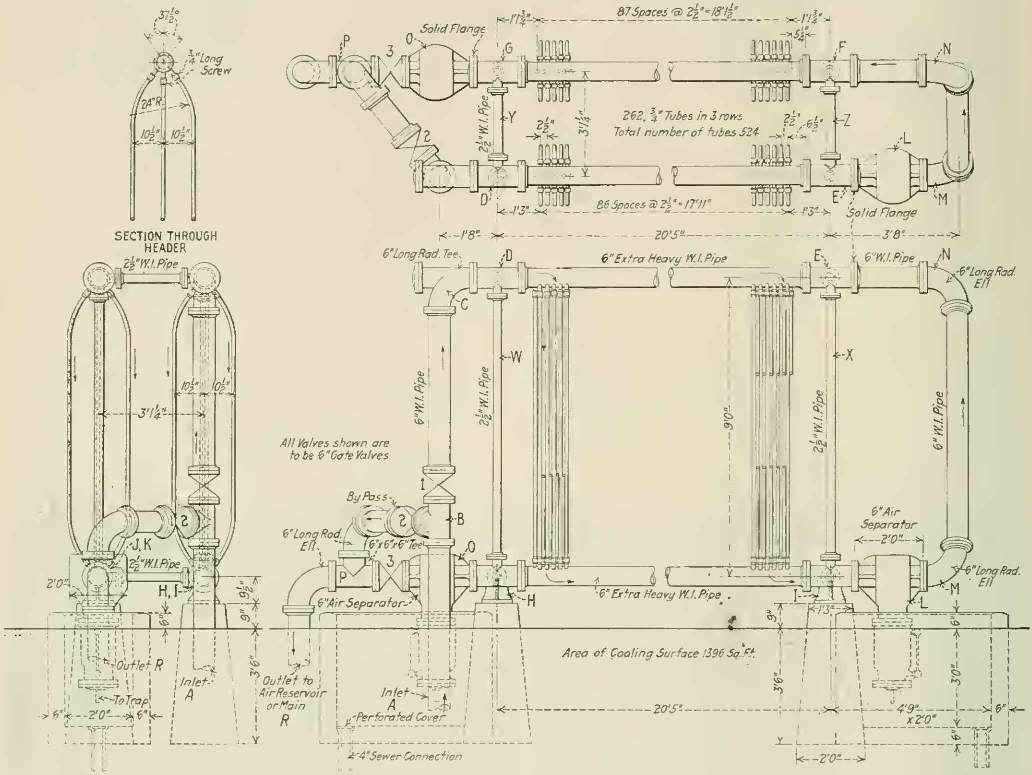


Fig. 1—Aftercooler Designed to Cool the Air and Precipitate Water After Leaving the Compressor

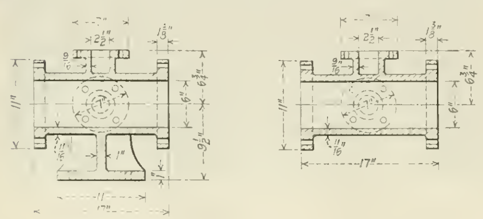


Fig. 2—Details of Special Tees H, I, J, K and D, E, F, G

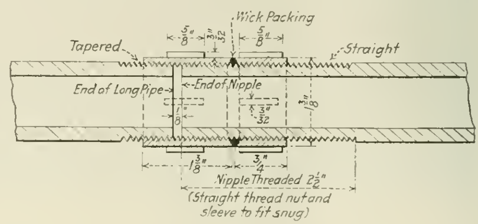


Fig. 3—Details of 3/4-in. Pipe Joint

which it passes to the upper, back section of 6-in. heavy pipe. The back set of small tubes then conveys the air to the lower back section of heavy pipe from which it goes through a second 6-in. air separator, valve 3, tee *P* and a 6-in. long radius ell to the outlet pipe *R*. Owing to the air being divided up into so many small currents there is ample opportunity for it to cool and percipitate the water which eventually collects in the air separators and is drained off from time to time as may be necessary.

Normally valves 1 and 3 (Fig. 1) are open and valve 2 closed. In case repairs are needed to the joints the by-pass can be used by closing valves 1 and 3 and opening valve 2. The four special tee castings *H*, *I*, *J*, and *K* at the bottom are referred to as tees on account of their shape but are not really tees in the true sense of the word since there is only one straight hole through them. They are shown in detail in Fig. 2 which also shows details of the four upper tees *D*, *E*, *F*, *G*. The small blind flanges connected to the 2½-in. pipe sections are used only to tie the structure together. Pipes *W* and *X* are simply a means of support and do not conduct the air. Pipes *Y* and *Z* serve only to hold the two upper 6-in. pipes together.

All 6-in. pipe used in the construction is extra heavy grade. Details of the ¾-in. pipe joints are shown in Fig. 3. The bent tubes are threaded on either end, being of a sufficient length to reach within approximately ⅛ in. of the short nipples threaded into the 6-in. pipes. The nipples are spaced 2½ in. on centers and a nut and sleeve, run up on each nipple is threaded back on the longer, curved pipe and locked with wick packing between the nut and sleeve. The threads on the longer pipe are tapered so that they will be air-tight when the sleeve is turned on as far as it will go. The nut is tightened up against the sleeve, the joint being made air-tight by wick packing. No provision for expansion or contraction is necessary since there is no great variation in temperature.

Two concrete pits are provided adjacent to the diagonal supporting piers and enclose the separators. Each separator is provided with a water glass as illustrated to indicate the accumulation of water and suitable arrangements are made to draw off this water from time to time.

Money Saved by Milling Keyways

Detailed Examples Are Given of the Savings Effected by Milling Piston Rod, Axle and Crank Pin Keyways

By M. J. Rogers
Machine Shop Foreman, New York, Chicago & St. Louis, Chicago, Ill.

It is necessary to cut keyways in many locomotive parts and experience at the Stony Island shops of the Nickel Plate has shown that these keyways can be milled in a much shorter time and at less cost than with the old method of drilling and planing, or drilling, chipping and filing. Comparatively few people realize that it takes almost three hours and costs over $2.00 to cut a piston rod keyway, for example, by the old methods whereas this keyway can be machined in one setting on a plain miller in slightly over one-half hour and at a cost of 42 cents. A special lathe milling attachment has been developed which reduces the cost of cutting six keyways in a main driving axle from approximately $8.00 to $2.00.

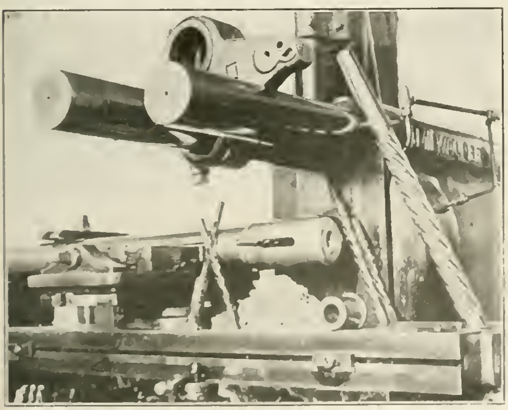


Fig. 1—Modern Plain Knee-Type Miller Cuts Piston Rod Keyway in Record Time

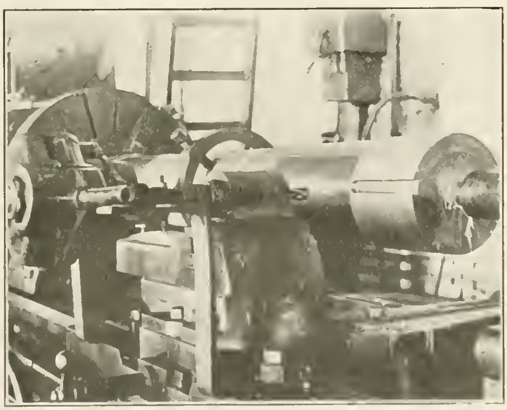


Fig. 2—Air-Operated Milling Attachment for Engine Lathe

Piston Rod Keyways

The method of milling a piston rod keyway on a plain knee-type milling machine is illustrated in Fig. 1. The piston rod, after being fitted to the crosshead and having the keyway laid out, is placed in a two-jaw chuck in the milling machine, being properly set by means of a surface gage. A hole is drilled through the piston rod and a spiral high-speed milling cutter, several of which are shown in the illustration, is passed through the hole to the spindle of the milling machine. The cutter has three flutes, a spiral angle of 27 deg. and is undercut 10 deg. A cutter rest (shown swung up out of the way in order not to interfere with the picture) is then adjusted in place and pushed over the outer end of the cutter, thus affording a rigid outer bearing.

The use of this cutter rest enables much heavier speeds and feeds to be taken with correspondingly greater production. The feed in this particular instance was 9/32 in. per min. The cutter was run at a speed of 320 r. p. m.

The old method of cutting piston rod keyways is relatively expensive as shown by the detailed figures in Table I. This table indicates a definite saving (A-B) of 142 min. and $1.707 for every piston rod keyway milled on this machine as compared to the old method of drilling, chipping and filing. It may also be stated that the keyway, as milled, is far more accurate and better finished than would be possible by hand filing except with the use of a prohibitive amount of care and time.

Driving Axle Keyways

Reference to Fig. 2 shows a device developed at the Stony Island machine shop for milling keyways in driving axles, crank pins, or any shafting that can be held between lathe centers. Ports in cylinder and valve bushings can also be milled by means of this device which is in reality an air-operated milling attachment for engine lathes.

The construction of the attachment is quite plainly shown in the illustration. An end mill is held in a spindle provided with suitable bearings to take up end thrust and arranged to be held in the tool rest of the lathe. The end of this spindle is machined to a standard Morse taper and fits in the socket of the air motor which drives the attachment. Two brackets or arms are bolted to the carriage and arranged to support the handles of the air motor as shown in the illustration. These arms also prevent rotation of the motor body and when the air is turned on the motor spindle revolves driving the end mill.

In operation, the axle is turned and the wheel fits made, the axle then being quartered and keyways laid out. The milling attachment, as shown in the illustration, is placed in the tool rest and driven by an air motor. The driver is set to the center of the axle and held by two set screws. Two hook bolts are passed through holes in the driver and hooks engaging the bed of the lathe hold the axle firmly against rotation. This arrangement is also used to adjust the axle to suit the position of the milling cutter. An end milling cutter of the proper size is held in the spindle of the milling attachment and driven by a 3-hp. air motor at a speed of 275 r. p. m. The motor is then started and the milling cutter run in the depth of the keyway at the end of the axle. A carriage feed of ½ in. per min. is applied and the keyway milled as shown in Fig. 2.

Not only are the wheel fit keyways machined but, in cases where the Stephenson valve gear is used, it is possible to lay out the eccentric keyways and mill them without removing the axle from the lathe. The particular advantages of this method are the greater accuracy in machining keyways and the reduced time and cost of the operation. The relative costs of milling two-wheel fit keyways and four eccentric keyways in a driving axle as against the older methods of drilling and planing, or chipping and dressing them, are shown in Table II, the saving being represented by (A)-(B). The saving in time is 512 min. and the saving in cost $6.253. A careful examination of the figures given in this table will show complete details of the machining operations and present conclusive evidence of the advantage of milling.

Crank Pin Keyways

As in the case of main driving axles, crank pin keyways can be machined with a considerable saving by milling as against the old method of drilling and planing, or chipping and filing. Complete details regarding the two operations are shown in Table III in which the saving is again represented by (A)-(B). In this case 33 min. in time is saved and $.639 in cost.

Table I—Relative Costs of Machining Piston Rod Keyways

Old method of drilling, chipping and filing:	Time	Cost
Setting up piston road on drill press	15 min.	....
One drill operator, at 65 cents an hour	....	$0.163
Drilling holes	70 min.	....
One drill operator, at 65 cents an hour	....	.812
Chipping and filing	90 min.	....
One machinist, at 77 cents an hour	....	1.155
(A) Totals	175 min.	$2.130
New method of milling:		
Setting up of piston rod on milling machine	10 min.	....
One machinist, at 77 cents an hour	....	.128
Drilling entering hole for milling cutter	12 min.	....
One machinist, at 77 cents an hour	....	.154
Milling keyway	11 min.	....
One machinist, at 77 cents an hour	....	.141
(B) Totals	33 min.	$0.423

Table II—Relative Costs of Machining Driving Axle Keyways

Old method of drilling and planing:	Time	Cost
Transferring axle to drill after fitting and quartering	15 min.	....
Two helpers, at 62 cents an hour	....	$0.310
Setting and clamping axle for six keyways (Two wheel fit and four eccentric keyways.)	60 min.	....
One drill operator, at 65 cents an hour	....	.650
Drilling two holes for wheel fit keyways (Two wheel fit keyways.)	14 min.	....
One drill operator, at 65 cents an hour	....	.152
Drilling holes for four eccentric keyways	200 min.	....
One drill operator, at 65 cents an hour	....	2.167
Transferring axle to planer	15 min.	....
Two helpers, at 62 cents an hour	....	.310
Setting up on planer for two wheel fit keyways	34 min.	....
One machinist, at 77 cents an hour	....	.436
Planing two wheel fit keyways	90 min.	....
One machinist, at 77 cents an hour	....	1,150
Chipping and dressing out four eccentric keyways (Four keyways.)	240 min.	....
One machinist, at 77 cents an hour	....	3.080
(A) Totals	668 min.	$8.255
New method of milling:		
Setting milling device for six keyways (Two wheel fit and four eccentric keyways.)	72 mins	....
One machinist, at 77 cents an hour	....	.924
Milling six keyways	84 min.	....
One machinist, at 77 cents an hour	....	1.078
(B) Totals	156 min.	$2.002

Table III—Relative Costs of Machining Crank Pin Keyways

Old method of drilling and planing:	Time	Cost
Transferring crank pin from lathe to drill press	10 min.	....
One helper, at 62 cents an hour	....	$0.103
Setting up on drill	8 min.	....
One drill operator, at 65 cents an hour	....	.087
Drilling one keyway hole for tool clearance	5 min.	....
One drill operator, at 65 cents an hour	....	.054
Transferring crank pin to shaper	3 min.	....
One helper, at 62 cents an hour	....	.031
Setting up on shaper	5 min.	....
One apprentice, at 51 cents an hour	....	.425
Cutting keyway	20 min.	....
One apprentice, at 51 cents an hour	....	.170
(A) Totals	51 min.	$0.870
New method of milling:		
Setting milling device	12 min.	....
One machinist, at 77 cents an hour	....	.154
Milling keyway	6 min.	....
One machinist, at 77 cents an hour	....	.077
(B) Totals	18 min.	$0.231

German Railways

At the close of the war German railway rolling stock showed increases in locomotives of 22 per cent and in freight and passenger cars of 10 per cent over numbers on hand at the beginning of 1914, due primarily to confiscation from invaded territory, according to Commerce Reports. As the terms of the armistice forced the return of 5,000 locomotives and 150,000 cars to France and Belgium, the rolling stock now available is considerably less than that of 1914. A difference of 31 per cent is given for locomotives in 1920, and 36 per cent and 25 per cent, respectively, for passenger and freight cars.

A great number of the locomotives and cars now in use are in need of repairs, as well as the roadbeds of most railways.

The railway deficit for the present year (operation and replacement) will amount to about 7,000,000,000 marks (about $35,000,000 at the present rate of exchange) as compared with 15,000,000,000 marks (about $75,000,000) in 1920. The extraordinary large figure last year was due to an unusual expansion in the number of employees.

Forging Presses for Blacksmith Shop Work

Superior to Steam Hammers for Heavy Forgings—Adaptable to a Wide Range of Work

PRACTICALLY every railroad blacksmith shop has a considerable proportion of fairly heavy forging work which is generally done under steam hammers. In fact the steam hammer is such a prominent part of the shop equipment that there is a tendency to use it for all classes of work within its range. The wide field of usefulness is an important advantage of the steam hammer, but the fact should also be recognized that hammer forging as an economical method has certain limitations.

Hammering is no doubt the best method of working miscellaneous small parts. For larger work it is not so desirable and for very large forgings it is a failure. Steam hammers are no longer made in the extremely large sizes that were built some years ago. The cost of the hammer and the foundation is so great and the output relatively so small that large hammers cannot compete successfully with forging presses.

Fig. 1—300-Ton Forging Press at the Greenville Shops of the Bessemer & Lake Erie

Some of the larger forgings made in railroad shops are so heavy that they are not readily manipulated under the steam hammer. The rate of reduction on these pieces is slow and several heats are often required before they are finished. These are the conditions that have led many industrial plants to replace hammers with forging presses which do the heavier work more quickly and cheaply. It is therefore pertinent to ask whether the forging press would not effect similar economies in railroad blacksmith shops.

Briefly stated, the advantages of the forging press as compared with the steam hammer are as follows: the press will give a greater output with forgings made closer to size, thus saving considerable machine work. A modern press will give approximately double the production that can be obtained from a hammer of the same capacity in the same time. The operating cost of the forging press is lower, the consumption of steam being approximately one-half that of a steam hammer on similar work. The flexibility and ease of operation due to the absence of shocks and of rapidly moving masses are also important considerations. No massive and costly foundation is required for the press because all stresses are taken up with the frame of the machine itself. The cost of upkeep of the press itself is low and there is no vibration or shock to surrounding buildings and machinery. The squeezing and kneading action of the press works the material clear to the center whereas the effect of hammering is confined largely to a limited area near the surface.

Forging presses of the steam-hydraulic type have been used on a small scale in railroad shops for a number of years. The design most generally installed is the open-frame press built by the United Engineering & Foundry Company, Pittsburgh, Pa. A press of this type having a rated capacity of 300 tons and installed in the Greenville shops of the Bessemer & Lake Erie is shown in the illustration (Fig. 1).

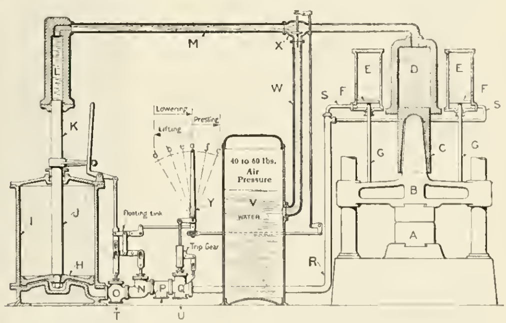


Fig. 2—Diagrammatic Section, Showing the Method of Operation

The operation of this press will be readily understood by reference to Fig. 2. While this represents a press of the closed-frame type, such as made in the larger sizes, the principle of operation is identical in both. The power for operating the press is obtained from the steam cylinder *I* and the prefiller chamber *V*. The prefiller keeps the hydraulic system filled with water and the ram *K* acting in the cylinder *L* creates a high pressure when needed, which is transmitted through pipe *M* to cylinder *D*. This cylinder is much larger in area than cylinder *L* and therefore greatly increases the force acting on the main ram *D* and the press head *B*.

When pressing a forging the operation is as follows: With the hand lever at position *a*, both the intensifier and the main rams are at the bottom of their stroke and all valves are seated except valve *O*. The hydraulic system is charged with water and air. In the open frame type of press, the supply of water is contained in the base. The steam connection is made at the inlet *P*. By moving the hand lever to position *b*, valve *X* commences to open and as valve *O* has already opened when passing position *c* and admitted steam to the pull back cylinders *EE*, the lifting power applied to the piston *F* overcomes the weight of the ram and press head and lifts them toward the top of the stroke. During the upward stroke water from cylinder *D* is forced past valve *X* and back to the prefiller *V*. The lifting speed can be increased by moving the hand lever to *d*, thus giving valve *X* its full opening.

If it is desired to stop the press head at any point on its upward stroke this is done by moving the hand lever forward to position *B*, thus closing valve *X*.

Assume that the forging is placed on the anvil or lower die and it is desired to bring the press head down. Moving the hand lever forward to position *e* closes the steam inlet to the pull back cylinders and bringing the lever to *a* will open the exhaust ports in valve *Q*. The pressure on the water in the prefiller will lift valve *X* from its seat and move the ram *C* and press head *D* down.

The forging pressure is applied by moving the hand lever forward to *c*. This admits steam through valve *N* to intensifier cylinder *I*, raising piston *H* and forcing ram *K* into cylinder *L*. Valve *X* drops to its seat and the water displaced from cylinder *L* passes through pipe *M* into cylinder *D* giving a very high pressure on ram *C*. Shortly after passing position *a*, valve *Q* automatically disconnects from the operating lever by a trip and thus puts steam pressure under the piston of the pull back cylinders ready to raise the ram.

When the hand lever is reversed to position *a* valve *N* closes and *O* opens, exhausting the steam from the intensifier cylinder allowing the piston *H* and ram *K* to fall by gravity to the lowest position while the press head rises to the height at which the pressing stroke commenced. Any number of pressing strokes can be made from this point without refilling or returning any water to the prefiller by working the lever back and forth between *a* and *b*.

The length of the pressing stroke is controlled by a patened device consisting of an inclined bar along which travels a roller attached to an arm on the intensifier ram. When the ram *K* moves upward, the movement is transmitted through a crank arm at the lower end of the inclined bar to a floating link. The opposite end of the floating link is connected to the hand lever, the center of the link being connected to valve *N*. The arrangement is such that the control gear automatically closes the steam valve when the intensifier piston reaches the same relative position as the hand lever, thus a short movement of the hand lever gives a short pressing stroke and a longer movement a proportionately longer stroke. This control not only enables the operator to regulate the stroke at will, but also prevents injury to the operator or damage to the machine in case the resistance between the dies is suddenly removed as any overrunning of the piston immediately closes the steam and opens the exhaust valve.

The 300 ton press illustrated will handle an ingot with a maximum dimension of approximately 14 in. The stroke of the press is 24 in. and the movement of the press head per stroke of the intensifier, 4 in. The ram can be operated as slowly as desired or from 60 to 120 short strokes per min. can be made if desirable. A good idea of the capacity of the machine can be gained from the fact that this press is rated as being equivalent to a 3,000 lb. to 4,000 lb. steam hammer.

For general forging work the press is adapted for any jobs that can be handled under the steam hammer. The accurate control makes it easy to forge parts close to the finished size and space blocks can be used between the upper and lower dies more readily than on a hammer. Parts can likewise be bent or straightened or cut off and holes can be punched quickly and accurately. In general it is found that operations can be performed with fewer men and in less time and more intricate forging work can be performed with simple tools. The adaptability of the press is shown by the fact that it is used in the Greenville shops for shearing coupler yoke rivets, for straightening coupler shanks cold, and for tightening spring bands cold, work which could not be handled satisfactorily under a steam hammer.

One of the most interesting and useful applications of the forging press is found in the making of difficult forgings and pressings with simple dies. The Bessemer & Lake Erie has used the press for straightening bent steel ties and has also made large numbers of stakes for the sides of steel cars. These stakes are made from a 9 in., 20 lb. channel, the web being pressed to a U shape until the two flanges are brought in line, extending outwardly along the side of the stakes. The stakes are 5 ft. 3/4 in. long and are bent in forming dies at a single stroke of the press. Numerous forgings are also made under the press, such as car center plates, heads for air drums, adjusting rods, yokes for brake rods, etc. Some of the tools used in forming these parts are shown in Fig. 3. The forging for the driver brake adjusting yoke is illustrated at *A*. The die used for punching out the center is made of cast iron and is shown on the anvil, while the finished yoke is illustrated at *B*. A simple punch for punching holes in piston nuts and similar parts is shown at *C*. The parts shown at *D* are used for forming clevis jaws for valve gear parts, an unusually interesting operation.

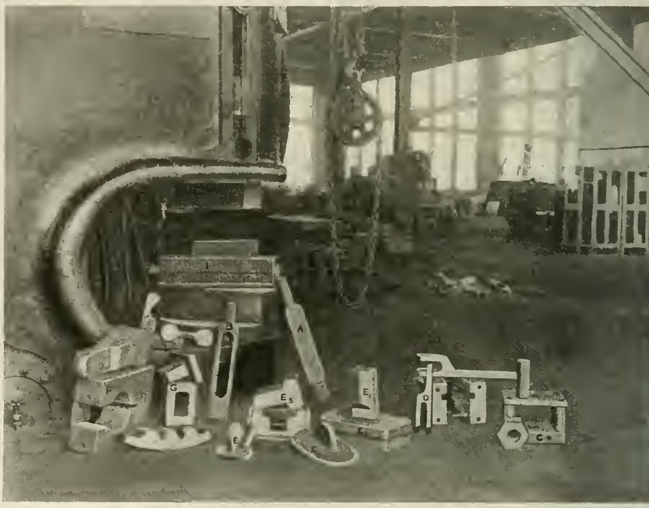


Fig. 3—A Group of Dies Used Under the Forging Press

An interesting operation is the making of the boiler brace shown at E6. The forging E1 is formed from a bar and the die E2 is used to forge this to the shape shown at E3. This is placed on the die E4 and the base is punched to form with the punch E5, making the completed brace as shown at E6. The dies shown at *F* are used to shape the ends of main and side rods, while *G* is used for forging brake stands.

Testing Locomotive Appliances at Readville

Apparatus for Assembling and Testing Ragonnet Reverse Gears, Pyle-National Headlights and Duplex Stoker Parts

AIR brake repair work and the apparatus for repairing and testing many appliances used on New York, New Haven & Hartford locomotives are segregated on the gallery of the repair shop at Readville, Mass. This location insures a separation from ordinary locomotive repair work and the best of light is available for the performance of more or less delicate operations. Work in the air brake department is under the direction of W. Hurst, who is responsible for the design of most of the testing apparatus. In the main, the idea has been to repair thoroughly and, wherever possible, test all parts before they leave the department for application to the locomotive. In this way a great deal of time and labor is saved by making sure that no part goes to the locomotive until it is in good operating condition. Where such test methods are not used an air compressor, for example, might be delivered to the erecting shop, bolted in place on the locomotive, and pipe connections made before it was discovered that the main valve in the steam head would not work, due to defective packing rings. The defect would not be found until the locomotive was fired up, with resultant delay, duplication of work and loss of time.

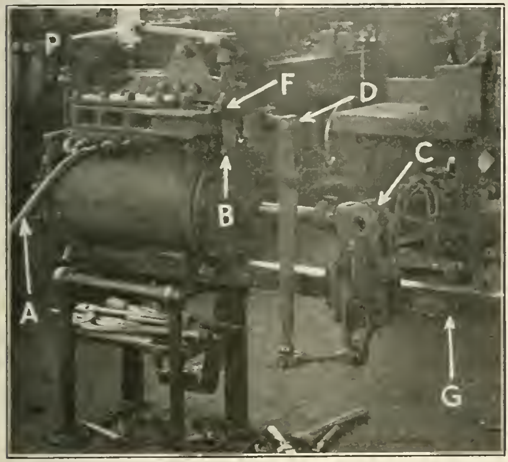


Fig. 1— Device for Testing Ragonnet Power Reverse Gears

In addition to apparatus for testing air compressors, injectors, air brake valves, etc., an arrangement for testing Ragonnet power reverse gears has been developed, as shown in Fig. 1. The reverse gear as received from the locomotive is entirely dismantled, all parts being thoroughly cleaned and cerefully inspected. Those which are worn or defective are then replaced and the gear assembled on a special rack, as illustrated. Air pressure is supplied to the gear through pipe *A* (Fig. 1), and the gear tried out as it would be on a locomotive under actual operating conditions. Pin *P*, for example, is moved to the left, thus moving pin *B* to the right by means of fulcrum *F*. The movement of pin *B* is transmitted directly to the long vertical lever and thus to pin *D*, attached valve stem and the main air valve. Movement of the main valve to the right admits air behind the piston, moving crosshead *C*, to the right on its guide *G*. With pins *P* and *B* stationary crosshead *C* continues to move to the right until backward movement of pin *D* and the main valve to the left closes the port.

In the main, the results accomplished by this test are first, the determination that all gaskets, packing, etc., in the gear are air-tight; second, the gear operates as designed, depending upon the movement of pin *P*; and, third, that there is no defect or leak around the main valve, causing the crosshead *C* to "creep" in either direction when pin *P* is still.

The dismantling and assembling of Duplex stokers presents a problem which has been solved by the construction of a special hydraulic press as indicated in Fig. 2. The press consists of two rails *RR* separated a short distance with the adjustable tail casting *T* mounted on one end of the rails and fixed head casting *H* on the other end. A fluid pressure jack is mounted firmly on head *H* and arranged to be driven through a small pump and air motor *M*. Gage

Fig. 2—Reassembling an Elevator Screw, Casing and Revolving Head of a Duplex Stoker

G is provided to register the mounting pressure. The spring *S*, through suitable levers, returns the plunger of the jack after the parts have been forced together. This spring also acts as a buffer to absorb the shock when two parts are finally separated. The head and tail castings are tied together along the top by means of bar *B*, the design being such that tail casting *T* can be advanced to any position desired, being held by pins through the holes shown.

This press has proved a very valuable tool for the separating and forcing together again of many parts, some of which would be awkward to handle in an upright press of the usual design. For example, the particular job illustrated in Fig. 2 consists of reassembling a Duplex stoker elevator casing *E* and elevator screw. The right-hand end of the screw *P* is a force fit in the revolving head *N* and the arrangement of casing, elevator screw and press for the operation is shown in the illustration. A glance at the location of this force fit will indicate how difficult it would be to press these parts together under the ordinary type of vertical press. The elevator screw *M* and head *N* can be readily separated and reassembled on this press. This press has also been found useful for many pressing operations other than assembling Duplex stoker parts.

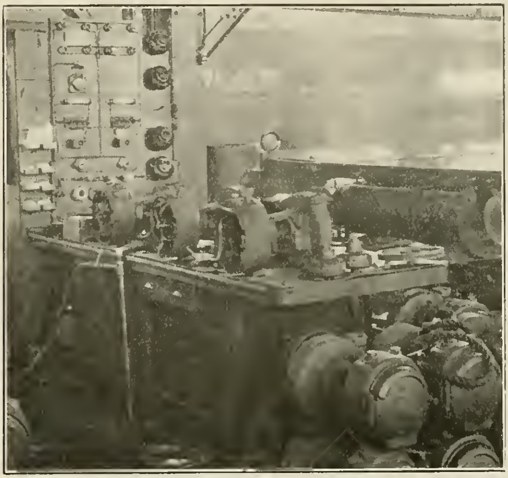


Fig. 3—Bench and Test Rack for Pyle-National Generator Sets

The repair bench and apparatus for testing Pyle-National headlight generator sets are shown in Fig. 3. These generator sets are thoroughly cleaned before being brought to the repair bench, where they are dismantled and all parts inspected for wear or other defects. Three casings are shown in position on the bench with the rotors and generator armatures ready for assembly. After all parts have been thoroughly overhauled and repaired they are reassembled and a connection made from the air line shown in the illustration to the steam inlet of the turbine. Air is used in order to eliminate the inconvenience caused by exhausting steam to the room and also to prevent heating the parts should it be necessary to take them apart again for subsequent alteration. The board at the extreme end of the table is wired and provided with lamps, resistances and switches. The load is supplied to the generator set by switching on the lights and while the conditions on the locomotive are not exactly duplicated with this test apparatus, an experienced operator can tell very closely how the generator will work when applied.

These generator sets operate as a rule under 180 or 200 lb. steam pressure and inasmuch as the shop pressure is usually not over 80 lb., it is necessary to boost the pressure of air used in testing by following the usual custom of bushing the air cylinder of the Westinghouse compressor, or by admitting air to both the steam inlet and air inlet.

Two Tool Room Grinders

The illustrations show two types of small grinding machines which are practically indispensable for use in modern tool rooms. The universal grinder illustrated in Fig. 1, for example, is of particular value for grinding different sizes and types of milling cutters and reamers. There is usually enough work in the average shop to keep one or more of these machines busy and owing to the increased production of cutters and reamers which are kept in good condition by frequent grinding, the machines pay for themselves quickly.

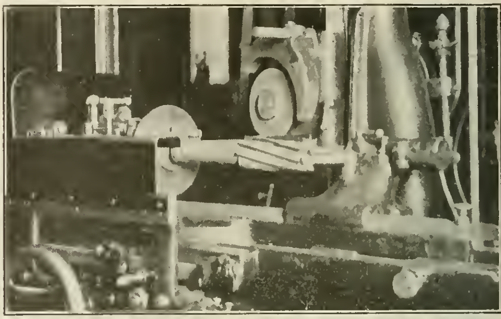


Fig. 1—Tool Room Grinder Sharpening Spiral Milling Cutter

While many railroad shop tool rooms are not equipped for surface grinding, the small surface grinder, illustrated in Fig. 2, can be used effectively for many operations which would require more time by other methods. The job shown in the illustration consists of finishing the surface of a wheel lathe forming tool blank. This particular work is greatly facilitated by use of the magnetic chuck which readily holds pieces that would be difficult to clamp. In fact, for many surface grinding operations, a magnetic chuck is a great timesaver. The speed, accuracy of work and smooth finish which it is possible to obtain with the surface grinder make it highly adaptable to use in tool rooms.

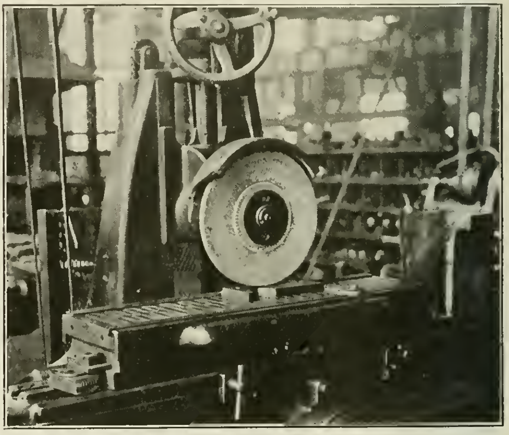


Fig. 2—Small Surface Grinder Equipped with Magnetic Chuck

Novel Engine Facilities for a Cold Climate

Canadian National Builds Rectangular Enginehouse with Radial Tracks and Enclosed Turntable

FAR up in the North country at Hornepayne, Ont., Can., where the winters are long and rigorous, the snowfall heavy and a temperature often as low as 60 deg. below zero, the Canadian National Railways has constructed an enginehouse of unique design. Rectangular in shape, of brick and concrete construction, with ample facilities for heat, light and ventilation, it encloses an 80-ft. turntable, thus completely protected from snow and ice, 16 radial engine stalls, a machine shop, a boiler room and other miscellaneous store and office facilities.

The new structure replaces an old 10-stall timber roundhouse and forms the major part of a small yard and terminal project. The old building, as well as its supplementary facilities, such as the machine shop, drop pits and other accommodations, were all lacking in modern improvements and had grown inadequate. The need for more extended facilities to handle efficiently the larger power necessary on this division had become more and more acute, but the immediate necessity for a change did not arise until the old roundhouse was destroyed by fire.

New Terminal Layout of Much Larger Capacity

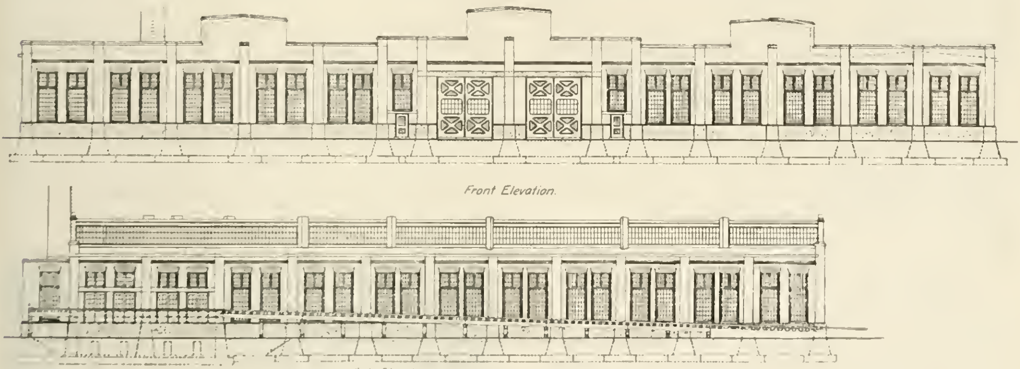
The present arrangements have been built of much greater capacity to meet both the present and possible future requirements at this point. As a consequence of the fire and the need for more modern and adequate facilities, the entire terminal layout was rearranged to conform with the increased capacity of the enginehouse. This entailed the construction of eight new supporting yard tracks, in-going and out-going engine tracks, sidings and emergency roundhouse tracks, etc., totaling about 17,700 ft. About 7,800 ft. of old trackage was removed. Other facilities included in the modernization of the Hornepayne engine terminal were a well-equipped coaling plant, an ash and cinder handling plant serving two tracks, a heated water tank, an ice house and a store house.

Large Size Provides Ample Space for All Facilities

In constructing the new enginehouse, the old 80-ft. turntable was utilized and the new structure built around it. Rectangular in shape, as stated, the long side of the building has been placed at right angles to the general center line of the enginehouse tracks. It is 287 ft. 7½ in. long and 223 ft. 3 in. deep, supported on concrete foundations carried down 7 ft. below the grade line, a depth necessary because of frost, and from the grade line up to the height of the window sills. The remainder of the walls is of brick pier construction with pilasters spaced 18 ft. 10 in. and 21 ft. 6 in. center to center, depending upon their location. The area covered by the enginehouse is approximately 1½ acres, the roofing over of which has been accomplished by the use of 19 steel columns carrying steel trusses and purlins. Three monitors run from front to rear with steel sash windows on each side. The roofing itself is 2¾ in., splined roofing covered with tar felt and gravel. The columns surrounding the turntable are spaced 56 ft. 6 in. from each other and 43 ft. from those adjacent. The maximum span is thus over the turntable, or a distance of 113 ft. The columns are all supported on concrete pedestals carried down 7 ft. below the grade line with bases of large dimensions, varying up to as high as 13 ft. square.

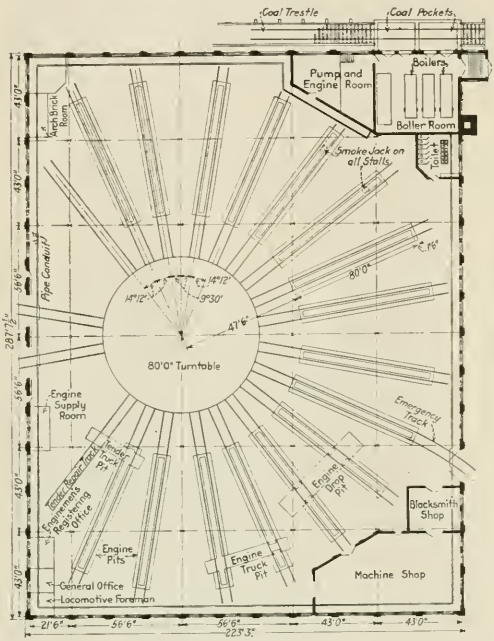
Modern Installation of Engine Pits and Drop Pits

The turntable serves 16 tracks, of which 14 are provided with concrete engine pits, 80 ft. long. The angle between track centers is 14 deg. 12 min., except where the roof columns are located around the turntable. At such points the angle has been increased to 9 deg. 30 min. from the line passing through the column and the turntable center, or a total of 19 deg. between adjoining track centers. The distance from the center of the turntable to the line of the smoke jacks is 119 ft. 6 in. A full complement of modern wheel pits has been provided, the construction including a driver drop pit, an engine truck pit and a tender truck pit.



Two Views of the Rectangular House

The two rear corners of the building have been utilized for the boiler and engine-room layout and the machine shop and blacksmith shop. In the former case a room 42 ft. 11 in. by 40 ft. houses three locomotive-type boilers and a washout plant. Coal is supplied by a hopper track and trestle at the rear which discharges into a large concrete hopper directly adjacent to the boiler room. The pump or engine room adjoining this contains the water pumps, air compressors and electric generator for lighting current. The other corner contains an irregularly-shaped machine shop fully equipped with the latest type machinery necessary for making running repairs. Its maximum dimensions are approximately 74 ft. by 40 ft. Other facilities include a locomotive foreman's office, an engineer's registering office, a general office, a locomotive supply room, an arch brick room, tool rooms and a modern lavatory and wash room, all within the walls of the building.



Floor Plan of Engine House

Ample ventilation and light are provided by the sash windows in the three monitors and by the numerous large windows in the side walls. The generator mentioned furnishes current for electric lights. Heating is provided by steam coils on the side walls and in the engine pits.

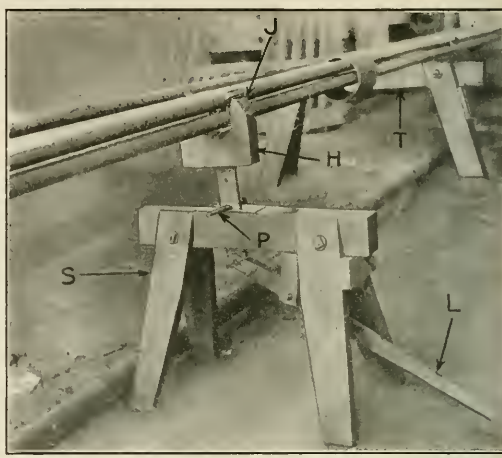
Banding Superheater Units

By E. A. Murray

Shop Superintendent, Chesapeake & Ohio, Huntington, W. Va

A SIMPLE device which has proved unusually effective at the Huntington shops of the Chesapeake & Ohio for banding superheater units is shown in the illustration. The units are supported on two carpenters' trestles, one of which is shown at *T* in the illustration. This trestle is 26 in. high and 65 in. long, having a sufficient capacity to hold nine superheater units while the joints are being ground and bands applied. The work of renewing bands and applying rivets is greatly facilitated by means of the trestle *S* shown in the foreground of the picture. This device is provided with a holder *H* of the correct dimensions to fit accurately around the superheater band and capable of vertical adjustment by means of foot lever *L*.

In operation all superheater units requiring new bands have the old ones removed and new ones placed lightly around the pipes. The trestle *S* is then slipped along under the units to the band which it is desired to rivet. Downward pressure on the foot lever *L* will raise holder *H* until it supports the weight of the unit, pin *P* being applied and holding the unit at this elevation until the operator can



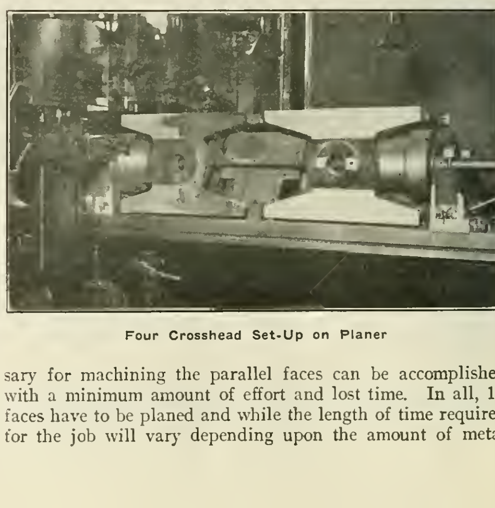
Device to Facilitate Applying Superheater Unit Bands

head over the rivets which are backed against jaw *J* of the holder. The device is light in weight, costs little to make and is successful in operation.

Planing Large Crossheads

THE operation of planing parallel faces on unusually large crossheads is shown in the illustration. In this particular case four cast steel crossheads 36 in. long by 10 in. wide and 21 in. between guide faces, are machined at one time on a four-head planer. The crossheads are lined up on dummy piston rods in order that all faces may be parallel with the bore for the piston rod. The method of supporting the dummy piston rods, also the blocking arrangement between crossheads is shown in the illustration.

It is apparent that with this arrangement the lining up and blocking of these crossheads in the four positions necessary for machining the parallel faces can be accomplished with a minimum amount of effort and lost time. In all, 12 faces have to be planed and while the length of time required for the job will vary depending upon the amount of metal



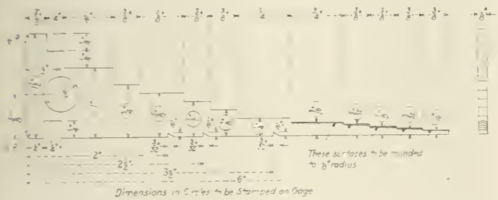
Four Crosshead Set-Up on Planer

to be removed and toughness of the castings, 9½ hours may be accepted as a good average time including the time of set-up. The planer is motor driven so that it is somewhat difficult to tell exactly what cutting speed is used but the best results can be received with a speed of approximately 30 ft. per min.

Pit Inspector's Clearance Gage

By E. A. Miller

THE illustration shows a valuable gage supplied to locomotive inspectors and inspection pits where locomotives are examined after coming in from their runs. The gage has proved its value as an aid in locating possible defects which should be remedied before the locomotives are again placed in service. Inspectors are also supplied with a list of instructions, a copy of which is shown in the



Locomotive Inspector's Gage

accompanying table, so that the various uses of the gage will be fully understood. After a little practice in using the gage, the different clearances will be firmly fixed in the mind of each inspector who can quickly determine whether the wear on any given part is within the required maximum and minimum limits.

The gage is made of ⅛ in. steel, the dimensions enclosed in circles on the drawing being stamped on the gage. The gage is both easy to carry and use.

INSTRUCTIONS FOR USE OF PIT INSPECTOR'S GAGE.

Dimensions Inches	Where Used
1/16	Minimum Clearance, Pedestal Type Truck Side Bearing.
	Maximum Wear of Front End Main Rod Brass on Pin.
3/32	Maximum Wear of Back End Main Rod Brass on Pin.
1/8	Maximum Side Play in Main Rods.
	Minimum Clearance, Crown Tender Truck Side Bearing.
5/32	Maximum Wear of Main Side Rod Bushing (Road Engines).
3/16	Maximum Vertical Wear in Crosshead.
	Maximum Wear in Side Rod Bushings. All Pins, Switching Service and All Pins Except Main Pin on Road Engines.
	Maximum Clearance in Rear Tender Truck Side Bearing on Pedestal Type Truck (Wallis Truck) and Crown Truck.
¼	Maximum Lateral Play in Crosshead.
	Maximum Lateral Play in Side Rods.
	Minimum Thickness of Tender Journal Collars.
	Minimum Clearance, Rear Tender Truck Side Bearing.
5/16	Maximum Tire Tread Wear for Road Engines.
3/8	Minimum Clearance, Front Tender Truck Side Bearing.
	Maximum Clearance, Rear Tender Truck Side Bearing.
	Maximum Driving Wheel Tire Tread Wear Switching Engines.
½	Maximum Clearance, Front Tender Truck Side Bearing.
⅝	Maximum Side Play in Not More Than One Pair of Driving Wheels.
¾	Truck Center Plates.
1	Lateral Motion Engine Truck Wheels (Swing Center).
	Lateral Motion Trailer Truck Wheels.
	Minimum Height of Driving and Trailing Wheel Tire Flange (Road Engines).
1½	Lateral Motion, Engine Truck Wheels (Rigid Center).
	Maximum Variation in Heights of Engine and Tender Deck Plates.
	Maximum Height of Tire Flanges.
2	Minimum Clearance in Hand Holds.
2½	Minimum Clearance Between Rails and Ash Pan and Foundation Brake Gear.
3½	Minimum Clearance Between Rails and Pilot.
6	Maximum Clearance Between Rails and Pilot.

SWEDISH RAILWAYS are using peat briquettes as fuel for locomotives. The Railway Board has acquired plant at Hasthagen bog, near Vislanda, with a capacity of 30,000 tons per annum, and a new method for treating peat on a large scale has been adopted.—The Times (London) Trade Supplement.

Increasing Welding Speed

By H. R. Pennington

Supervisor Electrical Equipment and Welding, Chicago, Rock Island & Pacific

ONE of the most important questions facing the advocates of fusion welding is that of finding methods of increasing the speed of arc welding. Welding speed on a given section is fundamentally dependent upon the rate of metal deposition and the amount of metal required to effect the jointure. The first factor—rate of metal deposition—varies with the energy required to liquefy the electrode material, arc stability, current density, etc. The amount of metal which must be applied obviously depends upon the type of joint and opening necessary to effect fusion between the edges or members to be joined.

The size electrode and arc current value that can be used seem to be limited only by the thermal capacity of the base metal or joint. That is, the heat or arc current and electrode diameter can be increased until the molten metal of the weld area becomes difficult to control, or until the effect of expansion and contraction becomes an obstacle.

One of the principal obstacles encountered in the past on attempting to use large diameter electrodes, was the poor welding qualities of such materials. With ordinary large diameter bare electrodes, a violently sputtering arc, throwing out metal in all directions, is a common occurrence at arc current values exceeding 200 amperes, and at 300 amperes the disturbances render the arc control very difficult and extremely uncomfortable. No doubt one reason for this is the fact that the beneficial effect to the welding characteristic incident to drawing of electrodes in wire form are not present to the same extent in large diameter electrodes or what would commonly be classed as rods. These disturbances and poor welding characteristics of large electrodes generally resulted in inadequate penetration and ununiform fusion.

If the electrodes are coated a quite stable arc will be secured, permitting welding with metallic arc up to 500 amperes with adequate penetration, uniform fusion and with a considerably lower electrode current density than that required for bare wire.

As a working basis for comparison, the rate of deposition for the usual size bare electrode and that of ¼-in. coated, both of mild steel grade on ½-in. plate wire were determined with the following results:

Elec. dia	Arc amps.	Lb. elec. consumed per hr.	Ft. per hr., single fillet lap weld	Lb. of elec. per ft. of fillet	Elec. current density
5/32 in. bare	150	2.3	6.8	0.33	7,850
¼ in. bare	300	7.7	10.4	0.74	6,220
¼ in. coated	300	8.09	18.6	0.43	6,220

It will be noted that the increased speed of ¼-in. bare over 5/32-in. bare is not in proportion to the increased arc current. The increased pounds of electrode material per foot of fillet is due to the excessive amount of metal loss in passing through the arc.

The lower speed and rate of deposition of the ¼-in. bare as compared to ¼-in. coated is due to the difficulty of controlling a high current arc when using bare electrodes. Despite the greater amount of metal deposited, high current welding resulted in over a 100 per cent increase in speed of welding of a single fillet lap joint.

These figures were obtained under ideal conditions and could not be equaled in commercial practice, as further tests have proved. However, the relative speed between small diameter bare electrodes and large ¼-in. coated electrodes with high arc current will remain practically the same. An additional factor to consider in using large electrodes is the fact that the time required to consume a large electrode is greater than that for a small one and therefore the percentage of welding time is actually increased. This load cycle should be given consideration when determining the capacity and basis of ratings of welding units for large electrode welding.

Experiments with high currents and large electrodes with exceptional penetration qualities, indicate that the speed of butt welding can be increased by 100 per cent over present practice, especially since by using deep penetration electrodes the amount of scarfing necessary would be greatly reduced, if not eliminated, on plate thickness up to ⅜ in. A reduction in the amount of scarfing is also desirable where high arc currents are used, in order to increase the thermal capacity of the joint.

The lap joint offers greater advantages, however, for large electrode welding than the butt joint, as the lap joint possesses inherently the requisite high thermal capacity and therefore permits a high energy concentration with an attendant high rate of fusion and deposition. In addition, lap joints with double fillet will permit the securing of 100 per cent weld strength without difficulty.

A recent check on pounds of metal consumed per hour, using ¼-in. mild steel coated electrodes with 240 amperes arc current, showed the rate of deposition to be six pounds per hour. These figures were obtained from actual shop practice on locomotive frame welding and include time for considerable cleaning necessitated by applying successive layers in a vertical position.

From the foregoing it is clear that the limit of speed and rate of metal deposition has by no means been attained in present day practice, but in order to permit the use of higher arc currents, the electrical resistance of the electrodes must be decreased by an increase of electrode area. Otherwise, difficulty of arc control will be experienced, due to overheating of electrode.

Attention has been drawn to the possibilities in this direction in order that those contemplating the adoption or extension of arc welding may give consideration to high arc current welding, which from present indications will be increased to at least 300 amperes for a great majority of the work now done with arc current values not exceeding 200 amperes.

A Comparative Test of Bare and Coated Welding Electrodes

In a comparative test of bare and coated welding electrodes, recently conducted in an industrial plant, a material increase in the amount of metal deposited per unit of power consumption and per unit of time, together with a marked decrease in the percentage loss of metal were found to accompany the use of coated electrodes.

The first two tests consisted of welding together two pieces of ⅜-in. tank steel plates the edges of which had been beveled to facilitate the welding. In the first test 5/32-in. bare electrodes were compared with 5/32-in. coated electrodes of two grades, designated as No. 1 and No. 6. In the second test ¼-in. electrodes were used. A third test was made using 5/32-in. coated electrodes in welding together two pieces of cast iron plate. In each case the plates and the wire were weighed before and after the test on a scale weighing accurately to one-half ounce to determine the loss of metal; time was taken with a stop watch and power consumption measured by an Esterline curve drawing watt meter.

Comparisons of the two types of electrodes from the standpoint of metal deposited per hour and per kilowatt hour and the metal loss per pound deposited are set forth in the table. All of the tests show an advantage for the coated wire in the matter of metal deposited per kilowatt hour and also per unit of time. If the metal deposited by the 5/32-in. bare electrodes be considered 100 per cent, then that deposited by the 5/32-in. coated electrodes showed increases of 22 per cent for the No. 1, 69 per cent for the No. 6 on the steel plate and 43 per cent for the No. 1 on cast iron. Comparing in the same manner the ¼-in. coated electrodes used on steel plate with the ¼-in. bare electrodes, the No. 1 coated showed an increase of 10 per cent in the amount of metal deposited per unit of power consumption while the No. 6 coated electrodes showed an increase of 44 per cent.

RESULTS OF COMPARATIVE TESTS OF BARE AND COATED ELECTRODES

Test No.	Electrode	Pounds of Electrode: Lost by vapor, etc., per lb. deposited	Pounds of Electrode: Deposited per hr.	Pounds of Electrode: Deposited per kwh.	Kwh. per lb. deposited	Hours per lb. deposited
I	5/32″ Bare	.43	1.543	.336	2.97	.65
I	5/32″ Coated No. 1	.00	1.875	.407	2.45	.534
I	5/32″ Coated No. 6	.00	2.560	.568	1.76	.391
II	1/4″ Bare	.38	2.76	.368	2.72	.362
II	1/4″ Coated No. 1	.09	2.85	.405	2.47	.351
II	1/4″ Coated No. 6	.00	3.79	.541	1.85	.264
III	5/32″ Coated No. 1	.00	2.19	.481	2.08	.457
Average for bare electrodes		.40	2.15	.352	2.84	.506
Average for coated electrodes		.018	2.76	.479	2.12	.384
In favor of coated		.382 lb.	.61 lb.	.127 lb.	.72 kwh.	.122 hrs.
Advantage of coated electrodes in per cent		95.5	28.4	36.1	24.4	24.1
Saving in dollars per lb. deposited at 9.25 cents per lb.		$0.0353	....	...	*....	†...

* At 3 cents per kwh. equals $0.0216.
† At 65 cents per hr., equals $0.0793.
Total, $.1362.

Comparing the metal deposited per unit of time in the same manner, increases of 22 per cent and 46 per cent respectively for the No. 1 and No. 6 coated electrodes on steel plate and 42 per cent for the No. 1 electrode on cast iron, were shown as compared with 5/32-in. bare electrodes on steel plate. A similar comparison for the ¼-in. electrodes showed increases of 3 per cent and 38 per cent respectively for the No. 1 and No. 6 coated electrodes as compared with the bare electrodes, all tests being made on steel plate.

Throughout the tests it was observed that with coated electrodes there was less sputtering and throwing off of metal, that the metal flowed more evenly and uniformly, that the arc did not jump off to one side and that the operator could hold the arc for a longer time than with the bare electrodes. No loss of metal in the vapor of the arc or by sputtering could be measured for the 5/32-in. coated wire but this was probably due to the fact that the scales used were not fine enough. Observation of the tests showed that there was some loss even though the scales did not show it. The advantage of the ¼-in. wire over the 5/32-in. wire is clearly shown in the table; that is, more metal can be deposited in a given time by ¼-in. electrodes with practically the same power consumption per pound as required for the 5/32-in. wire.

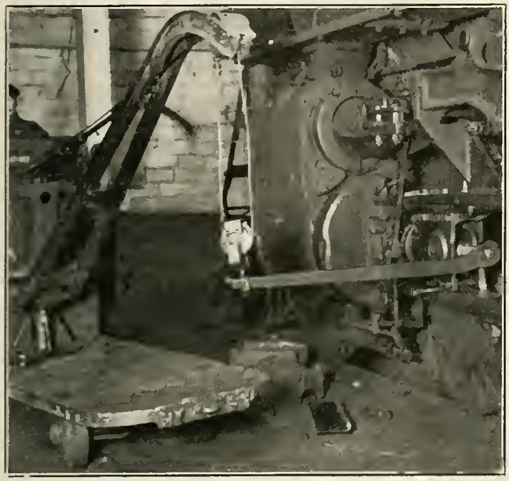
The outstanding advantage of the coated electrodes is most clearly shown in the saving of metal lost in the arc and by sputtering and to this fact are largely due the other advantages demonstrated.

A Versatile Crane Truck

No one can deny the advantages of storage battery trucks equipped with power-operated swing cranes. They are extremely effective labor-saving devices and new ways of using them are continually developing.

One uncommon use of this type of storage battery truck, shown in the illustration, is credited to D. P. Carey, general foreman of the New York, New Haven & Hartford at the Dover street roundhouse, Boston, Mass. The Dover street terminal is an extremely busy one, turning on an average of 140 passenger locomotives every 24 hours to handle trains in and out of the South Station, Boston. Locomotives are given running repairs at this point and if something happens to be the matter with the cylinder packing, for example, an inspection cannot be made until the piston rod is disconnected from the crosshead and the piston removed. In order to disconnect the piston some form of piston puller is used which, in the illustration, consists of a false wrist pin drilled and tapped to receive a 2¼-in. screw, the latter being squared on one end and arranged to be turned by a 5-ft. wrench fitted to that end.

In operation it was formerly the practice to remove the crosshead key and apply the piston puller, the services of



Elwell-Parker Truck Assists in "Pulling a Piston"

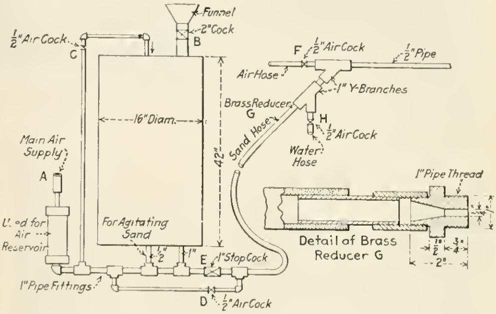
three or possibly four men being required to pull up on the wrench handle, thus tightening the screw and pushing the piston rod out of the crosshead. This operation can now be performed by one man holding the wrench and another operating the storage battery truck. The swinging crane pulls up on the wrench handle with a greater force than could be exerted by all the men who could get hold of it. A little reflection will show that in order to pull the piston on the right side of a locomotive, it is necessary to have another piston puller with a left handed screw. In pulling up on the wrench handle the truck crane will then revolve the screw to the left and force out the piston rod.

Scaling Boilers with Sand Blast

Through the courtesy of George McCormick, general superintendent motive power of the Southern Pacific at San Francisco, the following description and drawing of an hydro-pneumatic sand blast for cleaning boilers is published.

As shown in the drawing the device consists of a 16-in. by 42-in. tank which can be mounted on a four-wheel truck for easy movement about the shop. Suitable hose connections are provided to the air supply and water supply, the latter being used to keep down the dust. Air is furnished from the shop mains through flexible hose *A* to the line of 1-in. pipe and fittings beneath the tank. An auxiliary ½-in pipe is connected to the top of the tank and admits air through valve *C* on top of the sand. The tank can be filled with sand through the funnel and valve *B*. Valves *D* and *E* are located in the lower pipe lines as shown and a ½-in. pipe to the bottom of the tank facilitates keeping the sand in agitation so that it will readily fall through the 1-in. pipe to the moving air column. Air and sand are delivered through the flexible hose, brass reducer *G* and two Y branches to the ½-in. pipe which the operator uses in directing the final flow of air, sand and water. The blast is given force by means of air through valve *F* and water is admitted through valve *H*.

In operation the tank is filled with dry screened sand and valve *B* closed. With main air pressure on the tank



Tank and Apparatus Used in Sand Blasting

sand falls on the rapidly moving stream of air which carries it to the blast nozzle. The reducer *G* has a tapered hole (¼ in. at the smallest diameter) which automatically controls the amount of sand. The sand is moistened with water through valve *H* to keep down the dust and is finally ejected by the independent air hose connection at valve *F*. The strength of the blast and the amount of moisture are regulated by suitable adjustments of the respective valves. Valve *D* should be kept wide open to prevent water running back through the sand hose when valve *E* is shut.

Cautions for Bath Tempering*

Some of the cautions to be observed in bath tempering are:

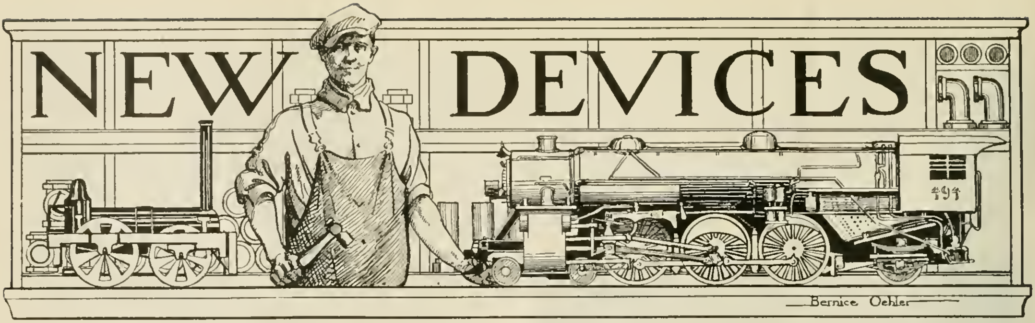
First never place the tool in the bath when it is extremely hot without first preheating the part. This applies especially to the salt and lead baths.

Second, always see that the piece is free from moisture, or splattering will result. Last, do not remove the tool immediately upon the bath reaching the desired temperature. Let it soak and be thoroughly penetrated with the heat, which must never go above the determined temperature.

Tool Tempering Temperatures

Color	Temperature	Tool
Faint yellow	420 deg. F.	Steel and wood engraving Hammer faces Paper cutting knives
Light yellow	440 deg. F.	Milling cutters Shear blades Rock drills Screw dies
Straw	[illegible] deg. F	Dies and punches Reamers Stone cutting tools Brace bits
Deep Straw	480 deg. F.	Twist drills Taps ½ in. or over Cold metal saws
Brown yellow	500 deg. F.	Axes Dental instruments Drifts
Full purple	540 deg. F.	Cold chisels Hack saws Rivet sets
Full blue	560 deg. F.	Battering tools in general Small taps
Very dark blue	600 deg. F.	Screw drivers Saws for wood Springs

*From the Melting Pot, Chicago Flexible Shaft Company.



Twenty-Inch High Duty Drilling Machine

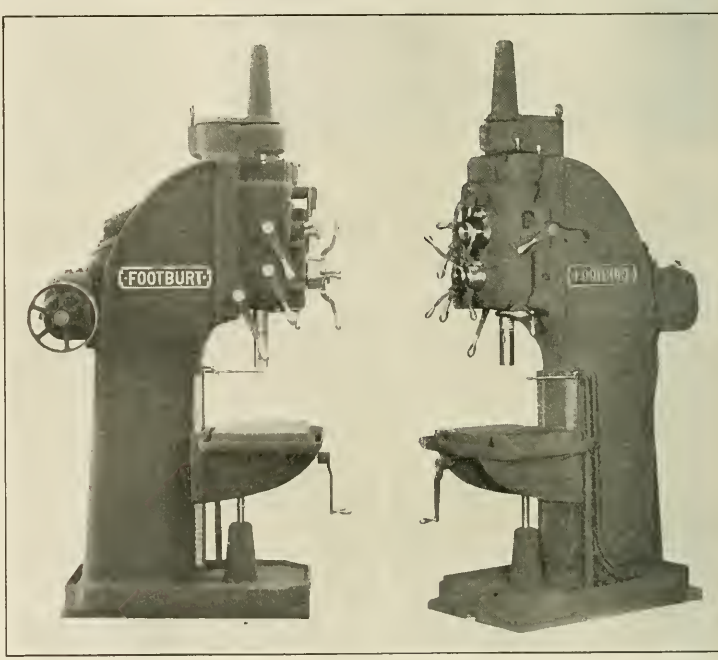
SIMPLICITY is the keynote in the design of the 20-in. high duty drilling machine illustrated. There are no loose brackets or other bolted-on devices on this machine, which has been placed on the market recently by the Foote-Burt Company, Cleveland, Ohio. All parts are readily accessible for inspection and adjustment. No telescoping screw is required under the table, a single screw permitting a vertical table adjustment of 12 in. without the necessity of providing a hole in the floor. All operating levers are easily controlled from the operator's working position in front of the machine.

The arrangement of the head and upright is such as to permit bolts to be in shear instead of in tension. Thus the bending stresses due to present extremely high drilling pressures are taken by the rigid upright, which is also reinforced by the head. It is claimed that this method of construction is far better suited to the modern practice of using high speeds and heavy feeds than the construction in which the upright is split horizontally at the point of maximum stress. Base, upright and jack screw supports are all cast integral which further adds to the rigidity of the structure. All gears and other driving mechanism are of unusually heavy construction.

There is but a single pulley drive, through a friction clutch, no countershaft being required. Nine instantly available spindle speeds and three feeds are provided. Speed and feed changes are made through sliding gears of heat treated steel, no clutches or sliding keys being used. Helical type driving gears to the spindle, which is counterbalanced by means of a weight, transmit power to the tool evenly and smoothly, and an exclusive double-rack feed eliminates side friction on the spindle sleeve. All driving shaft bearings are of the Hyatt or taper roller bearing type, the Hyatt type being used for radial loads and the taper roller bearing for combined radial and thrust. A heavy ball bearing takes the spindle thrust.

All parts of the feeding and driving mechanism are entirely enclosed, the speed change gears running in an oil bath and the feed gears being lubricated by means of a positive splash oiling system. The upper driving helical gears and their bearings are packed in grease, a sufficient supply being stored in the cap to last several months.

The machine drills holes up to 1½ in. in diameter in solid steel. The distance from the center of the spindle to the face of the column is 10 in.; the maximum distance from the nose of the spindle to the top of the table is 25⅝ in.; the length of power feed is 12 in.; the spindle has a No. 4 Morse taper and the size of the table working surface is 20 in. by 16 in.; the vertical adjustment of the table is 12 in. The three feed changes are .006 in., .012 in. and .026 in., and the nine spindle speed changes, 75, 100, 125, 155, 210, 260, 360, 490 and 610, respectively. The driving pulley is 12 in. by 2¾ in. and it has a speed of 500 r.p.m. The net weight of the machine is 2,700 lb.



Two Views of 20-In. Heavy Duty Drill Featured by Simplicity and Rugged Construction

Full Automatic Engine Lathe Development

A LINE of engine lathes, entirely automatic in action, which take the work from a magazine, grip it, turning one or more diameters simultaneously, and eject the finished piece independent of an operator, has been placed on the market by the Pratt & Whitney Co., Hartford, Conn. The machine, which is illustrated in Fig. 1, is designed for quantity production, handling cut lengths of bar stock or forgings that must be turned on centers. As the operator has but to replenish the magazine and keep cutting tools in proper condition, he may readily tend to a battery of machines, the number of which is dependent on the length of cut and amount of stock removed.

The general features of the engine lathe are present in this machine. Centers are provided upon which work is mounted while being turned; a driver rotates the work; a carriage is provided with the usual cross slide adjustments and tool post, in which may be inserted any form of standard tools. In place of the lead screw a drum cam is employed for the carriage traverse. This cam, as well as all other cams on the machine, is mounted on a heavy shaft extending the entire length of the bed. Adjustable dogs are provided which may be arranged to produce the proper length of cut on the work in hand.

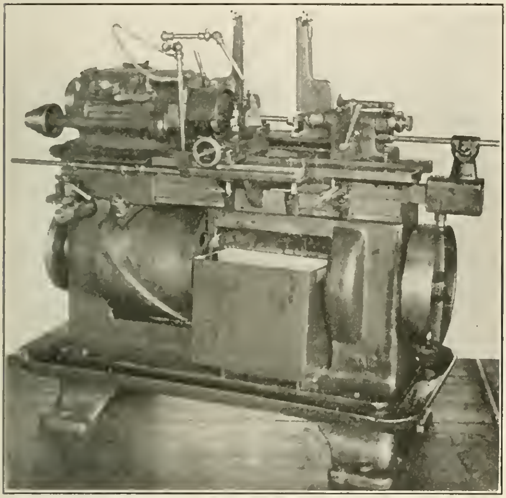


Fig. 1—Pratt & Whitney Automatic Engine Lathe

The carriage is mounted on an extended portion of the front ways of the bed, thus leaving an unobstructed space through which the work drops from the centers when released to the removable can below, shown in Fig. 1. A jointed taper bar, mounted on a bracket in front of the carriage, connects by engaging rolls with the cross slide of the carriage, thereby enabling taper work to be turned or continuous cuts, partly taper and partly straight, to be made. By the substitution of suitable former bars irregular forms may be turned.

These machines are built in two sizes and are fitted with either a cone or geared head drive. Fig. 1 shows a front view of the larger machine equipped with a geared head. Provision is made for bolting a motor on the rear of the machine when an individual drive is desired. Work is fed into the machine from a magazine mounted on a supporting bracket attached to the rear of the bed. The magazine consists of two uprights adjustable towards and from each other to accommodate short and long work. Two guides on each upright are adjustable to suit different diameters. The lower piece of work in the magazine rests on work carriers as shown in Fig. 2 and is held in place by yielding fingers that depress and allow the carriers to withdraw after the work has been placed upon the centers. A friction joint is placed in the train of levers actuating the magazine feed mechanism so that in case of accidental displacement of the work the mechanism will not be damaged.

Method of Operation

The sequence of movements is as follows: The carrier moves forward presenting the work in alinement with the centers, the footstock center then moves up, pushing the work between the jaws of the driver or chuck and in contact with the live center. The carrier then withdraws and the next piece of work drops into place on the fingers. The driver grips the work and the carriage moves the tool to the cutting position. The cam shaft has two speeds and the foregoing movements all take place during the high speed rotation, therefore lost time is reduced to a minimum. Adjustable dogs mounted on a cam located at the headstock of the machine provide a means for timing the cam shaft to suit the length of cut.

The driver or chuck is provided with three cam-shaped jaws that open by friction, operated by a cam mounted on the cam shaft. The jaws close on the work through the action of coil springs when the friction is relieved. The hardened contact surface of the jaws is so shaped that the greater the resistance caused by the cuts the harder the jaws will bite. The smooth contact surface of the jaws prevents scars on the work. The mounting of the chuck on the spindle nose provides lateral freedom, thereby eliminating any side strain on the centers. Slight variations in length of work and depth of center holes is taken care of by a slip ring actuating the footstock spindle to insure pressure on the work before the spindle is clamped.

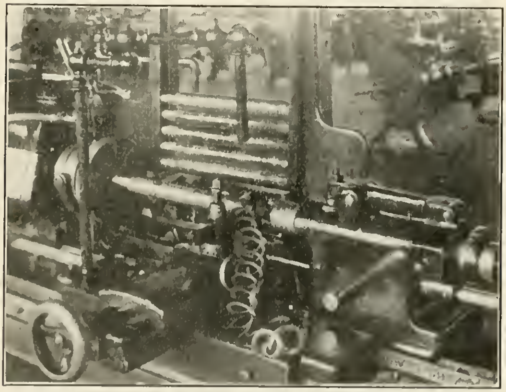


Fig. 2—Close Up View of Automatic Lathe in Operation

The tool being advanced to cutting position, the speed of the cam shaft changes from fast to slow and the turning operation is carried through to completion. At this point the cam shaft is again speeded up; the chuck is opened; the tailstock spindle withdrawn and the work dropped out. The carriage is then moved to the extreme right of its travel and a new piece of work is presented to the centers. The geared head machine has four spindle speeds, direct drive, and four reduced speeds through back gears. Four changes of feed for each spindle speed are provided on the large machine and three on the smaller one.

The hand lever at the extreme left of the bed in Fig. 1 provides means for shifting the cam shaft from fast to slow or vice versa, at the will of the operator. The same lever serves to disengage the power feed entirely to allow for hand manipulation when setting up. The squared shaft located below the lever is engaged by a hand crank for the purpose. Convenience in set up is a feature of these machines, making them practical for turning small numbers of pieces. The supply of cooling compound is assured by a geared pump chain driven at a constant speed. The tank located below the pan is mounted on rollers to facilitate cleaning.

These automatic lathes are said to have passed the experimental state, their prototype having been in constant use for many years at the builder's shops, turning blanks for taps and reamers.

The maximum and minimum lengths of work accommodated are 15 in. and 3¼ in. respectively, the maximum and minimum diameters are 1⅛ in. and ½ in. respectively; the maximum traverse of the carriage is 12 in. A 2-hp. motor is required to drive the heavier machine.

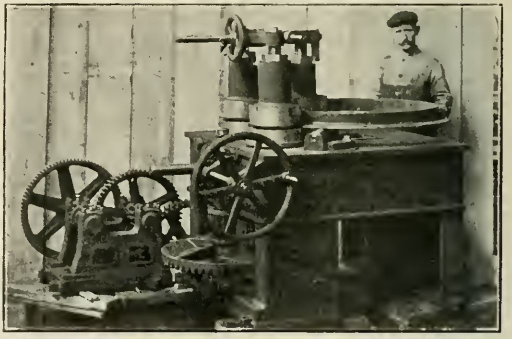
Bending Angles and Other Structural Shapes

FOR bending angles, beams, channels and other shapes, the Hercules power bending machines produced by Amplex, Inc., New York, have capacities for angles 3 in. by 3 in. by ⅜ in., up to 8 in. by 8 in. by 1 in. Hand-driven machines are made in sizes which will bend angles 2 in. by 2 in. by ⅜ in., up to 3 in. by 3 in. by ½ in.

The variety of forms in which structural shapes occur has made the design of a machine to bend any shape difficult. The Hercules machine, it is claimed, meets all the requirements of strength and simplicity of operation. The bar to be bent runs horizontally into and out of the machine so that even the largest sections can be handled by a simple roller trestle.

The bending is done while the metal is cold so that heating apparatus is unnecessary. Universal rolls are fitted which will take care of the bending of large or small sections, whether the legs of the shape are to come on the inside or outside of the curve.

This type of machine, by means of a slight adjustment, will bend right or left hand curves as desired. Reverse curves can be made in the machine without taking the angle or other shape out of the machine for adjustment.



Hercules Angle Bending Machine

Spiral and Curvex Hob-Grinding Attachment

A TOOLROOM grinder attachment has been developed recently by the R. K. Le Blonde Machine Tool Company, Cincinnati, Ohio, designed to grind spiral hobs increased feeds and faster cutting speeds. The problem of accurately grinding Curvex cutters is said to be successfully met with this attachment which is designed for application

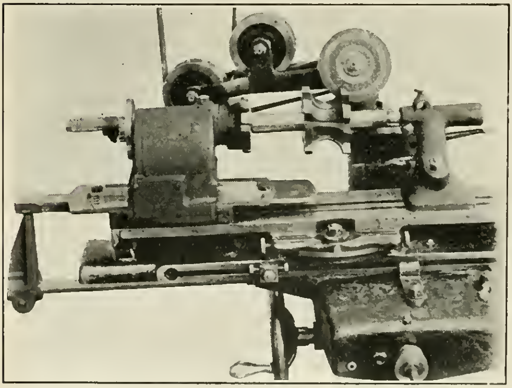


Fig. 1—Hob-Grinding Attachment for Le Blond Tool Room Grinder

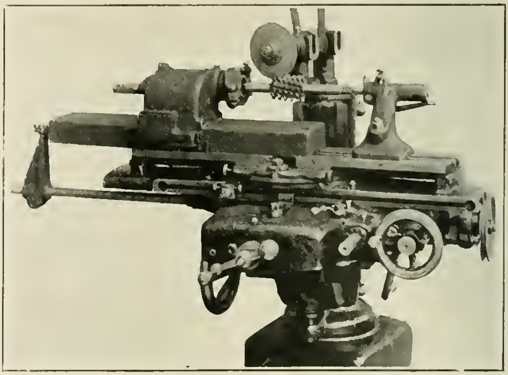


Fig. 2—Attachment as Used for Grinding Spiral Hobs

and the new line of Pratt Whitney Curvex cutters. The latter are spiral, formed, milling cutters giving a shearing cutting action and smooth finish which makes possible the use of to Le Blonde universal toolroom grinders but can be adapted to use on similar toolroom grinders if desired.

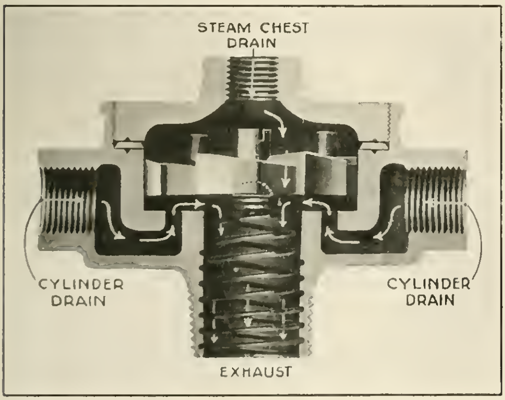
Referring to Fig. 1 the cutter to be ground is mounted on an arbor between the centers of the attachment; the machine table is set to zero; and from the chart of leads and angles furnished. the taper guide bar of the attachment is set to the required angle. As the table of the grinder is set horizontally the cutter spindle is automatically revolved in the proper relation to lead and spiral angles, which is stamped on each cutter by the manufacturer. The cutter is indexed, successively bringing each tooth to the grinding plane by means of the plunger and indexed plate shown. This is much more accurate than the uncertain method of using a tooth rest supporting the back of the tooth being ground.

The wheel head is mounted on an angular raising block, giving the wheel spindle an angle of 15 deg. from the horizontal spindle line. A special wheel is used, the front face of which is dressed vertically. This insures a single line of contact between the wheel and work and enables the work to be fed vertically on to the wheel to the depth of the tooth, eliminating any possibility of drawing the temper by attempt-to grind the entire tooth depth at one traverse of the table. The knee is swiveled on the stump to an angle corresponding to the helix angle of the cutter and the table reciprocated past the wheel by the regular rack and pinion movement. This takes place while the work is being rotated in proper relation to the lead and spiral angle. The attachment is so designed that the grinding plane is always on a true radial line of the cutter, and the wheel always clears itself in the work. The utility of this attachment is not limited to grinding curvex cutters or spiral hobs but it can be used advantageously on any work requiring regrinding on the face of the teeth.

For grinding spiral hobs the angular raising block and belt sheaves are not required and the attachment can be purchased simply as a hob grinding attachment omitting these parts as shown in Fig. 2.

Automatic Drain and Relief Valve

An automatic drain and relief valve for steam pipes and cylinders has been developed by the Diel-More Sales Company, Philadelphia, Pa. These valves have proved satisfactory for draining locomotive air compressors; stoker engines; steam brakes; steam pipes for electric headlight turbines, blowers and other connections; cylinders of



Automatic Drain and Relief Valve for Both Ends of Steam Cylinder

locomotive cranes, pile drivers, and steam shovels; stationary engines and pumps, and steam hammers.

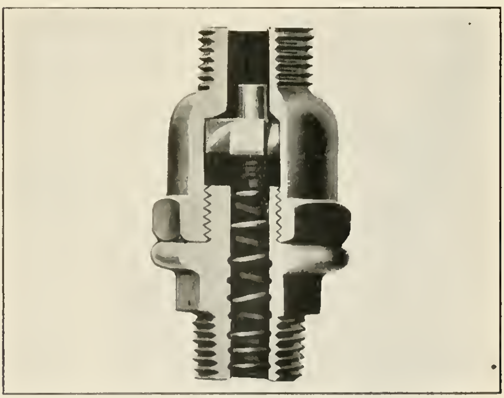
The valves can be obtained with steam connections ranging from 1/4 in. to 1 in. and of single, double or four-ported type; the double-ported type for ordinary single-cylinder engines and the four-ported type for duplex cylinder engines.

In the double-ported type the two end connections are piped to the cylinder cock openings, the valve being centrally located at any convenient point below the cylinder. The upper connection should be piped to the drain connection of the steam chest or to any point in the steam line between the throttle valve and the engine. The bottom connection is for carrying off the condensed water and may be piped to the most convenient drainage point. It is this type which has been used for duplex air compressors; one connection being made to the high pressure and the other to the low pressure cylinder. The four-ported type is the same as the double-ported type, except that it has provision on the body for four horizontal connections for the drainage of both cylinders of a duplex engine.

As will be noted from the illustration the valve is of simple design and contains only one moving part, the disc valve. When the engine is shut down the spring raises the disc valve and opens both ends of the cylinder to the drain pipe and also permits any condensed water in the steam pipe or steam chest to flow through the grooves at the circumference of the disc to the same drain connection.

When the throttle is opened the accumulation of pressure on top of the disc forces it down and closes all openings. Should excess pressure accumulate in either end of the cylinder, due to priming or other causes, the pressure on top of the disc will be over balanced and the valve will then be lifted.

A feature that should not be overlooked is the fact that the valve is self-grinding. This is accomplished by making



Automatic Drain Valve for Steam Pipes

the upper part of the disc of such a shape that when the steam is turned on the disc is given a rotative motion.

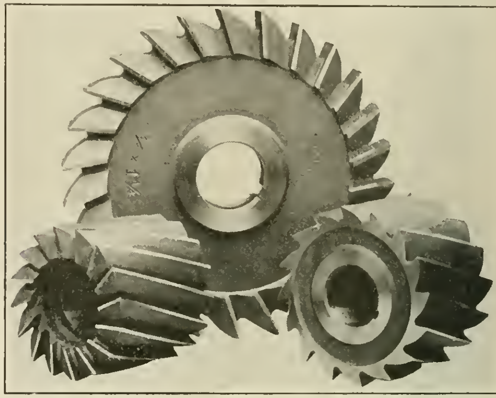
The lower end of the spring is enlarged and screws into a threaded groove in the valve body. By screwing the spring up or down there is obtained a considerable range in pressure against the disc. The upper end of the spring is closed in and fits a button on which the valve can rotate with little resistance.

The single connection valve is similar in construction and operation. It has been found to be well fitted for automatically draining locomotive blower pipes, also steam pipes to electric headlight turbines, and any other place where hand operated drain cocks are commonly used to prevent accumulation of condensed water with the possibility of damage from freezing if they are not used.

Milling Cutters Designed for Production

After extensive experimental research work, covering different phases of design and operation, the National Twist Drill & Tool Company, Detroit, Mich., has placed on the market a new type of milling cutter, known as the Parabolic cutter, designed to reduce production costs. Conflicting theories in cutter design were either proved or disproved by practical application to production work and it was decided that in order to make a milling cutter tooth of uniform strength throughout its length, its shape should be that of a parabola slightly modified at the small end.

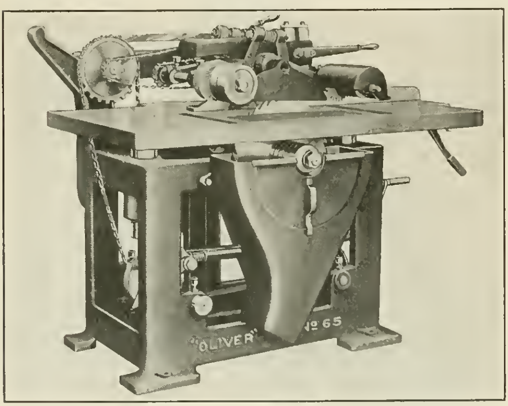
The number of teeth used is nearer to that of the conventional fine tooth cutter than to that of the coarse tooth type. In order to get the most efficient chip thickness per tooth without excessive peripheral speed a fairly large number of teeth was found desirable. Parabolic cutters are made in plain-side and end-mill types as well as for special purposes. The increased interest of railroad shop men in milling as an efficient method of performing many machine operations on locomotive parts makes the subject of cutter selection important at the present time. Among other types the Parabolic milling cutter will receive careful attention.



National Parabolic Milling Cutters

Safety Features Incorporated in Rip Saw

A self or power feed rip saw, placed on the market recently by the Oliver Machinery Company, Grand Rapids, Mich., has been designed with special attention to safety features. In addition, the dust chute is so arranged as to be readily connected to the exhaust system and thus eliminate flying sawdust which would otherwise accumulate on the floor or possibly get in the operator's eyes and cause trouble.



Rip Saw Equipped with Guards and Dust Chute

The machine is designed for ripping all kinds of lumber and is adapted to the ripping of rough as well as finished stock. The saw arbor is mounted on a frame, having a vertically adjustable table with an infeed spur roller, made corrugated or smooth according to the requirements of the work going into the machine. This roller carries stock through the saw and across the top of the table. The machine will take saws up to 18 in. in diameter and cut stock 5 in. thick by 24 in. wide.

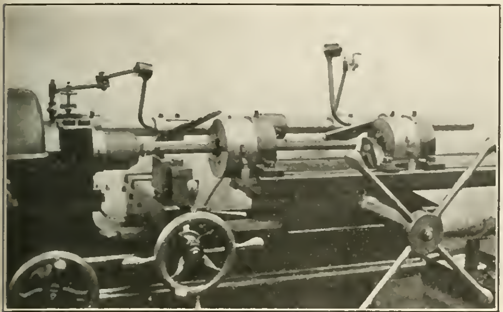
A gang of six saws with one inch space collars may be used at one time if desired and in this case, the machine is practically a gang rip saw and can produce strips at a minimum cost. Three rates of speed, 50 ft., 110 ft. and 140 ft. per min. are obtainable. Among other special features the machine has quick acting adjustment to feed rollers, quick action to adjustment and locking of ripping fence, quick raising and lowering adjustment of table and powerful and rapid feeds. Stock with ¾ in. difference in thickness can be sawed without readjusting the feed rolls. A mechanism for absorbing shocks on the feed rolls overcomes any jerks on starting stock through the machine, a feature tending to increase the life of the machine.

The lower portion of the saw is thoroughly guarded by means of the dust chute and the cover, the upper portion running in a guard carried by the feed mechanism. The star feed and the infeed roll are covered by a metal guard, thus making accidents while feeding the machine practically impossible. The table is 33½ in. wide by 56 in. long, being vertically adjusted by a lever locking cam. The saw arbor has five lubricating chambers which assures ample lubrication of the bearings.

The machine may be arranged for motor drive if desired. The regular equipment furnished with the machine includes one 16-in. saw, saw guard, feed spur, spur guard, swivel, one sectional outfeed roll group plain and one sectional outfeed roll group corrugated; also filling collars and sawdust chutes.

Staybolt Threading Attachment for Turret Lathe

STAYBOLT and crownstay threading, especially in repair shops, can be handled with less loss of time and without tying up two different machines by means of the staybolt threading machine illustrated, which has been designed for that purpose by the Warner & Swasey Company, Cleveland, Ohio. The new staybolt machine is made up of the



Warner & Swasey Crown, Button Head and Swivel Staybolt Threading Machine

standard Warner & Swasey No. 4 turret lathe with a special attachment instead of the regular turret slide and saddle. When not used for staybolt threading, the regular turret slide and saddle may be replaced instead of the staybolt attachment and used for the production of the many miscellaneous studs and bolts which are found necessary in railroad shops.

This machine handles crown stays, button head stays and swivel stays up to 40 in. in length and for any size of thread, because larger or smaller self-opening die heads may be used to answer the requirements of the particular shop in which it is installed.

Present day practice seems to lead principally toward the use of upset forgings and also toward the use of an increasing number of taper head staybolts. In a recent demonstration test button heads as shown in the picture were taper formed under the head and the thread cut on the end and under the head at the rate of one a minute.

In operation, the rough forging is passed through the back of the forward die head for insertion in the square collet in the automatic chuck. The die has an enlarged hole in the shank and the chasers have an especially large opening movement to pass the button head which was used in the demonstration.

After being chucked, the staybolt carriage is fed forward until the end of the bolt is supported in the steady-rest between the two heads. The head end is formed by a forming cutter on the cross slide while the other end is supported in the steady-rest. Then the staybolt carriage is fed forward, the die heads operated by the cams on the rear bar close automatically and cut the threads.

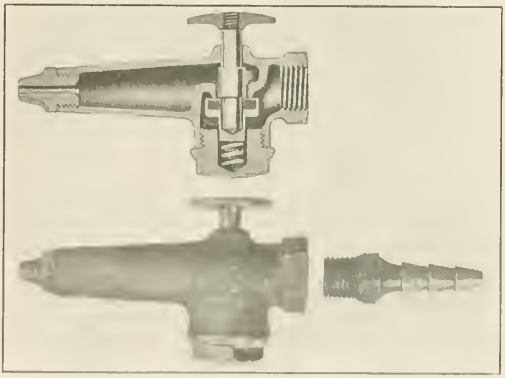
As soon as the die heads reach the end of the cams both die heads open. The cams may be made to cut any type thread desired, as the action of the head is dependent upon the contour of the cam. The carriage is then brought back and is ready for the next staybolt.

Air Gun Designed to Prevent Waste of Air

EVERYONE is familiar with the more or less wasteful methods of using compressed air about shops, foundries and mill rooms owing to lack of appreciation by many shop men that it costs money to compress air. One common method of wasting air is in the use of a ½-in., or larger, flexible hose attached to the shop air line just back of a valve which controls the supply of air. When for any reason it is necessary to blow off some machine part or casting, for example, the operator turns on the valve admitting air to the hose and after directing the blowing operation from the end of the hose goes back to the valve and shuts it off again.

The above method results in considerable waste of air which it is proposed to prevent by means of an air gun recently designed and placed on the market by Jenkins Bros., New York. An assembled and cross sectional view of this valve is shown in the illustration, giving a good idea of the construction. The main advantage claimed for the valve is economy in the use of air. By means of the small tip no more air than necessary is allowed to go through the valve and the control of the air supply is by means of the button immediately under the hand of the operator. In other words, the air can be started or shut off directly at the work while the valve is held in one hand and without going to a wall or post to operate the globe valve which is commonly used.

The Jenkins air gun is simple and is said to be durable in construction with an entire absence of complicated parts likely to get out of order. It is designed to hold tight under pressure, and quickly respond to a pressure of the button which freely emits the air. The renewable disc is made especially for air service and forms a durable contact for the seat taking up automatically the wear due to frequent usage. The disc can be quickly and easily renewed if necessary.



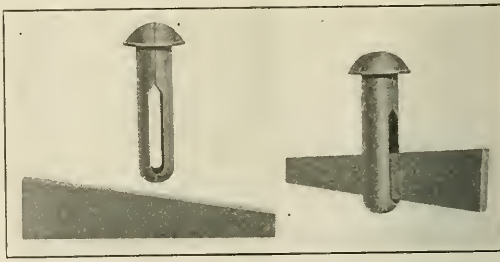
Jenkins Air Gun Featured by Air Economy and Control Button Located at Nozzle

These valves are made of bronze and are adaptable to use in foundries, machine shops, mill rooms and wherever air is used for blowing purposes.

Key-Bolts Prove Useful in Car Repair Work

THE illustration shows a type of key-bolt developed by the Key-Bolt Appliance Company, Buffalo, N. Y. and used for holding sheet metal plates together while being riveted. The particular advantage of this key-bolt is that it can be placed through two corresponding rivet holes and the sheets brought together quickly and firmly by one or two blows on the taper key. Two key-bolts will hold the sheets in correct alignment while rivets are being driven when a single blow of the hammer releases the taper key and allows the key-bolt to be knocked out or removed with the fingers. The common method of using short bolts and nuts is open to the objection that more time is required both when tightening the nuts to bring the plates together and when backing off the nuts after the rivets have been driven. It is stated that one large erecting contractor recently completed a tank job putting up 50 tons of steel a day with an estimated saving of $1.50 a ton due to the use of key-bolts.

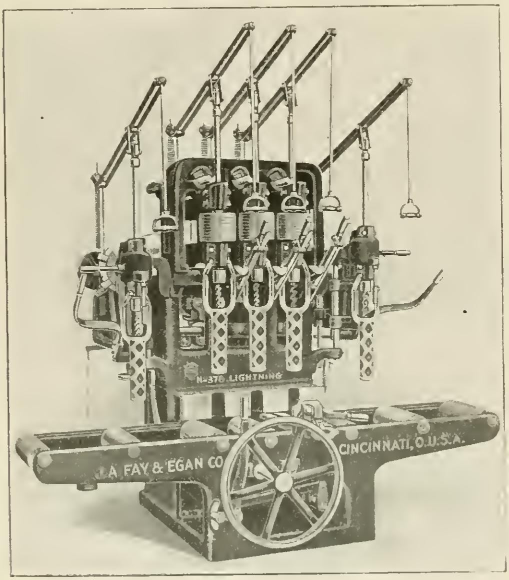
The key-bolts are made of high carbon steel, will stand much more abuse than threaded bolts and may be expected to save considerably in labor cost. The bolts are made in 30 different sizes as follows: ½-in. bolts in five lengths from 1¼ in. to 2½ in.; ⅝-in. bolts in six lengths from 1 in. to 3 in.; ¾-in. bolts in six lengths from 1¾ in. to 4 in.; ⅞-in. bolts in six lengths from 1¾ in. to 4 in.; and 1-in. bolts in six lengths from 1¾ in. to 4 in. Taper keys to correspond are furnished.



Key-Bolts for Holding Sheet Metal Plates Together While Being Riveted

Multiple Car Borer for Heavy Work

A MULTIPLE car borer adapted to heavy boring work in railroad car shops has been developed recently by J. A. Fay & Egan Company, Cincinnati, Ohio. The latest model (No. 378) of this high duty machine, shown in the illustration, is designed particularly for safety in operation, economy in power consumption and maximum output. It is made in three styles, A, B and C, with stationary table and power-driven rolls, stationary table and idle rolls and traveling table (when 14 ft. or longer), respectively. All styles are regularly made with three spindles but can be furnished with one or two auxiliary spindles as desired. The machine is entirely self-contained and can be belted from any direction or direct-coupled to a motor.



Fay & Egan Car Borer with Two Auxiliary Spindles

Timbers up to 15 in. by 15 in. in cross section can be bored, the largest hole being 3 in. in diameter. The depth of stroke is 16 in., the distance center to center of the spindles being 9 in. and the transverse movement of the spindles 15 in.

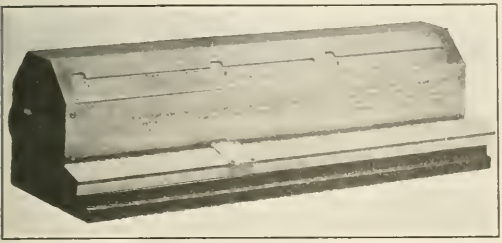
The column of this machine is a heavy, one-piece, cored casting, designed to resist the stress imposed upon it and eliminate vibration. The stationary table is 9 ft. long, 22 in. wide and 25 in. high. The type A size has seven 5-in. rolls, four of which are power-driven at 150 ft. per min. The table on the B type is the same size and has seven 5-in. rolls all of which are idle. The traveling table is made of steel I-beams, regularly 14 in. long, 22 in. wide, 25½ in. high and travels at 120 ft. per min. If desired, the machine can be connected in series with a mortiser and gainer, having one continuous traveling table. The traveling table is under constant control of the operator. Adjustable stops are provided to regulate the position of the holes and close adjustment can be made by means of the large hand wheel operating a rack and pinion. All types of tables are fitted with quick action clamps.

The spindle housings are mounted on ball bearings and spindle sleeves are fitted with centering take up bushings. The main spindles are driven by one continuous endless belt, an automatic gravity take-up binder being provided. Auxiliary boring spindles are furnished on either the right or left, or both sides of the machine as ordered. These spindles have a stroke of 15½ in., a transverse movement of 15 in., a vertical adjustment of 8 in., and are adjustable to an angle of 45 deg. to the inside and 30 deg. to the outside.

Aluminum boring guards are furnished when ordered and prevent the operator's clothes from catching in the revolving bit, at the same time in no way interfering with the efficient operation of the machine. Wire mesh belt guards can also be provided. The countershaft is self-contained in the machine and has 14-in. tight and loose pulleys designed to run at 900 r. p. m. A 10-hp. motor is recommended. The equipment regularly furnished with the car borer includes 16 augers from 7/16 in. to 2 in. in diameter having 16 in. twist.

Machine Time Calculating Device

THE illustration shows a calculating device brought out by the Simplex Calculator Company, York, Pa., and designed to cover the general machine tool field as it is applicable to use on either rotating or reciprocating work or tools. As illustrated, the calculator consists of a cylinder within an aluminum case and a slide rule of special design, attached to an extension of the base. For use in connection with rotating work or tools, such as lathe, boring mill, drill press or milling operations, the cylinder carries tables indicating revolutions per minute for diameters from ¼ in. to 10 ft. at all ordinary cutting speeds. The range of speeds is shown above the slot on the left end of case.



Simplex Machine Time Calculator

The number of revolutions per minute of a given piece of work is read in the slot opposite the diameter, directly under the cutting speed selected. This number is transferred to the rule, which bears four scales, indexed successively feed, r. p. m., length, and time. Locating this number on the r. p. m. scale of the slide, it is moved directly under the number representing the feeds per inch on the feed scale. The indicator is then moved along the third or length scale to the number representing the length of cut or inches to be traversed. Directly under this number, on the fourth scale, the result or time in minutes is read. Thus all the operations necessary to complete a problem for rotating work or tool requires but one setting of the cylinder, one movement of the slide and one movement of the indicator on the rule.

In connection with planer, shaper, slotter, or any other reciprocating tools, the procedure is quite similar. The square inches planed per minute at various forward and return speeds and feeds are read on the cylinder through the slot on right hand end of case. After determining the total number of square inches of surface to be planed, by multiplying the length by width, (either mentally or by the use of the rule) it only remains to divide this number by the square inches planed per minute. With one setting of the slide on the rule the quotient, or time required, is read on the fourth scale under the end of slide.

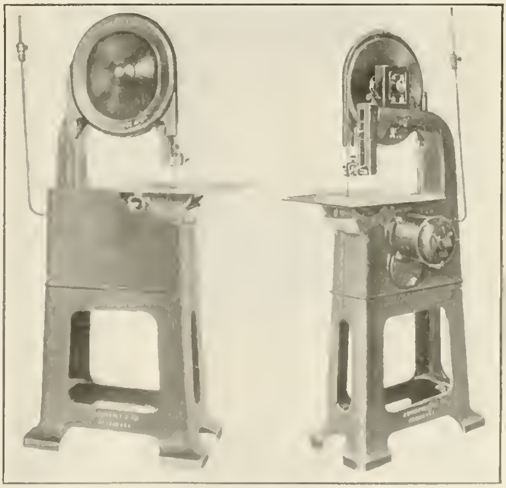
This instrument was designed primarily for rate setters, estimators, and those whose duties require the daily or frequent predetermination of time for machine-operations. It is a convenient desk size, being about 16 in. in length and not over 3 lb. in weight. With its use it is claimed that pencil calculations are practically eliminated, computing time greatly reduced, and chance for errors minimized. It is readily used by anyone familiar with the practical machine tool operations. The extent to which this machine time calculating device can be used in railroad shops remains to be seen but everyone familiar with conditions must admit that there is need for more accurate knowledge regarding actual cutting feeds, speeds and production time.

Sixteen-Inch Motor-Driven Band Saw

A BAND SAW driven by a self-contained electric motor has been placed on the market recently by J. T. Wallace & Company, Chicago. This saw is equipped with disc steel wheels which are both durable and accurate and have a large factor of safety. Ball bearings are provided throughout including the upper and lower roller guides, the saw bearing on the periphery of the rollers. A special feature is the totally enclosed electric motor, built into the machine and direct-connected to the lower wheel by a fabroil gear and steel pinion. The gears run in oil to insure adequate lubrication and a quiet running machine, centrifugal force throwing oil into the bearings and keeping them well lubricated at all times.

The saw table is a ground steel plate 19 in. by 21 in. in size, mounted on a large rocker bearing adjustable to any angle from 45 deg. to minus 5 deg. An indicator is provided to show the angle at which the table is tilted. All adjustments are controlled by hand-wheels or thumb screws without the use of special tools, and this feature is one of considerable importance because it makes the machine easy to handle and increases the production.

The height of the new 16-in. Wallace bench band saw is 5 ft. 9 in. overall; the table is 42 in. from the floor; and the floor space required is 15 in. by 29 in. Power is furnished by a ½-h.p. General Electric ball-bearing motor running at 1,750 r.p.m. The saw runs at 3,150 ft. per min. Safety guards are built into the machine and are a standard part of it. The blades used are especially made for this machine, being treated and cut so as to provide the greatest number of producing hours on this size of wheel.



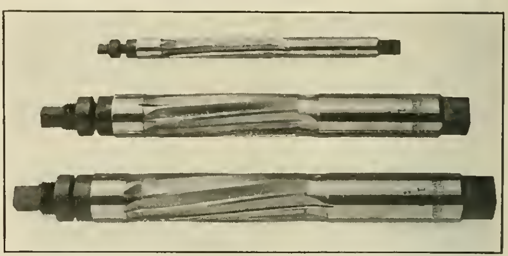
16-In. Wallace Band Saw With Direct Motor Drive

Spiral Fluted Expansion Hand Reamers

THE Pratt & Whitney Company, Hartford, Conn., has added to its line of small tools a spiral fluted expansion hand reamer. Expansion reamers have always found favor because of their long life and the adjustable feature that permits covering a range of sizes with one tool. Oversize or undersize holes can be reamed by simple adjustments. The advantages of the spiral flute with its free and clean cutting characteristics are obvious.

All reamers are equipped with lock nuts to hold the size and safety stops which prevent over-expansion and indicate positively when the maximum limits have been reached. Three sizes of spiral fluted expansion hand reamers are shown in the illustration, including ½-in., 1-in. and 1⅛-in. These reamers are made in all the regular sizes.

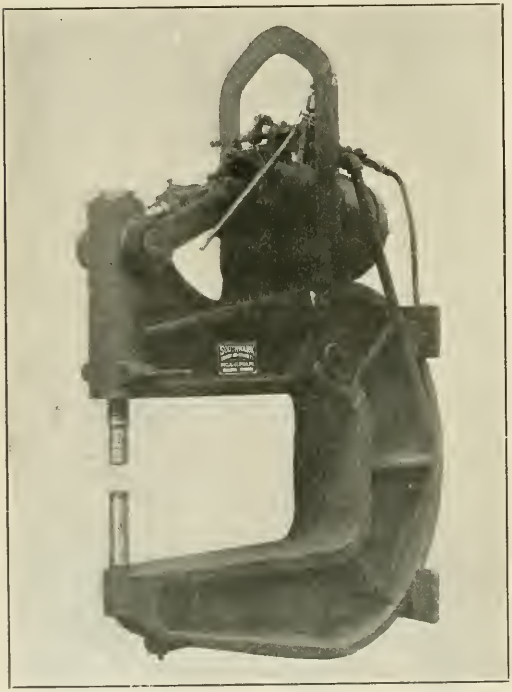
The spiral flutes afford a distinct advantage in reaming holes having keyways in them. The straight flutes catch and bind on the edges, but the spiral continuous shearing cut rides safely over the corners assuring a hole cut to size.



Pratt & Whitney Spiral Fluted Expansion Hand Reamers

Portable Toggle-Type Pneumatic Riveter

FOR portable service, pneumatic toggle-type compression riveters have been found well adapted, while hydraulic riveters are generally used in stationary work where machines of deep reach are needed. The following explanation is given of the action of the toggle arrangements on pneumatic compression yoke riveters built by the Southwark Foundry & Machine Company, Philadelphia, Pa., which especially adapts them to portable service. Riveters are made by this company in sizes from 15 tons up to those developing 150 tons on the die and having a reach of 23 ft.



Southwark Portable Pneumatic Riveter

The toggle mechanism is designed to act rapidly until the die reaches the point of the rivet when it gradually decreases in speed and at the same time increases the pressure exerted on the rivet. The die travel is practically uniform toward the last of the operation and thus ensures driving tight rivets, drawing the plates together and following up the shrinkage of the rivet with full pressure until it is set. The die should be adjusted for any run of work so that the rivet is headed when the piston has moved through three-quarters of its stroke. This allows a sufficient travel of the die at full pressure on either side of this position to take care of variations in subsequent rivets; i. e., in lengths of rivets, thickness of plates, dimensions of holes, etc., without further adjustment of the die screw.

The operating valve of this riveter is of the plain slide valve type requiring but one simple wick packing on the stem and having a removable seat for ready regrinding. It is further provided with means for using line pressure in the pull-back, thus producing a two-pressure machine without changing the air pressure. These riveters are designed to develop two separate pressures on the rivet die by simply turning a plug cock in the valve plate admitting air at full pressure in the full-back area, thus reducing the pressure to the next lower standard tonnage rating. For example, a standard 50-ton machine is arranged to develop both 30 and 50 tons on the die; a 75-ton machine develops both 50 and 75 tons on the die; a 100-ton machine, both 75 and 100 tons on the die. This eliminates the use of such special equipment as pressure regulating valves, auxiliary storage battery tanks, etc.

All compression riveter frames are of steel castings of I-beam section, a section found satisfactory for small machines, as well as for those of deep reach since the torsional stress or twisting moment due to side thrust of the dies is negligible and more than offset by the saving in weight to be effected in portable machines.

Error in Drill Press Description

The new No. 6 heavy duty drill press, made by the Colburn Machine Tool Company, Cleveland, Ohio, was described on page 112 of the February *Railway Mechanical Engineer*, an error occurring in the fourth paragraph of the second column. In this paragraph reference is made to the illustration as showing the drill press equipped with a plain table. This statement is obviously incorrect as the machine illustrated has a compound table.

GENERAL NEWS

The Central of Georgia reports that for the 12 months of the last calendar year 98.7 per cent of its passenger trains maintained schedule time.

The New York, New Haven & Hartford reports the total number of passenger trains run in 1921 as 505,853, of which 91.1 per cent were on time.

The Western Maryland has let to W. K. Hosier the contract for the operation of its repair shops at Elkins, Va. About 100 men have been employed at these shops.

Passenger trains moved over the Pacific system of the Southern Pacific during 1921, averaged 93.4 per cent on time at destination. This is an increase of 3.4 per cent over 1920.

The National Automobile Chamber of Commerce reports that there are now 35 railroads using motor cars, including 12 roads that have busses equipped with flanged wheels for use on tracks.

The Detroit Edison Company has recently put into service at one of its Detroit heating plants a boiler having more than 29,000 sq. ft. of heating surface, the largest in the world. Its rating is in excess of 2,900 hp.

The American Society for Testing Materials, C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Twenty-fifth annual meeting at Chalfonte-Haddon Hall, Atlantic City, N. J., during the week beginning June 26, 1922. The first day will be devoted to committee meetings and the convention will open on Tuesday morning, June 27, closing on Friday evening, June 30, or Saturday morning, July 1.

A report has recently been issued by the chief inspectors of the Bureau of Locomotive Inspection, Interstate Commerce Commission, giving the results of an investigation of an accident to Pennsylvania Railroad locomotive 2599, which occurred at Gould Mine, Pa., December 6, 1921. The report states that the accident, which resulted in the death of the locomotive engineer, was caused by grooving of the outer firebox sheet directly above the mud ring in conjunction with fractures of the staybolts in the adjacent area.

M. C. Hutchins, state fire warden in Worcester county, Mass., at a recent conference in Worcester said that the New York, New Haven & Hartford and the Boston & Albany were responsible for a large increase in the number of forest fires in Massachusetts last year. He said that there were more fires along the lines of these companies than ever before due to the fact that the right of way was not looked after and the locomotives not properly cared for. One New Haven locomotive set eight fires on one run last spring. One of these fires cost the road nearly $25,000.

A new thawing shed has just been put in service at the Pennsylvania Railroad coal terminal, at South Amboy, N. J., where coal for New York City and the Atlantic Seaboard is delivered to boats. This shed accommodates 20 cars at one time and cost about $100,000. It is 448 feet long and contains two tracks. The cars being placed inside the shed, the doors are locked, and air is forced by powerful blowers over steam radiators and heated to between 200 and 250 degrees. It is forced through long concrete ducts which have outlets underneath the cars, located at intervals of about six feet. The thawing takes from one to twelve hours, the average time being about three hours.

A new record for riveting, which it is believed has never been equalled by anyone on the railroad or by shipyard riveters during the war, has been established by L. M. McNeil, a Pennsylvania Railroad mechanic employed in the car shops at Altoona, Pa. During the month of December, 1921 Mr. McNeil with two other members of his riveting gang, a holder-on and a heater, drove an average of 1,544 rivets a day (eight hours). The maximum number driven in any one day (nine hours) was 1,981. The gang averaged on the day of maximum output practically four rivets per minute throughout the day. They averaged three and two-tenths rivets for every minute they worked during the month of December.

American Foundrymen's Association

Final arrangements have been made for holding the annual convention and exhibit of the American Foundrymen's Association and allied societies in Rochester, N. Y., the week of June 5, instead of in Cleveland as previously announced.

Wage Reductions in Britain

Under the sliding scale of wages in Great Britain, whereby railway wages are increased or decreased in accordance with the cost of living index number, wage rates suffered a further decrease of from 2 to 6 shillings ($.50 to $1.50) per week, effective January 1, according to the Railway Gazette (London).

Car Surplus

There was a marked decrease in the freight car surplus for the week ended January 31, 1922, according to the reports of the Car Service Division of the American Railway Association, the total standing at 330,681 cars, or 65,511 cars less than the figure of the previous week.

Swedish Electric Locomotives for France

The Allmänna Svenska Elektriska Aktiebolaget—the well known "A. S. E. A."—has recently secured a contract from the French State Railways for construction of 30 electric locomotives at the company's works at Vasteras, according to information from Consul D. I. Murphy, at Stockholm.

British Company to Build Locomotives in Austria

According to an Associated Press dispatch appearing in the New York Times, the Vickers-Armstrong Company, a British concern, has made an offer to the Austrian government for the Woellersdorf Arsenal. The British company, it appears, wishes to turn the arsenal into a plant for the manufacture of locomotives.

Additional Directors of A. R. A.

Additional directors of the American Railway Association, to enlarge the board, have been elected as follows; for the term expiring November, 1924, Julius Kruttschnitt, Southern Pacific; for the term expiring November, 1923, E. E. Loomis, Lehigh Valley; for the term expiring November, 1922, Howard Elliott, Northern Pacific.

Shop Construction

Chicago, Rock Island & Pacific.—This company has awarded a contract to the Miller Heating Company, Chicago, for the installation of a boiler washing system in its roundhouse at Chickasha, Okla., estimated to cost approximately $30,000. A water treating plant will also soon be installed in connection with the above.

India to Order Railway Equipment Once a Year

The Government of India, it is reported, beginning with the year 1923, will invite bids annually for all the railway locomotives and stocks required during the ensuing twelve months. The average annual requirements will be 160 locomotives and 160 additional boilers during 1923 and 1924, and thereafter 460 locomotives and 460 additional boilers.

Wage Statistics for October

The Interstate Commerce Commission's summary of wage statistics for October indicates an increase of 35,806 in the number of employees as of the middle of the month compared with September. The total compensation increased $12,630,137, making a total of $237,602,959 for a total of 1,754,736 employees. The report for the Detroit, Toledo & Ironton is not included.

German Railway Strike Ended

The strike on the railways of Germany has ended, the workers returning on the sole condition that there will be no wholesale discharges from the service. For a week transportation was virtually paralyzed and there seemed to be a grave danger of a general strike. The government fought the strike with every means available and the outcome would seem on its face to be a government victory.

Proceedings of the American Welding Society

The first monthly issue of the proceedings of the American Welding Society, dated January, 1922, has recently been published. The proceedings are 6 in. by 9 in. in size and the first number contains 44 pages. Copies of each issue will be mailed to each paid-up member.

A regular program has been laid out for the proceedings and each issue will contain editorials, news of the various local sections, activities of the American Bureau of Welding, a list of new members, an employment service bulletin, important technical papers presented to the society, a question and answer column, technical items of interest to the society and the industry, and a bibliography of current welding literature.

Labor Board Decisions

Employees Who Fail to Report for Work Not Entitled to Pay.—Two bridge and buildings mechanics on the Nashville, Chattanooga & St. Louis were temporarily out of service and notices sent to them concerning a newly organized paint gang were not received. When they did hear of these positions, they applied for them but were denied employment because the quota was full. The railroad recognized their seniority and stated that they would have been accepted if they had applied for the positions in time. The board denied the claim of the two men for pay during the time that this gang was in service. *Decision No.* 603.

Boilermaker Not Responsible for Violation of Federal Boiler Inspection Rules.—A boilermaker in the employ of the Fort Smith & Western, was dismissed on February 27, 1921, for alleged violation of rule 25 of the federal locomotive inspection laws. The employee contended that his dismissal should have been on the grounds of incompetency and not on the charge that he violated this rule. In its decision the Board stated that the evidence shows conclusively that the conditions on which the dismissal was based were entirely within the control of the carrier; that the employee in question was not the responsible party, and his reinstatement with seniority rights unimpaired and pay for time lost was ordered.

A dissenting opinion was filed by Horace Baker, in which he said: "In my judgment the responsibility for proper boiler inspection is a very important one that devolves upon the carrier, which must rely on its supervising forces to see that proper inspection is made. To absolve from blame a man who failed by reason of incompetency, neglect, or otherwise, to properly inspect boilers and report those which need attention, places a responsibility upon the Labor Board not contemplated by the Transportation Act, 1920. Action taken in this case is not only an injustice to the carrier, but may result in a serious menace to the public and employees of the carrier, to say nothing of damage to property."—*Decision No.* 598.

Method of Paying Roustabout Carpenters.—A roustabout carpenter on the Louisville & Nashville, with headquarters at Knoxville, Tenn., was engaged in miscellaneous repair work over a portion of the line. He was assigned to a certain carpenter gang but worked entirely without supervision except that he made material and work reports to the gang foreman at the end of each week. The railroad paid him on the basis of 10 hours a day at pro rata rates in accordance with Section *i* of Article V of the National Agreement. The employees contended that Section *m* of the same article was the one which applied in his case. Sections *i* and *m* are quoted below:

(i) Employees temporarily or permanently assigned to duties requiring variable hours, working on or traveling over an assigned territory and away from and out of reach of their regular boarding and lodging places or outfit cars, will provide board and lodging at their own expense and will be allowed time at the rate of 10 hours per day at pro rata rates and in addition pay for actual time worked in excess of 8 hours on the basis provided in these rules, excluding time traveling or waiting. When working at points accessible to regular boarding and lodging places or outfit cars, the provisions of this rule will not apply.

(m) Employees not in outfit cars will be allowed straight time for actual time traveling by train, by direction of the management, during or outside of regular work period or during overtime hours either on or off assigned territory, except as otherwise provided for in these rules. Employees will not be allowed time while traveling, in the exercise of seniority rights or between their homes and designated assembling points or for other personal reasons.

The Labor Board sustained the position of the carrier.—*Decision No.* 649.

Couplers Required Under Federal Law

The Circuit Court of Appeals, Seventh Circuit, holds that, under section 2 of the Federal Safety Appliance Act, couplers must be such that the act of coupling, as well as of uncoupling, can be accomplished "without the necessity of men going between the ends of the cars" (Johnson v. So. Pac., 196 U. S. 1, 25 Sup. Ct. 158), and that the act did not permit the use of a coupler which might require a brakeman to go on the track at the end of the car to open the knuckles, though the other train was some distance away. Offered evidence that it is impracticable to build couplers whose knuckles can always be opened by the lever extending to the side of the car, that no such couplers have yet been made, and that the defendant uses a generally approved type, was held irrelevant, the offer not professing to show that compliance with the statute is a mechanical impossibility. The Court says: "If the statute is harsh and is difficult to comply with, relief must come from the law-making, not the judicial, branch of the government."—Payne v. Colvin, 276 Fed. 15.

Passenger Car Orders

The Pennsylvania Railroad will build 20 all steel dining cars at its Altoona, Pa., shops.

The Union Pacific has ordered 25 steel baggage cars from the American Car & Foundry Company, and 20 coaches from the Pullman Company.

Freight Car Orders and Repairs

The Boston & Maine is having 1,000 box cars repaired at the shops of the Laconia Car Company.

The Pacific Fruit Express has ordered 2,600 refrigerator cars from the Standard Steel Car Company.

The Norfolk & Western is having 400 coal cars repaired at the shops of the Ralston Steel Car Company.

The Phillips Petroleum Company, Bartlesville, Okla., has ordered 60 insulated tank cars of 8,000 gal. capacity from the Standard Tank Car Company.

The United Fruit Company, New York City, has ordered 50 fruit cars of 20 tons capacity from the Magor Car Company. These cars are for use on the Tela Railway, Honduras.

The Delaware, Lackawanna & Western has placed orders for the repair of 700, 30-ton box cars with the Magor Car Company and for 500 with the American Car & Foundry Company.

The Philadelphia & Reading has divided an order for 2,000 cars equally between the American Car & Foundry, the Cambria Steel Company, the Pressed Steel Car Company and the Standard Steel Car Company.

The Great Northern has ordered 500 refrigerator cars from the General American Car Company, also 500 all-steel gondola cars from the Pressed Steel Car Company, and 500 stock cars from the Pullman Company.

The Seaboard Air Line, reported in the *Railway Mechanical Engineer* of February as having placed orders with the Chickasaw Shipbuilding Company, Birmingham, Ala., for new freight cars, has ordered 1,750 new steel underframe freight cars from this company and will have repairs made to 3,000 freight cars.

The Chicago, Burlington & Quincy has ordered 6,800 freight cars of the 7,300 on inquiry, distributed as follows: 1,000, 40-ton, steel frame box cars from the Mt. Vernon Car Manufacturing Company, 500 of this type from the Pullman Company and 500 from the General American Car Company; 500, 30-ton refrigerator cars with 40-ton trucks from the American Car & Foundry Company, 400 from the General American Car Company and 400 from the Pullman Company; 500 stock cars from the American Car & Foundry Company; 1,000, 50-ton composite gondolas from the Western Steel Car & Foundry Company, 500 from the Pullman Company, and 500 from the American Car & Foundry Company; and 1,000, 16 door, steel gondola cars from the Bettendorf Company.

MEETINGS AND CONVENTIONS

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

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City. Annual convention May 9, 10, 11 and 12, Hotel Washington, Washington, D. C.

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

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Next annual convention June 14 to 21, 1922, Atlantic City, N. J.

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

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

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

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, A. F. Stuebing, 2201 Woolworth Building, New York.

American Society for Steel Treating.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention and exposition September 25 to 30, 1922, Detroit, Mich.

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

Canadian Railway Club.—W. A. Booth, 53 Rushbrook St., Montreal, Que. Regular meeting second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal.

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

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

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Next meeting March 9, Hotel Iroquois, Buffalo, N. Y. Paper on Machine Tools for Car and Locomotive Departments will be presented by V. Z. Caracristi, New York City.

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

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio.

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

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich. Convention Hotel Sherman, Chicago, August 15, 16 and 17.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill. Next annual meeting Auditorium Hotel, Chicago, May 22 to 25, 1922.

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

Master Boilermakers' Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y. Next annual convention Hotel Sherman, Chicago, May 23 to 26, 1922.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting March 14, Copley-Plaza Hotel, Boston. Annual meeting election of officers and reports. Talk on Boston & Maine Y. M. C. A. Annual entertainment of club to be held at Copley-Plaza, April 11.

New York Railroad Club.—H. D. Vought, 26 Cortland St., New York, N. Y. Next meeting March 17.

Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Regular meetings fourth Thursday in each month, except June, July and August, at Fort Pitt Hotel, Pittsburgh, Pa.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo. Next meeting, March 10. Paper on Protection of Railroad Property by State Mounted Police.

Traveling Engineers' Association.—W. O. Thompson, Marine Trust Building, Buffalo, N. Y.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Regular meetings third Monday in each month, except June, July and August.

PERSONAL MENTION

GENERAL

T. F. Howley, special agent for the Erie, has been appointed superintendent of locomotive operation, with headquarters at New York.

Frederick A. Isaacson has been appointed assistant mechanical engineer of the Atchison, Topeka & Santa Fe, with headquarters at Topeka, Kan.

Charles Harter has been appointed assistant mechanical superintendent of the Missouri Pacific with headquarters at St. Louis, Mo., succeeding W. C. Smith.

M. W. Boucher, locomotive foreman of the Canadian Pacific, with headquarters at Field, B. C., has been appointed general locomotive foreman of the Edmonton, Dunvegan & British Columbia, with headquarters at McLennan, Alta. He will have direct supervision over both the mechanical and car departments, the positions of master mechanic and locomotive foreman having been abolished.

William C. Smith, whose appointment as mechanical superintendent of the Missouri Pacific, with headquarters at St. Louis, Mo., was announced in the February issue of the *Railway Mechanical Engineer*, was born at Detroit, Mich., on September 25, 1869. He entered railroad service in December, 1887 as a machinist's apprentice on the Missouri Pacific. He left in April, 1895, to enter the service of the Atchison, Topeka & Santa Fe as a machinist. In December of that year he returned to the Missouri Pacific as a gang foreman. He was promoted to shop foreman in September, 1897, and to division foreman in January, 1902, which latter position he held until January, 1905, when he was promoted to master mechanic. In July, 1912, he was promoted to general master mechanic and in September, 1915, to assistant mechanical superintendent, with headquarters at St. Louis, which position he was holding at the time of his recent promotion.

W. C. Smith

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

D. J. Durrell, master mechanic of the Pennsylvania, Southwestern Region, with headquarters at Cincinnati, Ohio, has been transferred to Lancaster, Ohio, succeeding R. J. Sponseller, who has been acting master mechanic.

A. B. Shanks, master mechanic of the Missouri, Kansas & Texas of Texas, with headquarters at Smithville, Tex., has been appointed master mechanic in charge of the newly created South Texas district, with headquarters at Waco, Tex.

G. Moth, division master mechanic of the Canadian Pacific, with headquarters at Edmonton, Alta., has been appointed to the advisory position of district master mechanic of the Edmonton, Dunvegan and British Columbia, with the same headquarters.

J. A. Conley, master mechanic of the Atchison, Topeka & Santa Fe, with headquarters at Calwa, Cal., has had his jurisdiction extended over the shops at Richmond, Cal., succeeding E. H. Harlow, formerly superintendent of shops, with headquarters at that point, who died on January 26, after which time his position was abolished.

CAR DEPARTMENT

H. K. York, car foreman of the Canadian Pacific, with headquarters at Alyth, Alta., has been promoted to general car foreman, with headquarters at Moose Jaw, Sask.

PURCHASING AND STORES

E. H. Gaines, Jr., has been appointed purchasing agent of the Tennessee Central, and will have his headquarters at Nashville, Tenn.

E. R. Brinton has been appointed general storekeeper of the Chesapeake & Ohio of Indiana, and of the Cincinnati division of the Chesapeake & Ohio, with headquarters at Covington, Ky. J. P. Kavanaugh has been appointed general storekeeper of the Eastern division of the Chesapeake & Ohio, with headquarters at Clifton Forge, Va. The position of inspector of stores has been abolished.

G. W. Bichlmeir, whose appointment as general purchasing agent of the Union Pacific, with headquarters at Omaha, Neb., was announced in the February issue of the *Railway Mechanical Engineer*, was born at Cincinnati, Ohio, on September 10, 1886. He entered railroad service in 1906 as a clerk in the office of the purchasing agent of the Cincinnati, Hamilton & Dayton (Baltimore & Ohio). In 1909 he left to become a clerk in the supply department of the Missouri Pacific at St. Louis, Mo., and the following year he was promoted to chief clerk to the division storekeeper at Osawatomie, Kan., which position he held until January, 1911, when he left to become chief clerk to the general storekeeper of the Kansas City Southern at Kansas City, Mo. Mr. Bichlmeir left railroad service in 1917 to engage in other business. He re-entered the employ of the Kansas City Southern in April, 1918, as chief clerk to the purchasing agent and, in August of the same year, he was promoted to assistant to the purchasing agent. He was promoted to purchasing agent with headquarters at Kansas City, Mo., in March, 1920, and in November of that year he left to become purchasing assistant of the Union Pacific, with headquarters at Omaha, Neb., which position he was holding at the time of his recent promotion.

G. W. Bichlmeir

Apprentices on Railroads and in Industries

In an article on the training of workers in manufacture published recently in American Machinist, J. V. L. Morris calls attention to the small number of apprentices in the metal working trades in this country. A survey of the enrollment of apprentices in various industries showed the following: In electrical manufacturing plants with 92,000 employees, there were 1,148 apprentices; in automobile plants with 67,000 employees, there were 1,122 apprentices; printing press manufacturing plants with 9,000 employees, had 223 apprentices; machine tool manufacturing plants with 14,400 employees, had 339 apprentices; in shipyards with 28,000 employees, there were 643 apprentices, and in locomotive manufacturing plants with 5,500 employees, 83 apprentices. Comparative figures for railroad shops are not available because the number of shop employees is not given. The total number of employees is stated as being 1,300 divided as follows: machinists and toolmakers, 795; electricians, 12; boilermakers, 175; sheet metal workers, 79; carpenters, 234; blacksmiths, 22; painters, 13. It is evident from this that very few workmen are being trained in railroad shops at the present time except in the machinist trade and that industries likewise have inadequate numbers of apprentices.

SUPPLY TRADE NOTES

M. C. Davidson, works manager of the Ryan Car Company, has been elected a director and second vice-president of the company.

Harry Frankel, president of the Frankel Connector Co., Inc., died at his home in New York City, on February 3, at the age of 55.

The Rathbun Jones Engineering Company, Toledo, Ohio, has appointed the Ingersoll-Rand Company, New York City, general sales agent for Rathbun gas engines.

George C. Ramer has been appointed manager of the new branch office of the Oliver Machinery Company, Grand Rapids, Mich., at 716 Lincoln Bank building, Minneapolis, Minn.

Pullman Company Reorganization

At a special meeting of the stockholders of the Pullman Company at Chicago, on January 14, the company was reorganized, following its absorption of the Haskell & Barker Car Company. John S. Runnells retired as president of the company and was elected chairman of the board of directors succeeding Robert T. Lincoln, and Edward F. Carry, president of the Haskell & Barker Car Company was elected president to succeed Mr. Runnells. Charles A. Liddle, vice-president of the Haskell & Barker Car Company and David A. Crawford, treasurer, were elected vice-presidents of the Pullman Company.

J. S. Runnels

John Sumner Runnels was born at Effingham, N. H., on July 30, 1844, and was educated at Amherst College, graduating with the degree of A. B. in the class of 1865. During 1868, he served as private secretary to Governor Merrill of Iowa. From 1869 to 1871, he was consul at Tunstall, Eng., returning to this country during the latter year and being admitted to the bar. He practiced law at Des Moines, Iowa, from 1871 to 1887, during which time he was a reporter for the Supreme Court of Iowa, and later United States district attorney. In 1887, Mr. Runnels was appointed counsel for the Pullman Company, and, in 1905, was promoted to vice-president retaining his duties as general counsel. He was elected president in 1911.

E. F. Carry

Edward F. Carry was born at Fort Wayne, Ind., on May 16, 1867, and was educated in the public schools of that city. He began his business career with the Wells & French Car Company at Chicago, and at the time of the consolidation of this company with the American Car & Foundry Company, was serving as secretary. He served the last named company successively as district manager, first vice-president, second vice-president, and first vice-president and general manager, a service extending over a period of 28 years. On January 1, 1916, Mr. Carry was elected president of the Haskell & Barker Car Company, which position he occupied at the time of his recent appointment.

C. A. Liddle

Charles A. Liddle, who has been elected vice-president of the Pullman Company, was educated in the public schools of Philadelphia, Pa., and entered business as an employee of the Allison Manufacturing Company at Philadelphia. Mr. Liddle later served the Jackson & Sharpe Company and the Harlan & Hollingsworth Company at Wilmington, Del., and the Pressed Steel Car Company at Allegheny, Pa. In 1901, he entered the service of the American Car & Foundry Company as an engineer. Later he was promoted to assistant to the vice-president and then to general manager, which position he resigned on January 1, 1916, to become vice-president of the Haskell & Barker Car Company, the position he occupied at the time of his recent appointment.

D. A. Crawford

David A. Crawford, vice-president of the Pullman Company, was born at St. Louis, Mo., on April 1, 1880. He was graduated from the University of Wisconsin in 1905, and for the following two years served as an instructor at the university. In 1907 he was appointed secretary to E. F. Carry, vice-president of the American Car & Foundry Company, and five years later was elected assistant secretary of the company. He was elected treasurer of the Haskell & Barker Car Company on January 13, 1916, which position he occupied at the time of his recent election, as above noted.

George W. Bender, formerly associated with Mudge & Co., has been appointed vice-president of the Argyle Railway Supply Company, Chicago. This company has opened offices in the Webster building, 327 S. LaSalle street, Chicago.

The Hauck Manufacturing Company, Brooklyn, N. Y., manufacturer of portable oil burners, furnaces, torches, etc., has moved its Philadelphia, Pa., office to 1726 Sansom street. Herbert Vogelsang, who has been connected with the company for six years, is in charge of this office.

Griffen S. Ackley, formerly from 1903 to 1909 president of the National Brake Company, Buffalo, N. Y., died in Brooklyn, N. Y., on January 23. Mr. Ackley sold his interests in the above company in 1909 and formed the Ackley Brake & Supply Corporation, with headquarters in New York City.

John Harvey Bryan, representative of the Apollo Steel Company, Apollo, Pa., manufacturer of steel sheets, has been appointed also representative of the Gulf States Steel Company, Birmingham, Ala., manufacturer of wire products and bars. Mr. Bryan's headquarters is at 50 Church street, New York City.

J. T. McGarry, vice-president of the American Valve and Meter Company, Cincinnati, Ohio, has been elected president and general manager, succeeding Wallace H. Gray, who has been elected chairman of the board of directors. C. F. Bastian has been elected secretary and treasurer of the same company, succeeding Dwight Marfield, resigned.

The Northern Refrigerator Car Company has been organized at Milwaukee, Wis., to operate 500, 40 ft. steel underframe refrigerator cars that are now being constructed by the Haskell & Barker Car Company, in addition to all of the cars heretofore operated by the Cudahy-Milwaukee Refrigerator Line, and the Peacock Refrigerator Line.

With the leasing of the Erie car shops at Youngstown, Ohio, to the Youngstown Equipment Company, W. W. Warner has resigned from the position of shop superintendent of the Erie to become manager of the Youngstown Equipment Company. Webster E. Harmison, master mechanic at Kent, Ohio, will have jurisdiction over all car department matters formerly handled by Mr. Warner.

Frank M. Morley has joined the service department field staff of the Franklin Railway Supply Company, New York City. He was born at Smithboro, N. Y., on January 31, 1884, and was educated in the public schools of Auburn, N. Y., and Sayre, Pa. After completing an apprenticeship in the Sayre, Pa. shop of the Lehigh Valley, he joined the Ingersoll-Rand Company. Mr. Morley has also been connected with the Seaboard Air Line, the United States Navy Yards at Norfolk, Va., the Washington Navy Yard and was at one time a field engineer for the Standard Stoker Company.

OBITUARY

Frank Solyman Dinsmore, for the last 24 years a member of the business department staff of the Railway Age, died at the Long Island College Hospital, Brooklyn, N. Y., at 1:30 on the morning of February 14, of chronic interstitial nephritis.

Frank S. Dinsmore

The end came sooner than was expected. On January 4, following advice of his doctor, Mr. Dinsmore sailed for the British West Indies in the hope that the warm climate would help nature, and that his life might thus be prolonged. But it was too late. By the time the steamer reached Barbadoes Mr. Dinsmore was too weak to disembark; so he came back, was taken to the hospital and there the spark of life gradually dimmed and then went out. With characteristic optimism, he scarcely realized the seriousness of his condition; and he passed away unconscious of the end and without pain.

Funeral services were held in Brooklyn, where he had lived, on the morning of February 16, after which the body was taken to Chicago. A second service was held at Rosehill Cemetery, Chicago February 18, after which the body was cremated.

Mr. Dinsmore is survived by a brother, a sister, a half-brother and a half-sister.

"F. S. D.," as he liked to be called and which he frequently applied to himself when reminiscencing, was born at Berlin, Wis., May 13, 1859. His father, a pioneer, treked by wagon from his birthplace in New Hampshire to northern New York, where he married before going West. At the age of 12, Frank, disgusted by his inability to convince his teacher that he was right in an argument when he was sure of the position he had taken, threw aside his books and went to work for his father, a maker of farm implements. In 1881 he made up his mind to study medicine; and for the next 16 years he so applied himself when not selling medical books to get money with which to pay his tuition fees. Thinking that his ambition to become a surgeon would be advanced thereby, he joined the staff of the Railway Surgeon in 1894, that paper being then published by the owner of the Railway Age. Three years later he transferred his affections to the latter publication and came to New York as its eastern representative. From that time to his death he was almost literally wedded to the Railway Age; because for it he lived and, in a sense, died—for he might have been spared longer had his devotion to his work not caused him to regard with contempt, until too late, the warnings he heard on every hand and of which he himself must have been convinced.

In trying to visualize another's character, it is not always easy to know just where to start. With Frank Dinsmore, he was, first of all, a philosopher, with characteristic calmness of temper and judgment and practical wisdom; to which should be added a natural love for his fellow man, gentleness, uprightness and loyalty.

Looking back over the last 24 years and applying to him those splendid attributes which were his, it is not hard to understand how, in the early days of the Railway Age, Frank Dinsmore, with his philosophical mind, an abiding faith in his mission and tireless devotion to duty, saved the day over and over again when the till was empty and the liabilities far exceeded the assets. At that time he might have advanced further along the road to material prosperity had he so willed; but instead he elected to stay in the niche he himself had selected, that his conscience might not be charged with lack of devotion to the man who had given him his job (the late Hugh M. Wilson) and to whom he had pledged his all.

Mr. Dinsmore's principal work was that of an advertising salesman; and therein lay the tangible measure of his pecuniary worth to this institution. But his employer values most what he did, by living example and fatherly advice, to help and encourage the younger men of the entire staff—business and editorial. When discouraged, he lifted them out of their depths; if he saw their jobs in jeopardy, he diplomatically and unobtrusively tried to awaken the sort of interest and ambition which would overcome the failing; and when they required a guiding hand, it was his that was always outstretched. And with his tribute to Mr. Dinsmore's immeasurable worth his employer of the last 14 years unstintingly links his own sense of obligation for the unswerving loyalty and devotion that was reflected in so many varied and delightful ways. With employer and co-workers alike, Mr. Dinsmore's death has created a vacancy that is real. Everyone who was intimately acquainted with him will have as his most lasting impression the beautiful example his living afforded. E. A. S.

Albert C. Ashton, treasurer of the Ashton Valve Company, East Cambridge, Mass., died on January 31, at St. Petersburg, Fla., where he had been for several weeks on account of ill health. He was born in England, 52 years ago and was a son of the late Henry G. Ashton, founder of the Ashton Valve Company. Albert C. Ashton graduated from Chauncey Hall School, Boston, and the Massachusetts Institute of Technology where he pursued a course in engineering. For over 20 years he had served as treasurer of the Ashton Valve Company and part of this time served also as general manager. Mr. Ashton took a constant and active interest in the local affairs of Somerville, Mass., where he had resided since his schoolboy days, and he was a member of many social and business organizations.

A. C. Ashton

TRADE PUBLICATIONS

Grease Cup.—The Realock grease cup is described and illustrated in a four-page leaflet recently issued by the Flannery Bolt Company, Pittsburgh, Pa.

Coaling Plant.—The Roberts & Schaefer Company, Chicago, has recently issued Bulletin No. 46 describing and illustrating in detail a new railroad coaling plant of substantial fireproof construction.

Boiler Tubes.—Illustrations and a detailed description of the manufacture of National and Shelby boiler tubes are contained in Bulletin No. 16D recently issued by the National Tube Company, Pittsburgh, Pa.

Motor Cars.—In a 20-page booklet recently issued by the Fairmont Gas Engine and Railway Motor Car Company, Fairmont, Minn., an interesting account is given of the Fairmont motor designed for application to section gang cars.

Pipe Machines.—Stoever pipe machines for cutting and threading steel or wrought iron pipe are illustrated and described in a neatly arranged booklet of 16 pages recently issued by the Treadwell Engineering Company, Easton, Pa.

Sprague Electric Dynamometers.—The Sprague Electric Works, New York, has published a well illustrated circular describing the construction, control and application of the research type of the Sprague electric dynamometer which is a highly accurate and easily operable apparatus for the measure of torque or power.

Generator Cooling Apparatus.—The B. F. Sturtevant Company, Boston, Mass., has issued Bulletin No. 246 describing and illustrating in detail its generator cooling apparatus. A psychrometric diagram showing the percentage of relative humidity has also been included in the bulletin which contains 27 neatly arranged pages.

Gasoline Power Units.—The Buda Company, Chicago, has issued bulletin No. 388, describing a four-cylinder gasoline power plant, which it has recently developed for use in driving electric generators, arc welding sets, triplex or other types of pumps, hoists, concrete mixers, air compressors and for similar uses in machine shops, etc.

Iron Workers Tools.—The Scully Steel and Iron Company, Chicago, is sending out a somewhat elaborate pamphlet showing iron workers' tools for hand and pneumatic work. The tools are made especially for boiler makers and iron workers and include hammers, sledges, chisels, punches, rivet snaps, side sets, calking tools, drift pins, rippers, beading tools, and the like.

Automatic Cutting Machine.—In a booklet recently issued the General Welding & Equipment Company, Boston, Mass., manufacturers of welding equipment, is described the construction and operation of the Gewe automatic cutting machine. This machine is mechanically driven, uses oxygen and hydrogen in the torch, and follows templates made of fiber or similar material for patterns during the cutting operation.

Locomotive Boosters.—The Franklin Railway Supply Company, New York, has issued a new bulletin, No. 976, describing the locomotive booster and showing how it helps in railroad operation. The possibilities of increased tonnage and greater revenue earning capacity from locomotives equipped with a booster are pointed out and diagrams are given which graphically show the increased tractive power in starting and at slow speeds.

Machine Tools.—The Triplex No. 1 machine tool designed for turning and boring, milling, thread cutting and drilling is described in detail and its application to each of these operations in a pamphlet sent out by the Triplex Machine Tool Corporation, New York. The advantage of this machine is that it combines a number of machine tools in one, cutting down equipment investment and saving floor space. A price list is included in the pamphlet.

Railway Mechanical Engineer

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For the Air Brake Man

Realizing the importance of the part which the air brake plays in the operation of the modern railroad and in response to the wishes expressed by a number of our readers, we have started in this issue a department called the "Air Brake Corner" where answers will be given to questions together with general news of the air brake field. If this department develops as anticipated, it will soon be necessary to allot considerably more space and assign a broader title. Brake matters will not be confined to this department, however, as articles of general interest, such as the one in this issue on the recent vacuum brake tests in England, will appear in other parts of the paper.

Boiler Tube Maintenance

According to the latest published statistics of the Interstate Commerce Commission there are approximately 68,000 steam locomotives operating in the United States and, assuming an average of 230 boiler tubes to each locomotive, the total number of tubes installed is about 16,000,000. These tubes pit, corrode, accumulate scale and in other ways become unfit for service, requiring frequent replacement. Even if this were not true, all boiler tubes would have to be removed, inspected and reapplied at least once in every four years in accordance with a ruling of the Interstate Commerce Commission. In other words, 25 per cent at the least calculation, of 16,000,000 locomotive boiler tubes (the proportion is probably twice that) must be removed annually, which gives some idea of the magnitude and importance of the problem of boiler tube installation and maintenance. An unusually valuable article on this subject is published in this issue (page 221), the authors describing the results of an extended comparison and checking of the boiler tube maintenance practice on over 50 railroads. Eliminating the unnecessary and keeping the best has resulted in the practice described which has been checked by one of the largest railroad systems in the country and qualifies as an approved standard practice. The article is published in two installments, the first of which appears in this issue and pertains to methods and tools for installing locomotive boiler tubes, superheater flues and arch tubes. A later installment will relate to safe-ending, welding and maintaining tubes tight under varying service conditions. A part of the later installment will also be devoted to shop layouts and service records.

A Prime Duty of the Foreman

One of the remaining evidences of the loss of morale with which the mechanical department has been so seriously handicapped during the past few years, is a laxity on the part of many foremen in the exercise of one of their most important functions. With the administration of discipline so largely removed from their hands during Railroad Administration control, it is not surprising that foremen were loath to examine too closely into the extent to which their instructions were carried out. At the present time, however, after a large measure of improvement has been effected in labor efficiency, it is still evident that many foremen are neglecting the part of their duties which is of even greater importance than the issuing of instructions, that is, to know and insist that they have been carried out effectively. The effect of laxity in the performance of this important duty is probably more marked in the roundhouse than in the shop, where the forces are more highly organized and the work more closely follows a well established routine. In the roundhouse it depends entirely on the foreman whether the efforts of the forces are to be spent effectively or are to be wasted. In many cases large additional expense is being incurred through repeatedly but ineffectively attempting to correct conditions which keep recurring on the work reports, that would soon be eliminated through the simple process of conscientiously checking the work after it has been performed. So long as the foreman is satisfied just to "get by" the men cannot be expected to put forth their efforts to maintain any higher standard. The ability of a foreman cannot be judged primarily by the way in which his work is assigned. A reasonably intelligent call boy could probably perform this part of the foreman's duties successfully since it can be largely reduced to a matter of routine procedure. The real test of the foreman's ability lies in the effectiveness of the results obtained from the labor and material expended under his direction.

Building Up Sharp Flanges

Long wheelbases and short radius curves result in the rapid wear of locomotive driving wheel flanges, causing one of the most troublesome maintenance problems in the mechanical department. Locomotives out of the shop less than four months often begin to cut flanges and in a short time the tires must be turned at a considerable expense, locomotives being held out of service in the meantime. On the page devoted to communications is an interesting letter to the editor on this subject, discussing the building up of worn flanges by gas welding. Doubtless important economies can be effected by this method provided it has no harmful effects in weakening the tires. The letter explains how one road has been building up sharp flanges with gas welding for about two years without a single defective flange developing. Other roads perform this same operation, but with electric welding, securing a greatly increased total service mileage from tires. It seems probable that changes in the structure of the tire steel are more localized with electric than with gas welding, but on the other hand the temperature at the point where the material is added is higher. There are those who claim that any such heating of tires changes the structure of the steel and is therefore dangerous. S. W. Miller, on page 104 of the February, 1918, *Railway Mechanical Engineer*, describes the results of extensive experiments indicating that without subsequent heat treatment to bring tire steel back to its normal state, any method of fusion welding applied to steel tire changes their physical properties and is dangerous. If the process of building up sharp flanges by fusion welding is safe, it presents great possibilities of economy, particularly where one tire of a set, almost down to the thickness limit, has a sharp flange. In view of the conflicting opinions and practices, the subject of building up sharp flanges by welding is apparently one which should come before the American Railway Association for careful consideration and report.

Buying vs. Making

Among the great number of small parts utilized in repairing cars and locomotives are many which should be purchased or made locally depending upon the relative costs. The question of "Buying vs. Making" is an important one as often large amounts of money are involved and, in any specific case, an intelligent decision is dependent on accurate knowledge of detailed costs. It must also be remembered that a decision once made is by no means final, as manufacturers' quotations change from time to time and shop costs are subject to variation. This point is strongly emphasized in an article entitled "Making Washers from Old Flues" published in this issue. The author explains in the article how common washers up to 7/8 in. in diameter can be punched, two at a time, from flattened scrap boiler flues at a cost of $2.075 per 100 lb. including labor, material and overhead charges. Obviously at that figure it was a good paying proposition to manufacture washers in local repair shops during 1919 and 1920 when the manufacturer's price averaged $5.425 per 100 lb. In July, 1921, this price dropped to $1.84 when it was no longer profitable to make the washers locally but cheaper to buy them. Had an accurate knowledge of shop costs not been available, the railroad in question might have continued the practice of making its own washers at an ever-increasing loss. Owing to marked changes in prices during the past year it will probably pay all railroads to check their present costs of both manufacturing and reclamation work to make sure that maximum economy is being secured.

Another important point brought out in the article is that while the work of punching washers requires no special skill and could be performed by a laborer as well as a mechanic, the higher priced man must be employed according to present rules. If laborers could be used on this class of work the labor charge would be reduced and the railroad could still afford to make its own washers with an appreciable saving in cost. This is but another example of the way in which certain standardized rules still handicap the railroads, increase their cost of operation, and cause unemployment among railroad workers.

What Is a Fair Wage?

Representatives of the railroads and the labor organizations are once more engaged in presenting arguments before the Labor Board on the question of wages for the shop crafts. The railroads have introduced testimony to show that the wages of railroad shop employees are higher in proportion to the cost of living than before the war and also considerably higher than are paid to men doing comparable work in other industries. In reply to these statements, B. M. Jewell, representing the unions, contended that the railroads should pay a wage sufficient to maintain an average family of five according to a "healthful standard of living."

The reduction of wages is never a pleasant subject and the statement that workers cannot support a family on the wages they are receiving, is entitled to sympathetic consideration. In justice to all concerned, it is necessary to consider carefully whether the railroads could, or whether they should pay the wage advocated by Mr. Jewell.

The budget for a family of five which Mr. Jewell proposed amounts to $2,637 a year and to secure this amount he stated that railway mechanics must earn 40 per cent more than they are now being paid. The question at once arises whether the railroads could afford to increase wages to such an extent.

It goes without saying that other employees are just as much entitled to a healthful standard of living as the shop crafts. The railroads at present have about 1,700,000 employees. An average wage of $2,637 would make the railway payroll over $4,500,000,000 a year, which is about $1,700,000,000 more than in 1921. If the railroads had paid this sum for wages last year and all other expenses had been the same, their expenses and taxes would have been $1,000,000,000 greater than their earnings without paying a cent for interest or dividends.

Mr. Jewell did not explain where the railroads were to get the additional $1,700,000,000 to pay these higher wages, but he intimated that the railroads pay excessive prices to supply companies and if the railroads paid lower prices, they could pay higher wages. In 1920, the railroads paid for fuel and other material and supplies $1,736,000,000 and in 1921 the cost was, of course, considerably lower, although figures are not available. If the supply companies were to cut prices so that the railroads could save even $1,000,000,000, it would certainly be necessary for the manufacturing concerns to reduce wages very greatly. It should be remembered, however, that wages in outside industries are already lower than the rates paid on the railroads. Furthermore, if railroad workers are entitled to an average wage of $2,637, why should not the same apply to workers in other industries?

The crux of the whole matter is the ability of the railroads and industry in general to pay the wage proposed. An investigation of the total production and income of the people of the United States showed that the production and income reached its maximum in 1919 when it was $66,000,000,000. The total number of persons "gainfully employed" in this country is about 42,000,000 and to provide the average income Mr. Jewell suggests would require an aggregate annual income of $111,000,000,000. It would be impossible to pay the average wage that Mr. Jewell proposes unless the production of the country was nearly doubled.

It is worth while to investigate some of the figures used by Mr. Jewell in arriving at his conclusion. It is assumed that the average family consists of five persons, but the records of the census show the average family contains 4.3 persons. The average family is not supported by the earnings of one person as the census again shows the average number of workers in each family to be 1¾. It would require an average individual income of $1,510 a year to give an average family income of $2,637. From this it is evident that present wage rates are not badly out of line. As a matter of fact, since the wages of railway workers are higher in relation to the cost of living than before the war, they represent a preferred class. Consider, for example, the incomes and expenses of farmers. In 1914 agricultural implements could be bought for the price the farmer received for 100 bushels of corn. In March, 1922, the farmer had to sell 274 bushels of corn to buy the same machine. The farmer is just as much entitled to fair dealing as the railroad worker and a readjustment of wages and prices is needed to improve his situation. One of the changes that will better conditions is a reduction in freight rates and the only way this can be accomplished seems to be by a fair reduction in wages. What this country as a whole needs is a restoration of better business conditions. Reduced freight rates would no doubt help to bring this about and railroad employees would benefit along with everyone else.

An Intimate Chat with the Editor

THIS is your paper! We are your representatives, or trustees, whose privilege it is to try to make the *Railway Mechanical Engineer* of the greatest possible practical value to each one of its subscribers.

During recent weeks many of you have written to me, and not a few of you have made some splendid suggestions as to how we can serve you more effectively.

Several, for instance, suggested that we could make the paper of greater value to them by incorporating a Questions and Answers Column; others intimated that they liked to see crisp and newsy letters from our readers on important topics and problems; still others criticised us because some of our articles have described practices and methods which in their opinion were not nearly as good as the ones used on their roads, or in their shops.

This is fine.

We quietly tried to start a Questions and Answers Department a little while ago, but you didn't bite—didn't even nibble. If you really want such a column, send in your questions. We will either answer them to the best of our ability or else print them and invite our readers at large to send in the answers.

We would like nothing better than to have you send in a letter for publication on some live mechanical department question. Obviously we can hardly be expected to write letters to ourselves, although we have sometimes been sorely tempted to do so, to use them as bait to get you started. We want our publication to be a clearing-house for all the good things in the mechanical department. If some of you will start the ball rolling, others will undoubtedly join in and we will all benefit from the exchange of ideas and experiences. Who will be the first?

Now as to some of the articles which may have described practices not as good as those on your own road or in your own shop. You are not a good sport, if you see anything of that sort and let it get by without bringing it to our attention. No man is a friend of ours who will let a mis-statement or a poor article go by unchallenged. I wish somehow or other I could vitalize these printed words so that you would realize clearly that calling attention to our shortcomings will be considered a friendly act. And we want you to be friends—not just subscribers.

How about it?

Sincerely,

Roy V. Wright

NEW BOOKS

Life of George Westinghouse. *By Henry G. Prout, C. E., A. M., LL. D., 375 pages. Portrait frontispiece and eight other illustrations. Size 6 in. x 9 in. Bound in cloth. Charles Scribner's Sons, New York.*

George Westinghouse was a great man. He was a genius, but a good deal more than that. He developed his own and others' inventions and was a business executive as well as an engineer. Above all this he was a gentleman. His pre-eminence as a noble citizen is indicated by the very lines of his portrait, and readers of this book who are unacquainted with his career will be charmed to see how the varied acts of his life confirm the impressions which they will gain from this picture.

Colonel Prout is not only a scholar, he is one of the most accomplished writers in the field of engineering, and a discriminating observer. Adding to this his own acquaintance with many of the topics dealt with, and his years of association with Westinghouse himself, one may reasonably expect a thoroughly illuminating narrative. This expectation is not disappointed. The reading public is fortunate in having the benefit of such an unusual combination.

Railroad men who shortsightedly have thought that the fame of Westinghouse rested on the air brake alone will find this book an eye-opener. The air brake was, indeed, the great outstanding mechanical feature in the railroad world from 1869 to 1889, and that alone served to put Westinghouse's name alongside of Stephenson's; but Westinghouse had a great career after that. The biographer classes his work in developing alternating electric current for the manufacture of power as at least of equal importance. In other fields—natural gas, friction draft gear, electric traction, turbo-generator and electro pneumatic apparatus for signaling—Westinghouse did a prodigious amount of pioneer work.

The candor of the author is always in evidence, and the great things which glorified the name of Westinghouse from a hundred different angles are not allowed to obscure the truth necessary to make an honest narrative. Mistakes and reverses are recognized with fidelity. Another point calling for frank treatment was the question of recognizing the work of the "large group of able, loyal and devoted assistants which Westinghouse attached to himself," these including brilliant and constructive organizers, administrators, executives and engineers. Of these a few exceptional names are mentioned, but as regards the list as a whole "the committee (mentioned below) and the editor regret that it is not practicable to enter upon the delicate task of telling what these men did."

The American Society of Mechanical Engineers is primarily responsible for this book, Messrs. Scribner working in co-operation with a committee of the society, of which Charles A. Terry was chairman. The author also gives, in the preface, the names of 18 other men who contributed material and advice; in short he has employed all the resources of the experienced editor, with a purpose of making a book of which every paragraph should be faultless.

The titles of some of the chapters are: the air brake; friction draft gear; a general sketch of electric activities, the induction motor and meter; rotary converter; the Chicago World's Fair; Niagara Falls; electric traction; steam and gas engines; the turbo-generator; signaling and interlocking; natural gas; various interests and activities; European enterprises; financial methods, etc. The lighting of the World's Fair at Chicago, in 1893, and the epoch-making work at Niagara Falls in 1889, and the following years—where now there are hydro-electric plants with an aggregate capacity of 500,000 h.p.—are among the most absorbing stories in the book.

In an appendix devoted to some description of the numerous patents taken out by Westinghouse, eight pages are re quired for a simple index, one line to each patent. In 1[illegible] years, from his 34th year to the end of his 44th, Westing house took out 134 patents, an average of more than one eacl month; and at the same time he was stimulating and direct ing the work of many other inventors. Another list, fillin two pages—a single line to each item—gives the names o the Westinghouse associated companies, chronologicall arranged.

Proceedings of the Traveling Engineers' Association. 20 *pages, 6 in. by 8½ in., bound in leather. Published by th association, W. O. Thompson, secretary, 1177 East Ninety eighth street, Cleveland, Ohio.*

This is the official report of the Twenty-ninth Annual Meet ing of the Traveling Engineers' Association, held in Chicago September, 1921. The subjects of the papers presented an discussed were: Distribution of power and effects on oper ating costs; recommended practice for conservation of loco motive appurtenances and supplies; advantages of self adjusting wedges, feed water heaters and boosters; bes method of operating stoker-fired locomotives; comprehensiv standard method of employing, educating and examinin engineers; operation and maintenance of oil-burning loco motives.

Milling Cutters and Milling. 69 *pages, 5 in. by 8 in., illus trated, bound in leather. Published by the National Twis Drill & Tool Company, Detroit, Mich.*

In view of the increasing use of milling machines in railroa machine shops this book will be of special interest. It ex plains in simple terms the fundamental principles of millin with particular emphasis on the effects of rake, clearanc and spiral, shape of teeth, chip space, number of teeth, feed cutting speeds, lubrication and cooling. Much of this mate rial is presented as a result of experiments conducted durin the past two years at the University of Michigan by Professo John Airey of the University of Michigan and Karl J Oxford, chief engineer of the National Twist Drill & Toc Company, Detroit, Mich. Early in the book there is a chap ter devoted to a comparison of milling with turning an planing. The last three chapters are devoted to the millin machine as related to the milling cutter, the care of millin cutters and various types of milling cutters and their use

Use of Southern Yellow Pine in Car Construction. *By H. S Sackett. 55 pages, 6 in. by 9 in., illustrated. Published b Southern Pine Association, New Orleans, La.*

This booklet will be of interest to and should be in the hanc of all those who have to do with the design, operation c maintenance of wooden or composite railway cars. The boo is well illustrated and is filled with much valuable informa tion and many good suggestions. A considerable portion c the subject matter is applicable not only to yellow pir lumber but also to other woods.

The book is divided into four parts. Part one outlin railroad car development from the early beginning of a cer tury ago. Particular attention is given to the use of wood i freight car construction and the advantages of the composi design. Box, gondola, stock and refrigerator cars are di cussed separately. Part two treats of the methods for storir and handling or the care and protection which should l given to prevent decay and guard against fires. Part thr deals with preservative treatments, offers practical sugge tions, and suggests an extension of the practice. Part fou is devoted to the properties of southern yellow pine and co tains a number of tables relative to mechanical propertie hardness, strength, weight, recommended working stresse etc., which add to the value of the book for referen purposes.

Walschaert Valve Gear with Variable Lead

Modifications Secure Ample Lead While Running Combined with No Lead When Starting

VARIOUS methods have at times been used to provide variable lead for the Walschaert valve gear, such as increasing the width of the link slot at each end to eliminate lead at starting, gradually increasing it as the running position was reached. With this method it was found that because of the balanced condition of the valve, the lost motion in the link would allow the link block to move over to the wrong side of the link and increase the lead. It was also found that starting an engine out of the shop with lost motion in the link caused wear throughout the entire motion. Another method tried was the adjustment of the eccentric crank, and while this provided for a variable lead in the forward motion, it was objectionable in that it distorted the back-up motion.

With a view of providing a variable lead that would insure a better steam distribution and at the same time not distort the valve motion in either direction nor cause rapid wear of motion work, the valve gear shown in the photograph and drawing was developed and patented by J. O. Jones, supervisor of valve motion, Chicago, Milwaukee & St. Paul, Milwaukee, Wis. By means of this modification of the Walschaert valve gear a variable lead is substituted for the constant lead which is characteristic of the standard design of gear.

An engine is given lead primarily to insure that full steam pressure will be exerted on the piston when it passes the dead center and starts on its working stroke. In order that this may be done it is necessary, due to wire-drawing of the steam at small openings, that the steam valve starts to open slightly in advance of the dead center. Lead is a disadvantage when starting but after the engine has started lead is a decided advantage, for in addition to providing full pressure on the piston at the beginning of the stroke, it also assists compression in cushioning the reciprocating parts as they come to rest at the dead center.

The Walschaert gear is a constant lead gear because the proportions of the combination lever remain fixed. If by some means these proportions could be varied, the lead could be varied. This is what is done in the Jones gear. The normal connection of the combination lever to the valve cross head is by means of a pin. In the Jones gear this permanent connection is changed to a movable one, made by putting an oblong slot in the combination lever and providing a block to slide in the slot, this block being fastened to the valve stem crosshead by a pin. By raising or lowering the combination lever, its proportions can then be changed as desired.

Description of Mechanism

To provide no lead in starting it is necessary to have the combination lever move the valve only twice the lap in full gear, the movement being increased as the cutoff is shortened. The mechanism which is used for this purpose is shown in Fig. 2. A cam A which contains a curved slot and is placed in guides, is attached to the reversing shaft of the engine by means of a reach rod D and lever arm H. The follower of the cam is attached to the upper end of the combination lever G by means of a link E and to the guide support by means of a tie C. The radius rod F is connected to the link E instead of to the top of the combination lever G as is done in the standard Walschaert gear.

As a result of these modifications, when the reverse lever is moved from the central position to either corner, the combination lever is lowered and the proportion of that part of the combination lever between the connection to the radius rod and the connection to the valve stem to the whole lever is decreased and consequently the motion of the valve due to the combination lever is decreased. As the reverse lever is hooked up the combination lever is raised and the amount of movement imparted to the valve from this source is increased. The limits of the change in the movement of the valve as received through the combination lever, are from

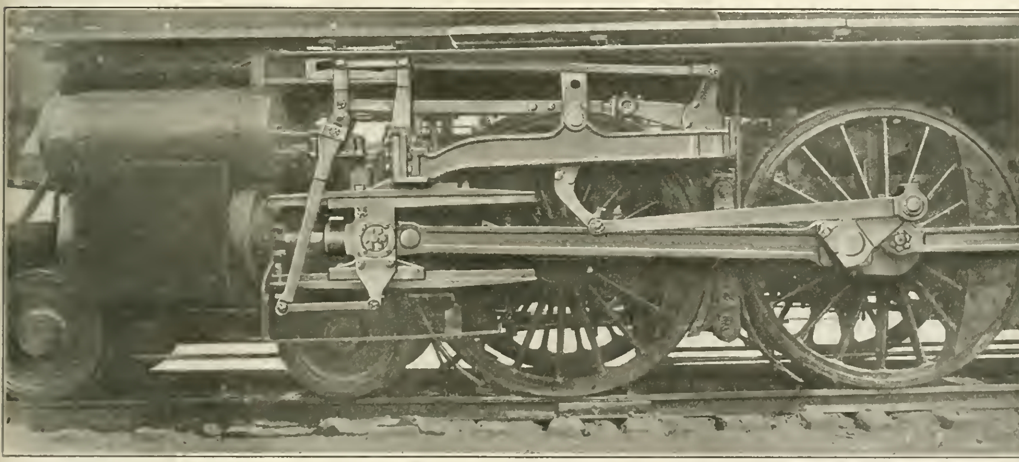


Fig. 1—Application of Jones Variable Lead Gear on Chicago, Milwaukee & St. Paul

twice the lap in the corner notch, to twice the sum of the lap and lead in the center notch.

By connecting the radius rod *F* to the link *C* instead of directly to the combination lever *G*, another feature is secured which tends to improve the starting qualities of the locomotive. Thus with the same link, radius rod and eccentric crank as is used on a standard Walschaert geared engine, by

senger service between Milwaukee and Chicago, a distance of 85 miles, handling a train of ten steel cars weighing 750 tons one way, and a return trip with from seven to ten cars, making nine station stops, in a running time of two hours and ten minutes.

The locomotive is performing very satisfactorily; the benefit of the new valve arrangement at starting, due to

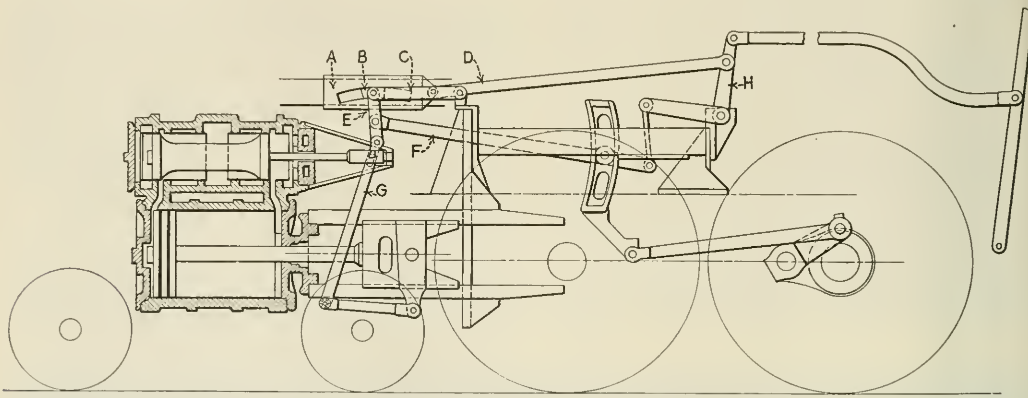


Fig. 2—Diagram of Jones Variable Lead Gear

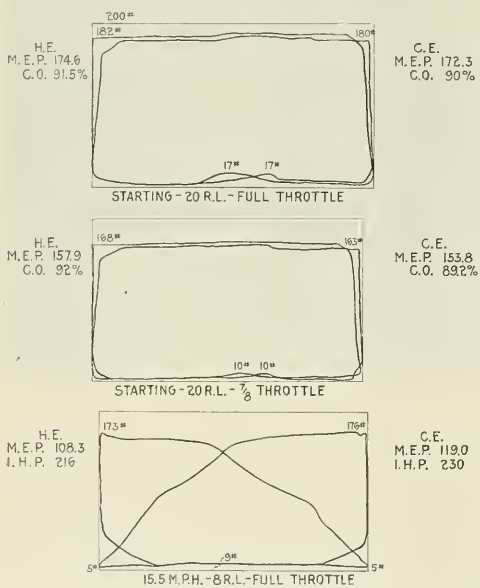


Fig. 3—Indicator Cards from Locomotive 6115 with Jones Variable Lead Gear

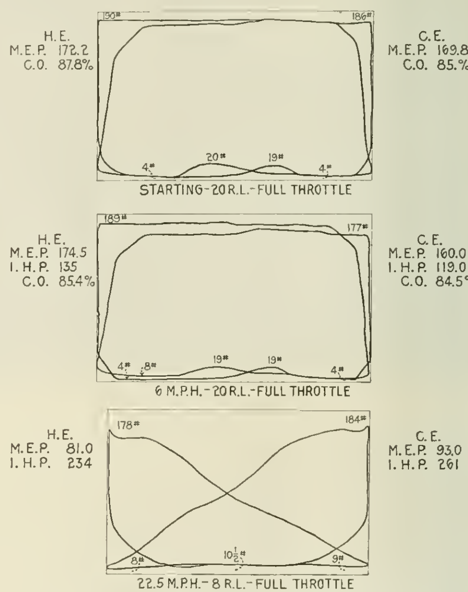
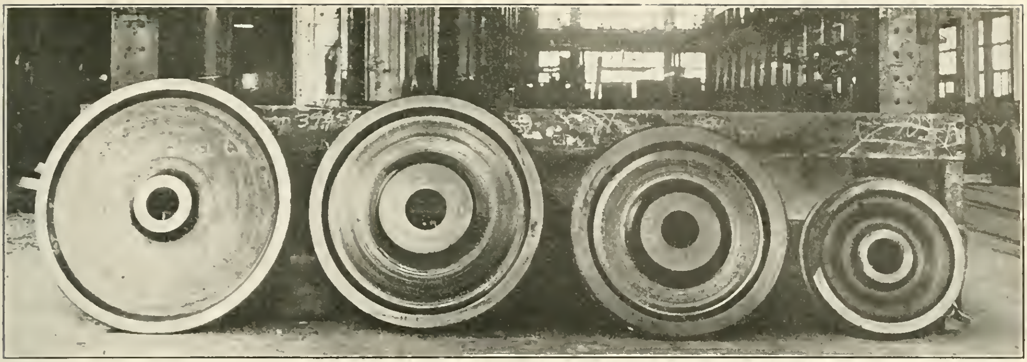


Fig. 4—Indicator Cards from Locomotives 6116 with Regular Walschaert Gear

connecting the radius rod as shown, a longer valve travel will result. This causes cut-off and compression to occur later in the stroke, which results in an increased mean effective pressure. The valve action is moreover quicker since in the same relative time the valve travels a greater distance.

A valve gear as above described was applied to a Chicago, Milwaukee & St. Paul locomotive of the Pacific type, No. 6115, on June 16, 1921, and has made 40,000 miles in pas-

taking away the resistance caused by lead in full cut-off, is noticeable, while the 1/16 in. increased lead in running notches over that obtained from the original gear provides more speed when hooked up. Sample indicator cars are shown of locomotive 6115 equipped with the Jones gear and of locomotive 6116 equipped with the regular Walschaert gear. These two locomotives are identical in all particulars except that of valve gear.



Four Sizes of Wheels Rolled on the Same Mill; Right to Left, a 33 in. Freight Car Wheel, 44 in. and 50 in. Trailer Wheels and a 53 in. Special Wheel

Rolled Steel Trailer Wheels for Locomotives

Edgewater Steel Company Produces Large Sizes for This Purpose—Method of Manufacture

During recent years rolled steel wheels have come into extensive use where steel tired wheels were formerly employed. The latest example of this tendency is found in the application of special rolled steel wheels on the trailing trucks of locomotives. These wheels have been developed by the Edgewater Steel Company of Pittsburgh, Pa., at the suggestion of an eastern railroad.

This extension of the field of rolled steel wheels is due to advantages in first cost and maintenance coupled with the high degree of reliability demanded for the most exacting service. Formerly steel tired wheels were favored for trailer trucks because the tires could be changed readily. On modern locomotives the trailing axles have outside bearings and the wheels must be dropped to change the tires. It is often cheaper to change the wheels and send the parts to the shop for turning than to remove the tires and shrink on a new set. Where this is the case, rolled steel wheels are often preferred.

In developing the roller trailer wheels it was found that the requirements for practically all classes of locomotives could be met by two sizes of wheels, 44 in. and 50 in. diameter with 5½ in. by 3 in. rims. The hubs are 8⅛ in. long and the diameters of the faces, 16 in. and 19 in., the large face being placed inside or outside as desired. The two sizes of wheels mentioned will fit in almost any trailing truck, but other sizes can be made if necessary. One of the illustrations shows four sizes of wheels produced by the Edgewater Steel Company: a 33 in. wheel for freight cars, 44 in. and 50 in. trailer wheels and a 53 in. wheel which was rolled to demonstrate the capacity of the mill.

Although rolled steel wheels are used extensively, few

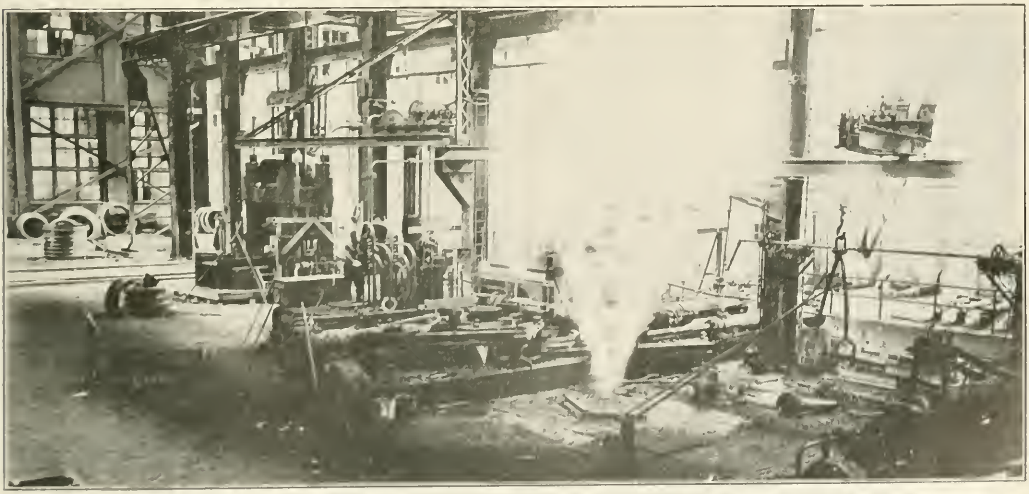


Fig. 1—Special Rolling Mill, Driven by 1,000 Hp. Motor, on Which Wheels and Tires Are Made

railroad men know except in a general way how they are made. The method of manufacture, especially that used by the Edgewater Steel Company, is most interesting.

The first step in producing rolled steel wheels is to make suitable steel. The specifications of the Mechanical Division of the American Railway Association call for the following chemical composition when the steel is made by the basic open-hearth process.

Carbon, 0.65 to 0.85 per cent.
Manganese, 0.55 to 0.80 per cent.
Silicon, 0.10 to 0.30 per cent.
Phosphorus, not over 0.05 per cent.
Sulphur, not over 0.05 per cent.

The Edgewater plant has four open-hearth steel furnaces; two of 75 tons capacity, one of 50 tons capacity, and one of 25 tons capacity. The steel is tapped into ladles and poured into ingot molds which are filled from the bottom in order to reduce the occlusion of gases and insure sound ingots. The composition of the steel is carefully controlled during the making by chemical and physical tests of each heat.

The ingots are allowed to cool and are cut into blocks in slicing lathes, as shown in Fig. 2, the size of the block depending upon the size and type of wheel to be made. The crop end of the ingot is discarded and the blocks are carefully inspected for defects.

The blocks which pass inspection are reheated in a special type continuous furnace which brings the entire block gradually up to a uniform forging heat. From the furnace the block is carried by a semi-automatic conveyor to a 6,000-ton hydraulic press. The first operation on the press is to flatten the block to approximately the width of the wheel rim, this operation serving also to remove the scale. The center is punched out and then the bloom is placed in a set of dies and pressed to the shape of the blank shown in Fig. 2. The blank as it comes from the dies has a hub of the correct dimensions but the diameter over the rim is less than that of the wheel to be made and the rim has no flange.

The finished blank as it comes from the dies is transferred immediately to the rolling mills. One of these mills is illustrated in Fig. 1, the details of the arrangement of the rolls being shown at the right in Fig. 2. By reference to the latter illustration it will be noted that the wheel is held on the rim between seven rolls; the main driven roll shown at the right, two guide rolls, two edging rolls and two pressure rolls mounted between the edging rolls. The actual rolling of the metal is done between the pressure rolls and the edging rolls. These are mounted on a carriage which can be moved toward or away from the main roll at the will of the operator, thus controlling the diameter of the piece being rolled. In this way the diameter of the piece is maintained until the flange and rim are fully formed by the rolls and then increased to the finished size.

The wheel is next transferred to a 2,500-ton hydraulic press where it is dished, giving the hub the required offset from the rim. During this operation the heat number and any other markings required are stamped on the wheel. After the wheels come from the press, they are allowed to cool, after which the hub is bored and faced and the groove showing the limit of wear is cut in the outside of the rim. The wheels are then measured and marked with the tape size, after which they are ready for mounting.

There are two unique features in this method of manufacturing wheels: the piece is developed from the block to the finished wheel in a single heat and the rim is worked on all sides throughout the rolling process. The thorough working of the metal and the low finishing temperature insure the proper structure of the steel in the finished wheel.

The method of making tires for locomotive or car wheels is in many respects similar to the process of making rolled steel wheels and the same machinery is used. The various steps in this process are shown at the left in Fig. 2. In preparing the bloom the center hole is enlarged in order that the bloom may be passed over the pressure roll. The flange is formed in the main roll while the top and bottom edging rolls maintain the proper width of the tire. In rolling tires two mills are used, the roughing mill forming the flange and drawing the tire partly to size, after which the rolling is finished in the second mill. In making tires, as in wheels, all sizes are rolled at one heat, thus insuring all the advantages of a low finishing temperature.

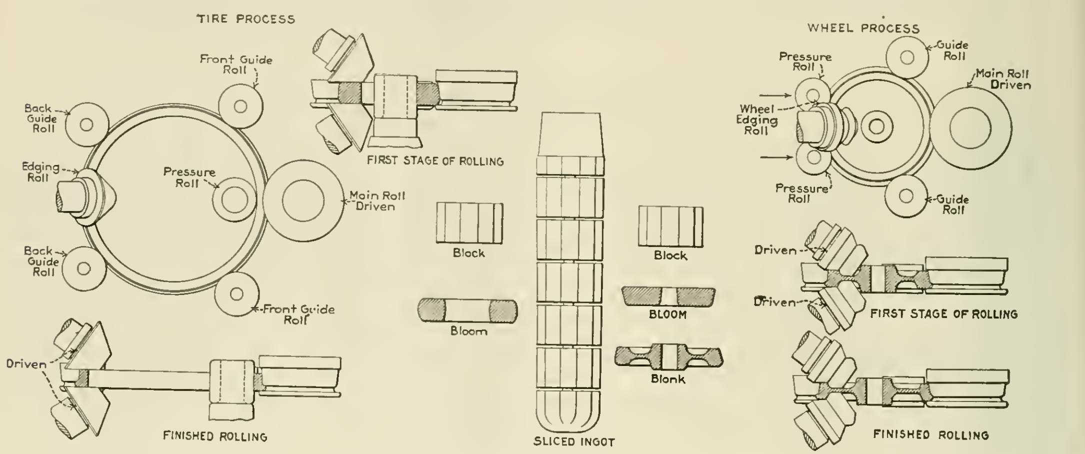


Fig. 2—Successive Steps in Converting an Ingot Into Rolled Steel Wheels or Tires

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Valuable Records of the Nashville, Chattanooga & St. Louis were destroyed in a fire which burned a building of that company in Nashville, Tenn., on March 3; estimated total loss $50,000.

Fifty Per Cent is the reduction reported by the Philadelphia & Reading in the number of fatal accidents to employees in 1921, as compared with 1920; sixty-eight killed in the last year and 34 in the year before. There was also a material reduction in the number injured.

Treated Water Improves Locomotive Performance

Six Years' Use of Soda Ash Demonstrates Value in Avoiding Failures, Reducing Repairs and Saving Fuel

By W. A. Pownall
Mechanical Engineer, Wabash Railway

THE writer has always taken great interest in the matter of scale prevention in boilers because of the large financial returns possible and would like to present for the information of those interested the results of systematic methods of boiler water treatment as in effect on the Wabash for the past 10 years.

Tests of Soda Ash Treatment

During the period 1902 to 1906, extensive service tests of soda ash treatment and observations of results were made on one of the large railroads. These tests showed conclusively that the treatment of all waters with enough soda ash to neutralize the sulphate hardness and provide enough excess always to show an excess of sodium carbonate in water drawn from the boiler, in connection with the systematic blowing off of the boiler through a blowoff cock properly located would accomplish the following principal results:

(1) Keep heating surfaces comparatively free from scale. (2) Cause the scale forming solids, instead of crystallizing on the heating surface, to be deposited as a soft sludge and be carried back to the point of least circulation, the back mud ring, where it could be removed through means of a perforated pipe connected to the blow-off cock in the back corner. (3) Practically eliminate engine failures due to leaking flues, fire boxes, stay bolts, mud rings, etc. (4) Reduce stay bolt breakage and fire box renewals to a very low figure. (5) Decrease the cost of boiler repairs from 30 to 65 percent. (6) Increase mileage between boiler washings to any desired amount. The tests also established the fact that the boiler would foam when the total dissolved solids were about 240 parts per 100,000 and that enough blowing off must be done always to keep below that point.

With full knowledge that these results were being obtained and that all methods were based not on any theorizing as to effects, but on actual observations of results, the Wabash started this method of treating water in roadside supply tanks with soda ash only and at every station where water contained any sulphates of lime and magnesia. Waters containing natural sodium carbonate, even though having a hardness of 20 to 40 parts per 100,000 are used in stationary boilers at several of our plants and do not form scale, the boilers being free from scale after having been in service for many years. Observations of boilers using this type of water ought to be evidence enough to any thoughtful investigator that similar results can be obtained on other waters containing sulphate hardness if enough soda ash is added to neutralize this hardness, or in other words to make it like the natural non-scaling water.

Let me emphasize, before discussing results, the fact that this method demands that all sulphate hardness waters over an operating district must be treated in order to obtain results. Treatment here and there by soda ash only will give practically no good results, and it is probable that experience with this sort of partial treatment has condemned this method in many cases.

Water treatment was started on the Wabash in 1912, and gradually extended until complete in 1916, when the total number of waters treated was 109. On one division this company operates over another road, and has not therefore been in a position to treat the water at roadside tanks. However, treatment has just been started on this division by placing enough soda ash in the tank at the terminal to treat all water used over the division, and although this is a crude method and one needing careful supervision, the results at the present writing are encouraging.

Engine Failures Due to Leaky Flues, Staybolts, Fireboxes, Etc.

A failure due to boiler leaking is an expensive failure since it usually involves giving up the train and having another engine and crew come out after the train and failed engine. Aside from the expense, leaking boiler failures are an absolute indication, particularly in cold weather, as to whether or not heating surfaces have scale on them, and are also evidence of all the other incidental troubles that go with scale. The following table shows the improvement in reducing failures due to leaking for the year 1921, as compared with the year 1911, the year before treatment was started.

ENGINE FAILURES DUE TO LEAKING FLUES, FIREBOXES, ETC.

Division	No. of failures 1911	No. of failures 1921	Per cent Decrease	Miles per failure 1911	Miles per failure 1921
Detroit	141	0	100.0	21,653	No failures
Peru	236	2	99.1	12,811	1,160,425
Decatur	232	4	98.3	20,878	989,068
Springfield	57	0	100.0	33,303	No failures
Moberly	265	23	91.3	25,596	248,035
Total	931	29	96.9	20,770	541,748

It will be noted that on two divisions the failures were entirely eliminated, on two other divisions they were practically eliminated and for all divisions the percentage of decrease was 96.9. The mileage per failure increased from 20,700 in 1911 to 541,748 in 1921. This improvement has not been made through the welding of flues into sheets, as this has been done on only a few engines and only on the superheater flues on divisions where the erratic water conditions and necessity for occasional use of very bad water made it seem advisable to weld in some of the superheater flues after they have been in service a year or two.

A good example of what has been accomplished is shown by the performance of 25 2-10-2 engines placed in service in July, 1917, on what was before treatment considered the hardest water division. These engines have flues 23 ft. long. During the 4½ years of service there have been seven failures due to leaking flues. The average time to first resetting of flues was 39 months, thirteen of the engines making from 40 to 48 months actual service. The average flue mileage on the ten highest engines (and one has not yet had the flues reset) is 116,477. Each engine has 3,047 staybolts including 2,320 rigid stays, 639 American flexible stays and 88 Tate flexible staybolts. There have been only 14 staybolts broken on the entire 25 engines. There are passenger engines running on this same division with nearly 300,000 miles between flue resetting.

Fire Box and Staybolt Renewals

Up to 1915 the firebox work on the Wabash was rather heavy, and the road did not begin to really feel the effect of water treatment in decreased firebox renewals until after 1915. However, from that time on there was a steady decrease in the number of new fireboxes applied each year, the records for the last three years showing a reduction in firebox renewals of 93 per cent over 1915. At the same time there have not been many renewals of side sheets or part side sheets. It is to be expected that there will be certain cycles of firebox life and that there may be in the future a few years with heavier firebox renewal, but generally speaking the indications are that obsolescence will overtake renewal.

The records of staybolt renewals per locomotive per year show that on the best treated division about one bolt per locomotive per year is renewed, whereas on the one division that has not had treated water, and which is not a really bad water division, the broken bolts per locomotive per year are 52. The broken bolts on the heaviest power on the Wabash consisting of Pacific, Consolidation, Mikado and Santa Fe type locomotives, all of which operate under treated water conditions, was from June, 1920, to July, 1921, only 0.77 bolts per locomotive per year. These locomotives are equipped with flexible staybolts in the breaking zones only.

Fuel Performance

Keeping heating surface free from scale results in considerable fuel saving. As a rough method of showing the fuel saving the total tons of coal used in locomotive service each year have been divided by total equivalent ton miles, obtained by assigning an increased ton mile value to passenger car ton miles and assuming that switch engine ton miles is a function of freight ton miles. The omission of a separate figure for switching service ton miles explains what may appear to be a high value for "lb. of coal per ton mile." This figure was kept up to 1919 and shows the following:

Year ending June 30.	1912	1913	1914	1915	1916	1919 (Dec. 31)
Lb. coal equivalent per 100 ton miles	32.7	31.65	30.93	29.2	27.0	25.75
Per cent decrease over 1912	0	3.21	5.41	10.69	17.41	21.25

The decrease in fuel consumption from the year previous to water treatment to 1919 was 21.25 per cent, part of which can be attributed to extended use of superheater engines and brick arch, and the formation of a competent fuel organization.

Cost of Water Treatment

Considerable has been said in articles in the *Railway Age* about the heavy cost of blowing out. The officers of the Wabash realize that considering the waste of fuel and water, the cost of blowing off is possibly the major part of the cost of water treatment, but there is no guess work as to this expense. On an ordinary division where the treatment will average 0.6 lb. of soda ash per 1,000 gallons of water, after the engine has made several hundred miles since the boiler was washed, it will then be necessary to blow out about 4 per cent of the water to keep below the foaming point. This will entail a fuel waste of approximately 1.1 per cent of the coal used, and the total cost of the coal and water wasted would be about $0.026 per 1,000 gallons. The average cost between washouts will be less than this, since very little blowing is done after washout until the concentration has reached the foaming point. This cost should always be considered as a part of the cost of water treatment. Under ordinary conditions it is usually cheaper to blow out a boiler than to wash it out at the terminal, but this cost of blowing out should never deter one from treating water, as it is much more than offset by fuel saving from clean heating surfaces and by other attendant benefits.

One thing that is very essential to the successful use of treated water is the support of the enginemen. It is their intelligent use of the blow-off cock that makes it possible to use this method of treatment. Blowing off a glass of water when the engine reaches its terminal relieves the engineman of part of the burden, but in freight service it is still necessary for considerable blowing off to be done between terminals.

I have read carefully the various articles brought about by Mr. Knowles' paper, and I do not feel like criticising any of the statements made but simply wish to present results that speak for themselves, and which will always be open to investigation by anybody interested. As regards the use of boiler compound, I agree with Mr. Bardwell—there is no mystery. It is a clean-cut proposition in which one knows what is used for treatment, and knowing what is in the water, and the amount of treatment applied, should know what to expect in the way of results. The use of anti-foaming compound reduces the amount of blowing off necessary, and where the alkali salts in the treated water are not very high and it is not desired to make large mileage between washouts or water changes, the use of the anti-foaming compound should make it possible to get along without blowing off. On districts where the natural alkali salts are high, the anti-foaming compound has been found a necessity for practical operation.

The statement made by Mr. Coyle of the Great Northern, that a foaming point of 200 grains per gallon had been settled on because it happened to be the foaming point in a boiler where a lot of sludge and fine scale was set loose, does not agree with our experience. We have found through analyses of many thousands of waters taken from locomotive boilers which have been free from scale for years, that the water will foam when the concentration of dissolved solids is about 240 parts per 100,000. This varies somewhat; it will be a little lower if there is any unusual amount of mud in the water or decayed vegetable matter, and will run a little higher when all waters are clear.

Wabash boiler waters are in general not high in sulphate hardness, although rather high in total hardness, so that when untreated they form heavy scale. We appreciate that waters on railroads further west and in the Southwest are in many cases very high in sulphates as well as in foaming solids, and that treatment presents a much more serious and difficult problem than we have had to deal with.

Any steam user who does not use some method of treatment to prevent scale formation in his boilers is over-looking an opportunity to save much money. Whether scale prevention is to be accomplished by the use of boiler compound, by soda ash, or by water softeners is governed by financial conditions—any method pays; but any one of these methods in order to be successful must be accompanied by proper and intelligent supervision. The greatest argument against the treatment with soda ash alone is the foaming tendency of the treated water or the cost of blowing off to overcome this foaming tendency. If all waters were treated through the softener the low amount of lime solids in the treated water would make it possible to run with higher concentration before foaming took place, and consequently with a lower cost for blowing off. Information as to how high concentration can be carried in the boiler water before foaming takes place when all waters are treated through softeners could possibly be furnished by a few roads that have a complete division or divisions equipped with softeners. This figure may be rather high where anti-foaming compound is used in connection with the completely softened water. On the other hand, there is the possibility of some one, or several plants not operating properly at all times which would mean an increase in lime solids with resultant foaming concentration not much greater than with other methods of treatment.

The saving due to reducing blowing off can be figured at a definite value per 1,000 gallons of water and set against the interest, depreciation and operating charges for the softeners. Similarly, costs can be figured in determining whether the use of anti-foaming compound to reduce the amount of blowing off would be profitable. Some value should be attached to the psychological effect on enginemen of not having to do so much blowing off.

Nothing in the foregoing should be construed as in opposition to any method of treatment. Each method, if properly supervised, may accomplish from partial to complete results in scale prevention, and I have merely tried to show results which have been obtained on the Wabash through the use of soda ash, and are possible on any other railroad.

Calculating the Efficiency of Boiler Seams

Tables Reduce the Chance for Error and Facilitate Work; Points Where Failure Is Likely to Occur

By R. J. Finch
American Locomotive Company, Schenectady, N. Y.

To determine the efficiency of a seam, it is necessary to calculate the breaking strength by the different ways in which it may fail; namely, by shearing the rivets, tearing the plates between rivets, crushing the rivets or plate, or by a combination of two or more of the foregoing causes. The calculation which shows the least result is the actual strength of the seam. Thus, the efficiency of a seam is the ratio of the actual strength of the seam, or the strength of its weakest part, to the strength of the solid plate.

To make these calculations is a tedious task, especially if the calculations are made longhand and no slide rules or calculating machines are available. The purpose of this article is to present two tables with an explanation of their use. These tables when thoroughly understood and then made use of, will shorten the work of finding the efficiency by at least one-half. The short method eliminates the tedious work and consequently, in making the calculations one is not so apt to overlook some vital point of weakness in the seam, which point may be out of the ordinary but still may exist. It is also the purpose of this article to indicate the places where weakness, or the point of lowest efficiency, may occur and yet might be easily overlooked.

To explain the use of the tables, two sketches of parts of longitudinal seams are shown. Fig. 1 shows a section of a sextuple riveted seam and Fig. 2 a section of a decuple riveted seam. While only the two types of seams are here shown, it should be understood that the tables apply equally well to a quadruple, octuple or any other type of riveted seam.

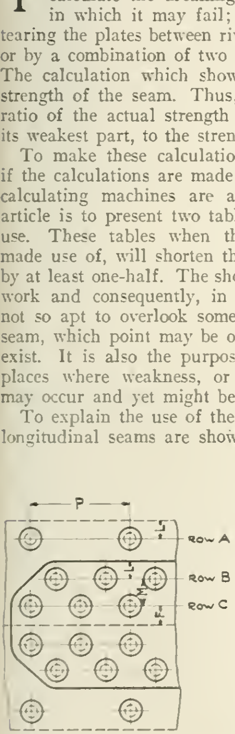


Fig. 1—Sextuple Riveted Seam

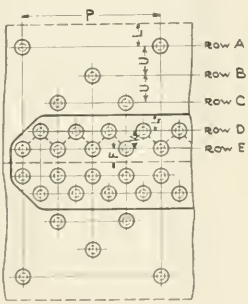


Fig. 2—Decuple Riveted Seam

Table I shows the "value of rivet holes in plates," or possibly it might be more explicit to say that this table shows the strength removed from the plate for various sizes of holes and thicknesses of plate. The table is based on an ultimate tensile strength of 55,000 lb. per square inch for boiler steel, which figure is almost universally used. The table ranges in thickness of plates from ¼ in. to 1 5/16 in., and in rivet diameters from ½ in. to 1 7/16 in., or a range in rivet hole diameters from 9/16 in. to 1½ in., the diameter of the driven rivet being taken as 1/16 in. larger than the rivet before driving.

Table II gives the shearing value of iron and steel rivets for the different sizes of rivets shown in Table I. This table is based on an ultimate shearing strength of iron rivets of 38,000 lb. per sq. in., and 40,000 and 44,000 lb. per sq. in. for steel rivets, the shearing strengths of 38,000 and 44,000 being those allowed by the Interstate Commerce Commission, while 40,000 lb. for steel rivets is the American Locomotive Company's practice.

Calculating the Efficiency of Seams

Referring to sextuple seam (Fig. 1) and assuming the pitch, *P*, is 8 in., diameter of rivet before driving 1⅛ in., after driving 1 3/16 in., thickness of plate 13/16 in., steel rivets being used, the efficiency through outer row, *A*, is found to be as follows:

$$\frac{8 - 1\ 3/16}{8} = 85.1 \text{ per cent}$$

To find the efficiency through other rows of rivets, proceed as follows:

Strength of solid plate is—

$$8 \times 13/16 \times 55{,}000 = 357{,}500 \text{ lb.}$$

In row *B* two rivet holes have been taken out, but if the plate fails here, it must shear off one rivet (two halves) in the outer row.

From Table I it is found that the strength removed is 2 × 53,066 lb. and the strength added, from Table II, is 48,730 lb. The efficiency through row *B* then is

$$\frac{357{,}500 - (2 \times 53{,}066) + 48{,}730}{357{,}500} = 83.9 \text{ per cent}$$

In row *C* two rivet holes are taken out, but to fail here it would be necessary to shear off five rivets (two rivets in double shear and one in single shear) and it is readily seen that the added strength is considerably more than the removed strength and no calculations are necessary.

The efficiency has been found by breaking through the different rows and the next step is to find the efficiency due to shearing of the rivets as a whole. To fail in this manner it is necessary to shear off nine rivets (four in double shear and one in single shear).

Then,

$$\frac{48{,}730 \times 9}{357{,}500} = 122.7 \text{ per cent, efficiency of rivets}$$

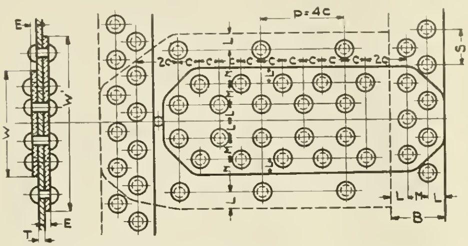
The efficiency of this seam is the value found for row *B*, or 83.9 per cent.

If the thickness of the plate had been assumed 11/16 in. instead of ¾ in., the strength of the metal removed by one rivet hole would be 44,902 lb. instead of 53,066 lb. It is at once noted that the least efficiency is in the outside row and is 85.1 per cent; in other words, on a seam of this type, when the shear of a rivet is greater than the strength removed by a rivet hole, the least efficiency must be in the outer row of rivets and it is not necessary to make any calculations for the efficiency of other rows. The shear of the rivets as a whole should always be calculated, as it sometimes happens, although seldom, that the least efficiency may be in the rivets.

Decuple Riveted Seam

The decuple riveted seam, Fig. 2, is taken care of identically the same as the sextuple riveted seam, except that an inspection of values from the two tables will quickly show that the efficiency through rows *B*, *C* and *E* must always be greater than the efficiency through the outer row, and, therefore, these rows in a riveted seam of this type need not be considered. The efficiency of the outer row is found exactly the same as for the sextuple riveted seam and the efficiency through row *D* is found the same as for row *B* of the sextuple seam, except that the tensile value of four rivet holes is deducted and the shearing strength of four rivets added. If the shearing value of a rivet is more than the strength removed by a rivet hole, it is useless to do any figuring for this row as it is at once noted that the efficiency will be more than in the outer row. The efficiency for the shear of the rivets as a whole is also found by the same method as for the sextuple riveted seam, except here the shear of 20 rivets (8 in double shear and 4 in single shear) is compared with the strength of the solid plate.

As for further points to be considered in calculating seam efficiencies, attention is called to the distance from the row of rivets to the edge of the welts (both inner and outer) or the dimension *L* on Figs. 1 and 2. In a well designed seam this distance or dimension *L* should always be great enough to insure that the metal between the rivet and the edge of

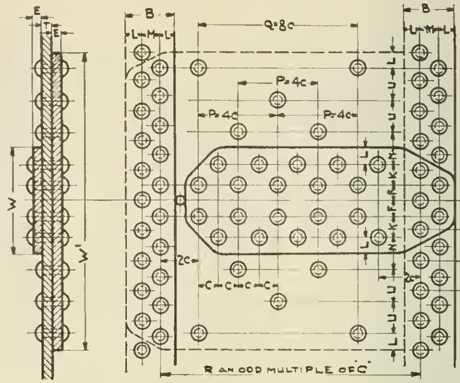


LONGITUDINAL SEAMS												CIRCUMFERENTIAL SEAMS				
T	DIA. OF RIVETS	DIA. OF HOLES	C	P	L	M	N	E	W	W'	PERCENT EFF.	S	L	M	B	PERCENT EFF.
3/8	3/4	13/16	1 1/4	5	1 1/8	1 1/2	2 3/8	3/8	7 1/2	12 1/4	83.7	2 3/4	1 1/8	1 1/2	3 3/4	70.5
13/32	7/8	15/16	1 1/2	6	1 3/8	1 3/4	2 3/4	7/16	9	14 1/2	84.3	3	1 1/4	1 3/4	4 1/4	68.7
7/16	7/8	15/16	1 1/2	6	1 3/8	1 3/4	2 3/4	7/16	9	14 1/2	84.3	3	1 1/4	1 3/4	4 1/4	68.7
15/32	7/8	15/16	1 1/2	6	1 3/8	1 3/4	2 3/4	7/16	9	14 1/2	84.3	3	1 1/4	1 3/4	4 1/4	68.7
1/2	7/8	15/16	1 1/2	6	1 3/8	1 3/4	2 3/4	7/16	9	14 1/2	84.3	3	1 1/4	1 3/4	4 1/4	66.9
17/32	1	1 1/16	1 3/4	7	1 1/2	1 7/8	3	7/16	9 3/4	15 3/4	84.8	3 1/4	1 1/2	1 3/4	4 3/4	67.4
9/16	1	1 1/16	1 3/4	7	1 1/2	1 7/8	3	1/2	9 3/4	15 3/4	84.8	3 1/4	1 1/2	1 3/4	4 3/4	67.4
19/32	1	1 1/16	1 3/4	7	1 1/2	1 7/8	3	1/2	9 3/4	15 3/4	84.8	3 1/4	1 1/2	1 3/4	4 3/4	66.8
5/8	1	1 1/16	1 3/4	7	1 1/2	1 7/8	3	9/16	9 3/4	15 3/4	84.4	3 1/4	1 1/2	1 3/4	4 3/4	63.5
21/32	1 1/8	1 3/16	2	8	1 5/8	2 1/8	3 1/4	9/16	10 3/4	17 1/4	85.1	3 1/2	1 5/8	2	5 1/4	66.0
11/16	1 1/8	1 3/16	2	8	1 5/8	2 1/8	3 1/4	9/16	10 3/4	17 1/4	84.9	3 1/2	1 5/8	2	5 1/4	66.0
23/32	1 1/8	1 3/16	2	8	1 5/8	2 1/8	3 1/4	9/16	10 3/4	17 1/4	84.3	3 1/2	1 5/8	2	5 1/4	63.9
3/4	1 1/8	1 3/16	2	8	1 5/8	2 1/8	3 1/4	9/16	10 3/4	17 1/4	83.6	3 1/2	1 5/8	2	5 1/4	61.4
25/32	1 1/8	1 3/16	2	8	1 5/8	2 1/8	3 1/4	5/8	10 3/4	17 1/4	83.1	3 1/2	1 5/8	2	5 1/4	58.9
13/16	1 1/8	1 3/16	2	8	1 5/8	2 1/8	3 1/4	[illegible]	10 3/4	17 1/4	82.6	3 1/2	1 5/8	2	5 1/4	56.[illegible]
27/32	1 1/4	1 5/16	2 1/4	9	1 3/4	2 3/8	3 1/2	11/16	11 3/4	18 3/4	83.8	3 3/4	1 3/4	2 1/4	5 3/4	62.2
7/8	1 1/4	1 5/16	2 1/4	9	1 3/4	2 3/8	3 1/2	11/16	11 3/4	18 3/4	83.3	3 3/4	1 3/4	2 1/4	5 3/4	60.0
29/32	1 1/4	1 5/16	2 1/4	9	1 3/4	2 3/8	3 1/2	11/16	11 3/4	18 3/4	82.9	3 3/4	1 3/4	2 1/4	5 3/4	57.9
15/16	1 1/4	1 5/16	2 1/4	9	1 3/4	2 3/8	3 1/2	[illegible]	11 3/4	18 3/4	82.5	3 3/4	1 3/4	2 1/4	5 3/4	56.[illegible]
31/32	1 1/4	1 5/16	2 1/4	9	1 3/4	2 3/8	3 1/2	[illegible]	11 3/4	18 3/4	82.1	3 3/4	1 3/4	2 1/4	5 3/4	54.1
1	1 1/4	1 5/16	2 1/4	9	1 3/4	2 3/8	3 1/2	[illegible]	11 3/4	18 3/4	81.7	3 3/4	1 3/4	2 1/4	5 3/4	52.5

Fig. 3—American Locomotive Company's Standard Sextuple Seam

the welt will stand the full shear of the rivet. This should always be calculated, and if found to be less than the value of the rivet, this value must be substituted instead of the rivet value for these particular rivets. Likewise, the dimension *F* (distance from inner row to center line of the seam) shown on Figs. 1 and 2 must be sufficient so that the metal between the rivet and the edge of the plate will stand the double shear of the rivet. If it should be found less than the rivet, this value must also be substituted. To compare this shearing strength of the plate behind the rivet with the strength of the rivet itself, it is simply necessary to find the cross sectional area of the metal behind the rivet in square inches and multiply this area by 100,000 lb. The crushing or shearing value of the plate is 50,000 lb. per sq. in., and this metal being in double shear accounts for the figure given above.

Another point to be considered for possible weakness is the back pitch, or distance between the longitudinal rows of rivets, dimension *M* in Fig. 1, sextuple seam, and dimen-



LONGITUDINAL SEAM																CIRCUMFERENTIAL SEAM				
T	DIA. OF RIVETS	DIA. OF HOLES	C	P	Q	F	K	N	U	E	F'	W	W'	L	PERCENT EFFICIENCY	S	L	M	B	PERCENT EFFICIENCY
21/32	1 1/8	1 3/16	2	8	16	1 5/8	2 1/8	3 3/4	3 3/4	9/16	1/2	10 3/4	33 1/4	1 5/8	92.6	3 1/2	1 5/8	2	5 1/4	66.0
11/16	1 1/8	1 3/16	2	8	16	1 5/8	2 1/8	3 3/4	3 3/4	9/16	1/2	10 3/4	33 1/4	1 5/8	92.6	3 1/2	1 5/8	2	5 1/4	66.0
23/32	1 1/8	1 3/16	2	8	16	1 5/8	2 1/8	3 3/4	3 3/4	9/16	1/2	10 3/4	33 1/4	1 5/8	92.6	3 1/2	1 5/8	2	5 1/4	63.9
3/4	1 1/8	1 3/16	2	8	16	1 5/8	2 1/8	3 3/4	3 3/4	9/16	1/2	10 3/4	33 1/4	1 5/8	92.6	3 1/2	1 5/8	2	5 1/4	61.4
25/32	1 1/8	1 3/16	2	8	16	1 5/8	2 1/8	3 3/4	3 3/4	5/8	9/16	10 3/4	33 1/4	1 5/8	92.6	3 1/2	1 5/8	2	5 1/4	58.9
13/16	1 1/8	1 3/16	2	8	16	1 5/8	2 1/8	3 3/4	3 3/4	5/8	9/16	10 3/4	33 1/4	1 5/8	92.6	3 1/2	1 5/8	2	5 1/4	56.6
27/32	1 1/4	1 5/16	2 1/4	9	18	1 3/4	2 3/8	4	4	11/16	5/8	11 3/4	35 3/4	1 3/4	92.7	3 3/4	1 3/4	2 1/4	5 3/4	62.2
7/8	1 1/4	1 5/16	2 1/4	9	18	1 3/4	2 3/8	4	4	11/16	5/8	11 3/4	35 3/4	1 3/4	92.7	3 3/4	1 3/4	2 1/4	5 3/4	60.0
29/32	1 1/4	1 5/16	2 1/4	9	18	1 3/4	2 3/8	4	4	3/4	11/16	11 3/4	35 3/4	1 3/4	92.7	3 3/4	1 3/4	2 1/4	5 3/4	57.9
15/16	1 1/4	1 5/16	2 1/4	9	18	1 3/4	2 3/8	4	4	3/4	11/16	11 3/4	35 3/4	1 3/4	92.7	3 3/4	1 3/4	2 1/4	5 3/4	56.0
31/32	1 1/4	1 5/16	2 1/4	9	18	1 3/4	2 3/8	4	4	3/4	11/16	11 3/4	35 3/4	1 3/4	92.7	3 3/4	1 3/4	2 1/4	5 3/4	54.1
1	1 5/16	1 3/8	2 1/2	10	20	2	2 1/2	4	4 1/4	3/4	11/16	12 3/4	37 3/4	1 7/8	93.1	3 3/4	1 7/8	2 3/8	6 1/8	57.6
1 1/32	1 5/16	1 3/8	2 1/2	10	20	2	2 1/2	4	4 1/4	13/16	3/4	12 3/4	37 3/4	1 7/8	93.1	3 3/4	1 7/8	2 3/8	6 1/8	55.9
1 1/16	1 5/16	1 3/8	2 1/2	10	20	2	2 1/2	4	4 1/4	13/16	3/4	12 3/4	37 3/4	1 7/8	92.8	3 3/4	1 7/8	2 3/8	6 1/8	54.3
1 3/32	1 5/16	1 3/8	2 1/2	10	20	2	2 1/2	4	4 1/4	7/8	13/16	12 3/4	37 3/4	1 7/8	92.2	3 3/4	1 7/8	2 3/8	6 1/8	52.8
1 1/8	1 5/16	1 3/8	2 1/2	10	20	2	2 1/2	4	4 1/4	7/8	13/16	12 3/4	37 3/4	1 7/8	91.7	3 3/4	1 7/8	2 3/8	6 1/8	51.2

Fig. 4—American Locomotive Company's Standard Decuple Seam

sions *U* and *K* in Fig. 2, decuple seam. Here it is essential that this distance be sufficiently great, so that the diagonal distance with two rows of rivet holes deducted, be greater than the straight distance with one row of rivet holes deducted. In other words, the net breaking strength through the diagonal must be greater than the net breaking strength through the straight rows, or the sheet might break sawtooth fashion and the calculations for efficiency be upset. (A dotted line in Fig. 2 shows what is meant by breaking diagonally between rows.) In order to be assured of the proper distance for the back pitch, it is advisable, when designing seams, to have some sort of a formula that will give the desired distance. This condition is well covered by the formulæ given in the A.S.M.E. Rules for the Construction of Boilers of Locomotives, Part I, Section III, of the A.S.M.E. Boiler Code, page 8, paragraph L-23.

Seams of high efficiency, like the decuple seam illustrated in Fig. 2 and the diamond seam, which will be discussed later, are used where a saving of weight is important, and oftentimes the welts (both inner and outer) are made thin to save weight, but there is a limit to the reduction in thickness of the welt strips. Suppose for example, this decuple seam was used on a plate 1 1/8 in. thick and this seam was to have an efficiency of 92 per cent. Should the welts be made only 9/16 in. thick, both welts could then fail through row *E*, leaving this row of rivets intact in the plate itself. Therefore, it is very important that the ratio of net area of the metal in the two welts through the row of rivets next to the center line of the seam to the plate be at least equal to the percentage of efficiency of the seam.

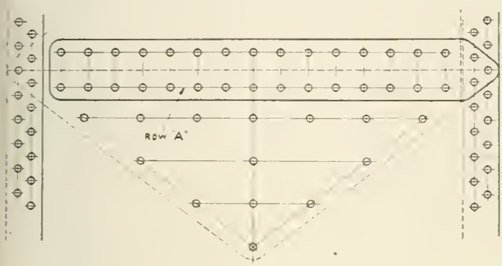


Fig. 5—Diamond Seam

The American Locomotive Company's standard sextuple riveted seams are shown in Fig. 3, while Fig. 4 shows standard decuple seams. These tables not only show rivet pitches, rivet diameters, thicknesses and widths of welts for the different thicknesses of plates, but also carry the efficiencies for different plate thicknesses. The efficiencies shown on these standard seams are on the basis of an ultimate tensile strength of plates of 55,000 lb. per sq. in. and 40,000 lb. per sq. in. for shear of rivets. In checking the efficiencies of these seams by the method given above, the line next the bottom in Table II should be used for rivet values, or the line based on a rivet shear of 40,000 lb. per sq. in.

The question might be asked as to the reason for having both a standard sextuple and decuple riveted seam covering the same thickness of plates. The American Locomotive Company's general practice is to use the sextuple riveted seam on smaller boilers, up to approximately 65 in. diameter, and the decuple seam for larger sizes. The decuple seam has an efficiency about eight per cent greater than the sextuple seam, and by using this seam the same factor of safety is obtained with correspondingly thinner plates. In cases where a saving in weight is important, the decuple riveted seam is often used where the diameter is less than 65 in., and vice versa, larger boilers than 65 in. are built with sextuple riveted seams due to some modifying factor, such as railroad company's specification, additional weight required, etc.

It is within the limits of possibility to design a seam with a higher efficiency than the decuple seam shown, the most common type being the diamond seam illustrated by Fig. 5. This seam on long barrel courses and properly designed, can have a theoretical efficiency as high as 98 per cent. There are, however, certain drawbacks to a seam of too high an

TABLE I—REDUCTION IN TENSILE STRENGTH OF PLATES DUE TO RIVET HOLES OF VARIOUS SIZES

Based on Plates Having a Tensile Strength of 55,000 Lb. Per Sq. In.

Diameter of rivet, inches	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1	1 1/16	1 1/8	1 3/16	1 1/4	1 5/16	1 3/8	1 7/16
Diam. of rivet hole, inches	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1	1 1/16	1 1/8	1 3/16	1 1/4	1 5/16	1 3/8	1 7/16	1 1/2
Thickness of plate, inches																
1/4	7,734	8,594	9,453	10,313	11,172											
9/32	8,701	9,668	10,635	11,602	12,568	13,535										
5/16	9,668	10,742	11,816	12,891	13,965	15,039										
11/32	10,635	11,816	12,998	14,180	15,361	16,543	17,725									
3/8	11,602	12,891	14,180	15,469	16,758	18,047	19,336									
13/32	12,568	13,965	15,361	16,758	18,154	19,551	20,947	22,344								
7/16	13,535	15,039	16,543	18,047	19,551	21,055	22,559	24,063	25,566							
15/32		16,113	17,725	19,336	20,947	22,559	24,170	25,781	27,393	29,004						
1/2			18,906	20,625	22,344	24,063	25,781	27,500	29,219	30,938						
17/32				21,914	23,740	25,567	27,393	29,219	31,045	32,871	34,697					
9/16					25,137	27,071	29,004	30,937	32,871	34,305	36,738					
19/32					26,533	28,575	30,615	32,656	34,697	36,738	38,779					
5/8						30,078	32,226	34,375	36,523	38,672	40,820	42,969				
21/32						31,582	33,837	36,094	38,350	40,605	42,861	45,117				
11/16							35,449	37,813	40,176	42,539	44,902	47,266	49,629			
23/32								39,531	42,002	44,473	46,943	49,414	51,885			
3/4								41,250	43,828	46,406	48,984	51,563	54,141			
25/32									45,654	48,340	51,025	53,711	56,396	59,082		
13/16									47,480	50,273	53,066	55,859	58,652	61,445		
27/32										52,207	55,107	58,008	60,908	63,809		
7/8										54,141	57,148	60,156	63,164	66,172		
29/32											59,189	62,305	65,420	68,535	71,650	
15/16											61,230	64,453	67,676	70,898	74,121	
31/32											63,271	66,602	69,932	73,262	76,592	
1											65,313	68,750	72,188	75,625	79,063	82,500
1 1/32												70,898	74,443	77,988	81,533	85,078
1 1/16												73,047	76,699	80,352	84,004	87,656
1 3/32												75,195	78,955	82,715	86,475	90,234
1 1/8												77,344	81,211	85,078	88,945	92,813
1 5/32													83,467	87,441	91,416	95,391
1 3/16													85,723	89,805	93,887	97,969
1 7/32													87,979	92,168	96,357	100,547
1 1/4													90,234	94,531	98,828	103,125
1 9/32													92,490	96,895	101,299	105,703
1 5/16													94,746	99,258	103,770	108,281

TABLE II—SHEARING VALUE OF IRON AND STEEL RIVETS

Diameter of rivet, inches	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7/8	[illegible]	1	1 1/16	[illegible]	1 3/16	[illegible]	[illegible]	1 3/8	[illegible]
Area of rivet, sq. in.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.6013	.6903	[illegible]	[illegible]	.9940	1.1075	[illegible]	1.3530	1.4849	[illegible]
Diameter of rivet hole, inches	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7/8	[illegible]	1	1 1/16	[illegible]	1 3/16	[illegible]	[illegible]	[illegible]	1 7/16	[illegible]
Area of rivet hole, sq. in.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.6903	[illegible]	.8866	[illegible]	1.107[illegible]	1.227[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Shearing value of iron rivet [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] row "A" [illegible] per sq. in.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Shearing value of steel rivet (44,000) [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	53,997	59,532	[illegible]	71,412	77,752

efficiency as well as to a seam requiring a wide inside welt like the diamond seam, some of these drawbacks being as follows: Accessories to a locomotive such as air pumps and reverse gears are fastened to the boiler shell by means of brackets, and it is almost always impossible to design these brackets so that the studs attaching them to the shell will permit of as high an efficiency in the shell sheet as 98 per cent, thereby making it necessary to apply diamond shaped liners to the shell underneath these brackets, in order to keep the efficiency through these stud or bolt holes up to the efficiency of the seam, which is absolutely necessary inasmuch as the thickness of the plate is generally based on the seam. The wide seam noted above also interferes with these brackets and liners, oftentimes making it necessary to put studs or rivets in the seam itself, thereby weakening it to below its theoretical efficiency. Especially is this true in the case of handrail post studs, which very often necessarily come in the seam. Unless the seam has some rows of high efficiency as the decuple seam rows *B*, *C* and *E* where these studs can be placed, the efficiency of the seam is impaired. The difficulty in locating attachments when wide welt seams are used, accounts for the sextuple seam being used on small boilers; that is, the smaller the boiler the harder to find place for attachments, and consequently here the seam with narrower welt works out the best.

The diamond seam is even more susceptible than the decuple seam to weakness at the inner row of rivets (marked *A* on Fig. 5) due to the higher efficiency and to the fact that the rivets must be placed close together in order to get sufficient rivets in the seam. The usual spacing of rivets in this row is about 3½ in. Assuming ¾ in. plate, 1 5/16 in. rivet holes, 98 per cent efficiency, the thickness of the two welts must be as follows:

$$\frac{3\tfrac{1}{2} \times \tfrac{3}{4} \times .98}{3\tfrac{1}{2} - 1\ 5/16} = 1\ 3/16 \text{ in.}$$

against ½ in. and 9/16 in. welts, or a total thickness of 1 1/16 in. for the decuple seam. This greater thickness of welts, coupled with the much wider inside welt, eliminates to a great extent, if not wholly, the saving in weight in the plate itself, due to the higher efficiency, and thus the reason for the use of this seam has been defeated.

Fuel and Locomotive Performance on the Central of Georgia

The statement has been made that whatever tends to conserve locomotive fuel tends also to improve the general operating performance of a railroad. This seems to be borne out by the statistics of the Central of Georgia for the year 1921. During the year the railroad conducted a fuel economy campaign that developed a fine spirit of co-operation among the employees. The results in fuel saving were excellent. As shown in Table 1 the railroad saved more than half a million dollars during the year by improved locomotive fuel performance, this saving resulting in part from direct reductions in the fuel bill and to a lesser degree from incidental economies in operation as shown in the summary.

The spirit developed by the campaign on fuel saving has materially affected the operation in other ways and it is felt that it was an important factor in the excellent passenger train performance. Throughout the 12 months, 98.7 per cent of all passenger trains were on time. The operation of manifest freight trains was also improved, the percentage on time increasing from 76.5 in 1920 to 93.1 in 1921. Engine failures were materially reduced and the average mileage per failure rose to 57,572. Overtime was reduced to a remarkable degree, the overtime for enginemen and trainmen in 1921 being 23 per cent less than 1920. In yard service, overtime was 45 per cent less and in shops, 67 per cent less.

In announcing the results of the fuel saving campaign, the Central of Georgia Employees' Magazine makes the following comments:

"It is not necessary to state that this amount of money saved in coal has enabled the maintenance of equipment and maintenance of way departments to work more men and to use more material in the past year than would have been possible if this saving had not been effected.

"The credit for this fine performance is due to every one on the railroad who had anything to do directly or indirectly with the consumption of coal. By this time, as a result of the very intensive campaign on fuel economy, all of us are thoroughly familiar with the fact that practically every one on the railroad has something to do directly or indirectly with the question of fuel economy.

"At the various meetings which have been held by division committees on fuel and employees generally on the various divisions, the latter part of December, 1921, and the first part of January, 1922, resolutions have been made to the effect that every effort will be made to make a still greater saving in the year 1922. Fuel economy is a vital element in the operation of our railroad at this time; not only in respect to the direct saving as result of decrease in amount of coal used, but it has a direct influence on the prompt handling of business. The employees of the Central of Georgia are to be congratulated on the fine showing in the year 1921 as reflected by the figures given herewith."

TABLE 1—ANALYSIS OF FUEL SAVING

Actual cost of coal 12 months ending December 31, 1921-1920, as charged to operating expenses

	12 Months 1921	12 Months 1920	Decrease
Tons of coal	511,520	637,412	125,892
Cost	$2,092,647	$2,741,133	$648,486
Average cost per ton	$4,091	$4,300	$0.209
Saved by better performance			91,254 tons

At an average of 50 tons per car, the detention of 1,825 cars was saved.

Figuring an average of 10 days per car, from mine back to mine, there were saved 18,250 car days.

Figuring an average of 28 cars per train at an average haul of 250 miles, there were saved the operation of 261 trains, also operating 32,625 locomotive miles.

Saving in car miles and ton miles based on average haul of 250 miles loaded cars and 250 miles empty back to the mine:

Car miles	912,500	..
Ton miles	36,503,750	

Summary Saving in Money

91,265 Tons of coal valued at	$350,999.47
18,250 Car days at $1.00 per day	18,250.00
36,503,750 Ton miles at actual transportation cost, or .0034 per ton mile	124,112.75
Locomotive repairs 32,625 miles at .30 per mile	9,878.50
Freight car repairs 912,500 miles at .02 per mile	18,250.00
Total saving	$521,399.72

TABLE 2—PASSENGER TRAIN PERFORMANCE, 1921

Month	Number passenger trains run	Number passenger trains on time	Percentage on time
January	2,937	2,867	98
February	2,656	2,592	98
March	2,941	2,888	98
April	2,850	2,816	99
May	2,814	2,779	99
June	2,792	2,763	99
July	2,814	2,780	98.8
August	2,820	2,802	99.4
September	2,722	2,706	99.4
October	2,811	2,795	99.4
November	2,803	2,779	99.1
December	2,935	2,889	98.4
Totals for 1921	33,895	33,456	98.7

TABLE 3—COMPARISON OF ENGINE FAILURES, 1920 AND 1921

	Number failures		Miles per engine failure	
Month	1921	1920	1921	1920
January	16	40	42,788	18,015
February	17	27	36,731	25,452
March	18	48	39,198	15,462
April	6	34	112,174	19,733
May	11	17	63,271	41,716
June	6	19	118,942	39,317
July	8	31	94,406	22,492
August	12	33	58,747	22,731
September	16	42	40,611	17,132
October	6	19	112,813	38,457
November	15	36	43,139	18,966
December	13	24	48,819	29,045
	144	370	Average 1921	Average 1920
	...	...	57,572	23,798

Increase in average miles per engine failure, 1921 over 1920, 33,774 miles. or 58.66 per cent.

Handling Locomotives at Enginehouses*

By J. P. Gundaker,
28th Street Enginehouse, Pennsylvania Railroad, Pittsburgh

THE Twenty-eighth Street enginehouse at Pittsburgh handles from 160 to 180 passenger and switching locomotives each 24 hours in normal times. When a passenger train arrives at the Pennsylvania station, the locomotive is cut off from the train and run up to the inspection pits at Twenty-sixth Street, where it is inspected.

The defects found are reported on forms M. P. 62, and these forms are then sent through a pneumatic tube to the enginehouse office at Twenty-eighth Street.

Two clerks on each eight hour trick write up the work from the forms, M. P. 62 on work cards, M. P. 142 b, which are then sent to the storage yard through another pneumatic tube, if the locomotive has only minor defects; or if fire is to be drawn for repairs, the work is delivered by the work distributor to the gang foreman at the repair pits or to the gang foreman in the enginehouse.

After the locomotive has been inspected, the crew takes it to the ash pit where they turn it over to the enginehouse force.

The fire is then cleaned or drawn on one of the four pits, which are filled with water to within several inches of the base of the rail to reduce dust and gas and to quench the live cinders. The cinders are removed from the pits to cinder cars by an overhead electric crane with a clam-shell bucket.

After the fire is cleaned or drawn the locomotive is moved past the coal wharf where the tank is loaded with passenger coal and about five hundred pounds of low volatile coal is placed on the front of the tank to keep down the smoke while in the city limits, in accordance with a city ordinance.

After the coal is placed on the tank the locomotive is moved to the sand house and the water plug, where the sand box and the cistern are filled.

The locomotive is then run on to the turntable and headed in the direction in which it is next to be used, after which the hostler places it in the storage yard or on the repair pit.

The head inspector on the inspection pit marks on the bulkhead of the tank, in chalk, the destination of the locomotive for the information of the hostler.

The repair pits at Twenty-eighth Street, Pittsburgh, are three in number with a capacity of from twelve to fifteen locomotives, according to their classes or sizes. Light repairs, which require the locomotive to be jacked up, such as renewal of driving spring hangers, renewal of engine truck or trailer shells, or slight alterations to spring rigging, are performed on the repair pits. Also work which requires the fire to be drawn, such as flues or firebox calked or flues cleaned or light repairs in smoke box or to boiler valves, can be performed on the repair pits.

After the repairs to the locomotives are completed on the repair pits or in the enginehouse they are sent to the storage yard to remain until they are marked up and dispatched on runs.

Locomotives which are originally sent to the storage yard from the ash pits and which require only light repairs, such as tightening bolts and nuts, refilling grease cups, and repairs to piston rod or valve stem packings, are placed on one of the three pits in the storage yard until repairs are completed and then are lined up on one of the seven out-bound tracks.

After a locomotive is assigned to a run by the engine dispatcher the allowance of valve oil is placed in the lubricator by a locomotive preparer, the engine oil, to oil the machinery, and the cotton waste, to clean windows and lamps, are placed on the engine. The hand lanterns are filled with signal oil and the markers and torches are filled with carbon oil.

Eighty minutes before depot leaving time on a through passenger run, or 60 minutes before depot leaving time on a local passenger run, the engineer and fireman are required to report for duty and oil and inspect the locomotive and build up the fire. At 40 minutes before depot leaving time the engine is required to leave the storage yard and proceed to the depot, the fireman filling the cistern with water at the plug on the out-bound track.

Every precaution is taken to make the locomotives safe for the train employees and the traveling public. Two outbound inspectors examine carefully every locomotive marked up for service and report any defects found to a gang foreman who sees that they are corrected before the locomotive leaves.

An assistant enginehouse foreman is present at all times to see that defects are corrected and locomotives dispatched promptly so there will be no delay to the trains at the depot and, so far as is humanly possible, no delay to trains on the road due to locomotive failures.

*Reprinted from the M[illegible] Magazine.

The Railway and Locomotive Historical Society

LESS than 100 years ago the first locomotive was placed in operation in this country. The development of the railroads which followed brought about such rapid progress that in half a century the continent was settled from the Atlantic to the Pacific and girded with a network of steel which so hastened its industrial development that within a short span of a century the American republic rivaled in wealth and power the leading countries of the old world. This is but one aspect of the influence of the railroads upon the progress of this nation. The complete story, if it could be told, would be more thrilling than fiction, of deeper significance than military campaigns or battles.

The history of the railroads in the United States is recorded only in fragments. There is no record of many of the important details of the early development and as time goes on the present knowledge will be lost unless carefully preserved. Here and there throughout the country will be found a few earnest workers whose interest in railroad history has led them to collect data on the early progress of rail transportation. In order to make their work more effective, about 50 persons interested in early railroad history have formed an organization under the name of the Railway and Locomotive Historical Society.

The first two bulletins of the society have now been issued, and contain some interesting articles which can be judged from the following titles: Yesterdays on the New York Central, The Story of the New England, America's Most Famous Train, The Fall River Line Boat Train, Eddy Clocks, Some Experimental and Historical Locomotives of the Chicago and North Western, The Rival Builders, the last named giving many important particulars of locomotives built by William Mason and the Taunton Locomotive Works.

Some of the data regarding these locomotives is noteworthy as giving an indication of the rapidity with which mechanical design progressed in the early period of railroad history and also as showing the extent to which the pioneer builders anticipated some of the most recent innovations in locomotive appliances. The changes in the type of valve gear furnishes a typical illustration. The early locomotives were built with V-hook valve motion. In 1855 William Mason built locomotives for the Toledo & Illinois with Stephenson link motion and in 1874 a locomotive for the New Bedford Railroad was fitted with the Walschaert gear. It was not until

30 years later that the Walschaert design was generally adopted. Other interesting items which may be worthy of mention are the following: William Mason locomotive No. 139, built for the Chicago, Burlington & Quincy in 1863, had a water leg in the firebox; No. 233, built for Toledo, Wabash & Western in 1866, had electric apparatus in the boiler to prevent formation of scale.

The officers of the Railway and Locomotive Historical Society are: President, Charles E. Fisher, Taunton, Mass.; vice-president, Herbert Fisher, Taunton, Mass.; recording secretary, C. W. Phillips, Taunton, Mass.; corresponding secretary, R. W. Carlson, Escanaba, Mich.; treasurer, A. A. Loomis, Jr., Berea, Ohio.

Interstate Commerce Commission Orders Power Brake Investigation

THE Interstate Commerce Commission, under date of February 20, has ordered an investigation to determine whether and to what extent, power brakes now in general use are adequate and in accordance with requirements of safety; what improved appliances or devices are available for use; and what improvements may or should be made. Hearing to be held at Washington, April 6.

A supplementary order was issued on March 4, addressed to all railroads reporting to the I. C. C., directing them to file a statement not later than the first day of April, 1922, covering the information called for below:

1. Copies of rules, bulletins and other instructions pertaining to operation, inspection, testing and maintenance of air brake equipment.

2. List of locations where facilities are provided for inspection, testing and repair of air brake equipment, together with a brief description of facilities and number of employees engaged in this work at each of such points.

3. List of locations where tests of pressure retaining valves are made, and description of such tests.

4. Statement showing location, length and gradient of all grades more than one mile in length and having a maximum gradient of one per cent or greater.

5. Description of practices in manipulating brake equipment for controlling trains descending said grades, showing types of equipment and brake pipe and main reservoir pressures used; limiting number of cars or tonnage for each of said grades; and speed limits specified.

6. Statement showing locations, if any, where trains are required to stop on said grades for the purpose of inspection of brakes or cooling of wheels.

7. List of accidents on said grades which occurred during the calendar years 1919, 1920 and 1921, resulting from failure properly to control speed of trains on grades, which caused personal injury, loss of life or property loss of $500 or more, together with number of injuries and fatalities and the property loss sustained by the carrier as a result of each such accident.

8. Statement for each of three years named, showing number of couplers broken, drawbars pulled out, and break-in-twos from other causes, together with derailments resulting therefrom, which occurred on said grades.

9. Statement for each of three years named, showing number of car wheels renewed for the following causes: (a) Burst, (b) Cracked, (c) Brake burn, (d) Slid flat.

10. Statement showing in detail to what extent, if any, hand brakes are used for controlling the speed of trains.

11. Statement showing what power brake equipment other than air brake equipment, if any, is used and extent of such use.

12. Number of accidents which occurred during the calendar year 1921, resulting in personal injury or loss of life from each of the following causes: (a) Burst or parted air hose, (b) Emergency application of air brakes, (c) Undesired quick action of brakes, (d) Train parting, (e) Faulty manipulation, and (f) Accidental interference with proper operation of brakes. Show the cause, number of injuries and fatalities in each case, and the total property loss sustained by the carrier.

13. Statement for the calendar year 1921, showing terminal and road delays to trains, due to causes attributable to improper manipulation or operation of air brakes or defective brake equipment.

14. Suggestions for improvement of air brake conditions or practices, and any other data which may be of value in connection with the commission's inquiry into this subject.

Action of American Railway Association

In connection with the above orders, the General Committee of the Mechanical Division of the American Railway Association at its meeting in Chicago, March 14, reached the following conclusions:

(a) That the time was not sufficient to assemble the data required; (b) that for the hearing on April 6 it is suggested each carrier send its representative to Washington with whatever information can be obtained by that date; (c) that the Committee on Safety Appliances of the Mechanical Division, consisting of C. E. Chambers (chairman), superintendent motive power and equipment, Central Railroad of New Jersey; C. E. Fuller, superintendent motive power and machinery, Union Pacific; W. J. Tollerton, general mechanical superintendent, Chicago, Rock Island & Pacific; J. T. Wallis, chief of motive power, Pennsylvania System; C. F. Giles, superintendent machinery, Louisville & Nashville, and T. H. Goodnow, superintendent car department, Chicago & North Western, be delegated to handle the matter for the association and that it be given any assistance necessary by the Train Brake and Signal Equipment Committee; (d) further, that the Committee on Safety Appliances be directed to advocate that present brake arrangements are satisfactory and that the percentage of mileage on grades is too small in proportion to total mileage to warrant any greater investment in brake appliances.

Subsequent to the meeting, it was requested that all information developed by each of the carriers and supplied to the Interstate Commerce Commission be forwarded to C. E. Chambers, superintendent of motive power and equipment, Central Railroad of New Jersey.

Deposition by Automatic Straight Air Brake Company

The Interstate Commerce Commission, in connection with its investigation of power brakes and appliances, ordered that upon application of Clark & La Roe, attorneys for the Automatic Straight Air Brake Company, the deposition of F. K. Vial of Chicago, with respect to the authorship and the subject matter stated in a certain communication addressed by him to H. I. Miller, president, Automatic Straight Air Brake Company, New York, N. Y., under date of September 20, 1918; and also with respect to the authorship of and the subject matter in a paper read before the Richmond Railroad Club, April, 1915, "The Chilled Iron Wheel," be taken before Examiner John T. Money, at the offices of said Vial, in Chicago, on March 20.

Power Brake Hearing Postponed

The Interstate Commerce Commission has postponed from April 6 to May 17 its hearing at Washington in connection with its investigation of power brakes and appliances; and the time-limit of its order requiring the carriers to furnish certain information regarding power brakes and appliances has been extended from April 1 to May 1.

Labor Board Announces Rules for Mechanics

ANOTHER new code of rules governing, in this case, the working conditions of employees who are members of the International Association of Railroad Supervisors of Mechanics, was announced by the Railroad Labor Board on February 28. The new rules, which are reproduced in full below, apply to the Baltimore & Ohio Chicago Terminal; the Boston & Maine; the Colorado & Southern; the El Paso & Southwestern; the Gulf Coast Lines, including the Beaumont, Sour Lake & Western, the Houston Belt & Terminal, the New Iberia & Northern, the New Orleans, Texas & Mexico, the Orange & Northwestern and the St. Louis, Brownsville & Mexico; the St. Louis Southwestern, and the Southern Pacific (Pacific System). They are effective March 1.

The new rules are as follows:

Rule 1. The term "supervisor of mechanics" as hereinafter used, shall be understood to include all foremen below the rank of general foreman supervising mechanics in the maintenance of equipment department.

Rule 2. All supervisors of mechanics, herein specified, shall be compensated on a monthly salary basis.

Rule 3. To determine the daily basis for all employees herein specified, multiply by twelve the regular monthly rate (exclusive of compensation for extra service), and divide the result by the number of days in a year that service has been customarily performed.

Rule 4. Monthly salaried supervisors of mechanics shall be required to remain on duty only a sufficient length of time after the shift of mechanics they supervise have completed their tour of duty, to properly turn over the work to their successors, if on a relief position; or if not on a relief position to see that there are no fire hazards and that everything is in proper place and order.

Rule 5. Supervisors of mechanics will not be required to report for work on Sundays, unless they have supervisory duties to perform, or when attending a conference in the interest of the service.

Rule 6. Supervisors of mechanics whose tour of duty consists of seven days per week, will be granted two days off each month. If for any reason the supervisor is not permitted to have two days off each month, he will be compensated for those days on the pro rata basis, in addition to the regular monthly compensation.

Rule 7. There will be no deduction in the compensation of supervisors of mechanics on account of shops working reduced hours.

Rule 8. The entering of employees in the positions occupied in the service, or changing their classification or work, shall not operate to establish a less favorable rate of pay or condition of employment than is herein established.

Rule 9. When a new position is created the rate of pay will be established to conform to positions of similar character and responsibility.

Rule 10. Foremen temporarily assigned to higher-rated positions will receive the higher rate.

Rule 11. When supervisors of mechanics are required to leave their established headquarters (which will be designated by superior officers), in compliance with the directions of superior officers, they will be paid necessary actual expenses while away.

Rule 12. Employees covered by this schedule and those dependent upon them for support will be given same consideration in granting free transportation as is granted other employees in service.

Rule 13. In filling vacancies or new positions, supervisors of mechanics senior in the service employed on a division or terminal making written application for such position, shall be granted preference where ability is conceded; the superintendent or master mechanic to be the judge.

Rule 14. When a position held by a supervisor of mechanics is abolished, advance notice thereof will be given, and so far as the management is concerned, he may resume his seniority in the craft from which he was promoted.

Rule 15. Efforts will be made to provide suitable employment for supervisors of mechanics who have given long and faithful service and have become unable, on account of age or infirmity, to handle their present positions.

Rule 16. In case a supervisor of mechanics accepts an official position with the carrier, or a salaried position as a representative of the employees, he will retain all seniority rights as provided for in Rules 13 and 14.

Rule 17. This agreement shall be effective as of March 1, 1922, and shall continue in effect until it is changed as provided herein or under the provisions of the Transportation Act, 1920.

Rule 18. Should either of the parties to this agreement desire to revise or modify these rules, 30 days' written advance notice containing the proposed changes, shall be given and conferences shall be held immediately on the expiration of said notice unless another date is mutually agreed upon.

The new rules are to apply to each of the above-named carriers "except in such instances as any particular carrier may have agreed with its employees upon any one or more of such rules, in which case the rule or rules agreed upon * * * shall apply * * *."

Referring to certain rules proposed by the employees, the decision says:

The Board has eliminated proposed rules relative to classification of shops, classification of supervisors of mechanics, and duties required in case of industrial disputes. These rules shall cease and terminate, except in such instances as any particular carrier may have agreed or may hereafter agree with its employees upon any one or more of such rules, in which case the rule or rules agreed upon by the carrier and its employees shall apply on said road.

All rules regarding the subject of discipline and grievances are left to the carriers and their employees for adjustment, the decision stating that a "substantial number of the carriers and their employees have agreed upon the major part of" these rules. The Board also adds:

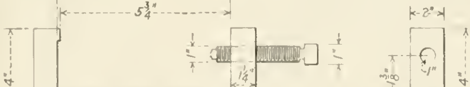
The Labor Board believes that certain other subject matters may not be covered in all localities by rules of general application, and require further consideration by the parties directly concerned.

Similarly the questions of vacations and sick leaves with pay are, according to the terms of this decision, remanded to the carriers and the employees for settlement.

Crosshead Blocking Clamp

By Leo. J. Welch

THE accompanying sketch shows a handy clamp, one or more of which should be carried in every locomotive engineer's tool box. The clamp is made to the dimensions shown and is intended to be used instead of wooden blocking whenever for any reason it may be necessary to disconnect the main rod and block the crosshead of a locomotive. The clamp takes up but little room and is as effective as wooden blocking, being applied to the guides just back of the cross-



Handy Clamp Facilitates Blocking of Crossheads

head and resting firmly against it with the piston at the extreme front of the stroke.

This clamp can also be used in case of broken guides, missing guide bolts or broken trunnion plates. When guide bolts are missing the clamp is applied to hold the guide against the cylinder block in such a way as to clear all moving parts. In this way, a locomotive can often be quickly fixed up to permit its movement to a terminal or the nearest repair point. The ready means of clamping the trunnion plate of a Walschaert valve gear may also prevent a locomotive or train delay.

WHAT OUR READERS THINK

The editors of the Railway Mechanical Engineer *will be glad to receive communications for publication. This department is intended to reflect the views of the readers and the opinions expressed do not necessarily represent the sentiments of the editorial staff.*

Building Up Sharp Flanges by Gas Welding

Pittsburgh, Kan.

To the Editor:

At the present time there is considerable discussion, pro and con, as to the desirability of building up sharp flanges on locomotive tires by autogenous gas welding. On the Kansas City Southern we use this method of reclaiming tires mainly where one tire in a set has become worn to the extent that it has reached our rejection limit. This is particularly advantageous where the tire that develops the sharp flange is near the rejection limit for thickness as it avoids turning down new tires which would otherwise be necessary.

Our method of doing this is to remove the tire from the wheel and place it on a trestle or face plate, flange down. Our experience has been that preheating the tire is not absolutely essential but it might tend to facilitate the operation if the heat was applied uniformly around the circumference of the tire. To heat the tire locally in a forge before laying n the welding metal will warp the tire. Our usual method is to start one or two welders on the tire without preheating. The welding metal is then laid in until the flange is brought up to contour and takes the gage full. The welder then makes use of a fuller and hand hammer to bring contour down to gage.

We find it best to use a welding wire higher in carbon than the tire itself. We have experimented to a certain extent with turnings from tires, drawing out and using these turnings instead of welding wire. Our experience with the turnings, however, has not been satisfactory and has been discontinued. After building up the flange, the tire can be turned if necessary. Our practice, however, is to mount the tire on the wheel and use an abrasive wheel-truing brake shoe in order to bring the tires down to normal contour.

This method has been in use on the Kansas City Southern for approximately two years and we have yet to find the first defective flange brought about by autogenous welding.

M. A. Hall,
Superintendent Machinery.

Unbalanced Steam Pressure on Pistons

Council Bluffs, Ia.

To the Editor:

That the piston of a steam engine or locomotive may be subjected to unbalanced steam pressure, frequently of such amount as to be the cause of excessive friction and wear, is a possibility that evidently has not occurred to many designers. Such is the case, however, as will be seen on inspection of the accompanying cuts.

Fig. 1 is a sectional view of the type of piston used in the U.S.R.A. locomotives. The piston is built up of a central web and hub of cast steel, to which is riveted an annular bull ring of cast iron. That portion of the bull ring which is designed to run in contact with the bottom of the cylinder is made wider over a portion of the circumference, the periphery of the bull ring being extended to form a sort of slipper, the object being to increase the area of this part of the piston, upon which the weight is carried, thus reducing the unit pressure. The object is praiseworthy, but the ultimate results are far from what it was desired to attain.

This extended slipper surface projecting beyond the face of the piston is subjected to unbalanced steam pressure, for if it does what it is expected to do, i.e., run in actual contact with the cylinder wall, except for the film of lubricant which may or may not be present, then the steam is excluded from beneath the piston and acts only on the upper surface. The weight of the piston is therefore increased by an amount equal to the product of this projected area by the steam pressure. Thus, instead of reducing the unit pressure on the cylinder wall, it is actually increased three or four hundred per cent. The inevitable result is excessive wear, as an examination of cylinders where this type of piston is used will show.

Not only is the wear unduly severe on account of the increased pressure, but it is very apt to be much increased by a condition which enlarges the unbalanced area. After the wear has progressed sufficiently to open the space above the piston, as shown exaggerated in Fig. 2, the annular area of

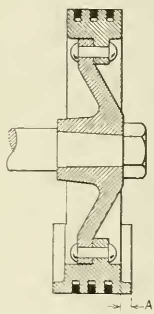


FIG. 1

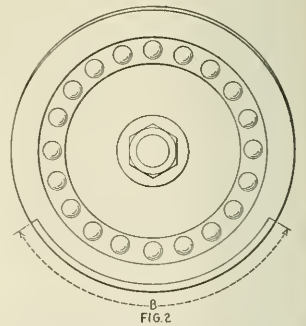


FIG. 2

that part of the upper surface of the piston, outside of the first piston ring, becomes unbalanced and the unit pressure on the cylinder wall is further augmented.

The remedy for the condition outlined above is obvious. It is to put the piston in the lathe and turn off the extended slipper portion.

The complete and absolute remedy for possible unbalancing of pistons is to support the piston centrally in the cylinder, as far as possible, and this can only be done by using extended piston or tail rods. It is also clear that the first ring should be close to the face of the piston and the face beveled back toward the first ring, to reduce the area of the annular space outside of the outer ring.

In addition it may be said that there is absolutely no necessity for the excessive amount of metal and consequent weight of pistons as usually designed. This excess weight is productive of a large share of the evils met with in operation of the heavier types of locomotives in use. Much of it is due to the fancied necessity for the use of three rings in pistons. A single ring of a positive seal type will undoubtedly give better service with less loss of steam than the three rings as usually applied. It will certainly afford an opportunity to dispense with considerable of the excess weight. It is also certain that with a reduction of weight, that many difficulties with lubrication will also disappear.

Thomas E. Stuart.

A Workman Expresses Himself

New York State.

To the Editor:

During the last year the *Railway Mechanical Engineer* seems to me to be a great deal inclined always to favor the railroads' supervisory forces. The mechanics and other workmen on the railroads are run down and criticized in nearly all points in their efforts to increase efficiency and economy.

There is some criticism due the mechanics but there is greater criticism due the supervisory forces—I firmly believe that a great many of them do not even know what the words efficiency and production mean.

I have worked at the mechanical game on the railroads as a mechanic and a foreman. I have made a close study of the situation and find that the one great wall to get over is that the under foreman—and other small officials as they are classed by the management—have pulled the wool over the superintendent of motive power's eyes for so many years that they have the idea that they can do so indefinitely.

Their effort toward keeping the power on the road is all right but (here is that one little bad feature "but") they overdo themselves and only do half of the work and send the running stock out to break down on the road just to show that the engine or car, whichever it may be, was put in service when it was promised to the master mechanic.

If I had the right of free speech I would criticize the under subordinate officials till they had to get out and produce the goods or vacate. But as the situation is at present the railroad officials can see nothing that a workman may remark or propose, if there is one thread of criticism toward any of the officers.

I hope some official will come back at this letter with an answer; I believe my points can be easily proven without in any way crippling the power on any railroad. I believe if the railroads would come half-way and show a little co-operation with the men, and not try to trick them at every move, there would be far better results. Mechanic.

The Possibilities of High Power Internal Combustion Main Line Locomotives

London, England.

To the Editor:

I have read with a great deal of interest your article on the above subject on page 120 of the March issue. Whilst quite agreeing with many of the remarks so clearly given therein, I must draw your attention to the defects of the so-called Diesel locomotive.

Although it is true that locomotives have been built and operated in Europe in which the prime mover has been a Diesel-cycle, internal-combustion engine, they have not been satisfactory in any sort of way; in the first place they are much too costly and heavy, the danger of broken crank-shafts has been amply demonstrated, and as a hauling machine for main line traction the Diesel is out of the question and only a waste of money to further use it. It is true also that the constant pressure internal combustion engine has been now brought to such a state of perfection that the time has arrived when a serious attempt is being made to increase the capacity of our railways by the introduction of internal combustion main line locomotives of high power.

This work I have had the pleasure of carrying out and at the present time am constructing two standard gage locomotives for demonstrating purposes. Laboratory tests have indicated that there will be a saving in fuel per 1,000 tons hauled at given speed and other conditions of no less than 75 per cent as compared with oil fired ordinary superheated steam locomotives, of which I have had also considerable experience during the last 20 years. The internal combustion engine, which is embodied in the new Paragon internal combustion locomotives is known in this country as the super-Diesel oil engine and is the result of some 30 years' experience in many types of internal combustion prime movers, closely studied with a view to the ultimate application of same to heavy railway haulage.

The exhaust is silent, the temperature of same is very low and the thermal efficiency far exceeds that of any Diesel-cycle engine whether of the two or four stroke type. One of the two locomotives under construction is fitted with my variable voltage electrical power transmission of special design for driving the axles, and is of the 0-4-4-0 type and the tests will be made in a few months' time on a 1,000-ton freight train.

The other locomotive is of equal power as regards the internal combustion engines, but in this case steam is used as the medium for transmitting the power of the internal combustion engines to the driving axles, so that all the tremendous advantages of steam are still retained for speed regulation, reversing and operation purposes, whilst the use of internal combustion means as the prime source of energy gives now a new and long lease of life to the steam locomotive even against electrification for trunk line operation.

For the purposes of the experiment we have taken one of our standard 14 in. by 22 in. six-wheel coupled standard steam locomotives, put her under the crane, lifted the boiler, superheater, pumps, injectors, etc., off, disconnected the tender (as this of course is not now required), and in the place of the ordinary steam boiler we are installing a set of Paragon internal combustion engines which drive a Paragon specially constructed steam compressor. Steam is first made in a small flash type steam generator (about 30 gallons of water used), and this small amount of steam is raised to about 16 lb. gage pressure. The internal combustion engines are then started, which driving the Paragon compressor, draw the low pressure steam and compress it (in this case to 180 lb. per sq. in. gage pressure), the steam is then admitted through the ordinary throttle and cutoff gear to the working steam cylinders, the tractive effort is produced (same as when the boiler was installed), the exhaust steam, however, does not exhaust to the atmosphere, it exhausts to the low pressure side of the system and is drawn in and recompressed by the Paragon steam compressor, and transferred with all its latent heat to the high pressure side for use again.

The Paragon is now nearly completed, the compressor has been tested and a very high thermal transformation efficiency has been obtained, sufficient to warrant me for stating that we estimate a rail horsepower thermo-dynamic efficiency of quite 25 to 30 per cent, which compared with many types of oil-fired steam locomotives, indicates a fuel saving of 75 per cent, which will simply chase off the earth any scheme of electrification in the ordinary way.

The Paragon electric steam locomotive system is a further development of the previously mentioned invention, and consists of means by which existing steam locomotives may be converted and operated on electrified railways, and with greater economy than with high class ordinary electric locomotives. The mechanical energy given by the electric motor is first transformed into steam heat energy by the compressor; it is then re-transformed into mechanical energy by the working cylinders, which produce the tractive effort, expanding and cooling the steam in the process, the exhaust steam is then taken by the compressor and is re-compressed by means of the electrically driven Paragon steam compressor, ready for use again, continually flowing at various pressures and temperatures in a close circuit, no discharge to the atmosphere.

A feature also demonstrated during my experiments, is that on running down grades the kinetic energy of the locomotive and train is arrested and transformed into electrical energy which is returned to the line, also with a much higher efficiency than with ordinary locomotives.

William P. Durtnall.

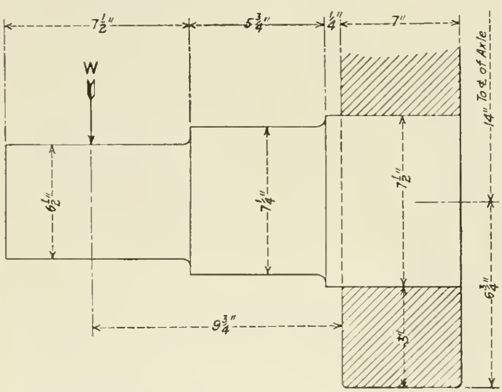
THE QUESTION BOX

WHEN a question arises that you cannot answer, what do you do? Some of the readers of the *Railway Mechanical Engineer* refer knotty problems to the editorial staff and the editors always try to answer inquiries insofar as their numerous other duties will permit. It has been suggested that a department of questions and answers would add value to the paper and in order to see whether it would be popular with our readers, the Question Box has been started.

The editors will try to get answers for any questions sent in. Probably more problems will be submitted than can be handled by the limited staff. Some may deal with matters that only a specialist is competent to pass on. Such questions will be submitted to recognized authorities in the respective fields, or will be referred to our readers. It is hoped that those who are able to supply information will help by sending in replies. This is, in a special sense, your department. The benefits you derive from it will depend on the interest that you show. We hope you will help to make it of value both by sending in questions and by co-operating in answering the inquiries published.—*The Editors.*

Design of Crank Pin and Crank Pin Hub

Question.—Referring to the sketch attached, please show the method used in arriving at the following data needed in design: (1) Fibre stress in the crank pin hub due to pressing in the pin with a pressure of 140 tons; (2) maximum pressure at which the crank pin can be pressed in without



causing the hub to burst; (3) fibre stress in the hub due to pressing in the pin at 140 tons, plus the stress due to the thrust from the main rod (cylinders 25-in. diameter by 28-in. stroke, boiler pressure 180 lb. per sq. in.); (4) find the strength of the pin to resist the load W.

The wheel center is of cast steel and the pins are carbon steel forgings, both conforming to the specifications of the Mechanical Division of the A. R. A.—P. F. R.

* * *

The Railway Mechanical Engineer invites answers to the above problem. The best solutions will be published and paid for at the usual space rate.

Automatic Couplers

Questions.—

1. When were automatic couplers first applied to freight and passenger cars?

2. To what extent were automatic couplers applied before their use was required by law?

Answers.—

1. The Janney coupler was invented in 1873; the Miller hook was developed about the same time and was applied to a large number of passenger cars prior to 1880.

2. A large number of different types of automatic couplers were applied before their use was required by law and practically all passenger equipment was fitted with some type of automatic coupler before 1889. Automatic couplers also came into use extensively on freight cars a few years later. A summary included in one of the early reports of the Interstate Commerce Commission shows the per cent of freight cars fitted with automatic couplers was as follows: 1889, 6 per cent; 1890, 8 per cent; 1891, 12 per cent; 1892, 16 per cent; 1893, 22 per cent; 1894, 26 per cent; 1895, 31 per cent; 1896, 38 per cent.

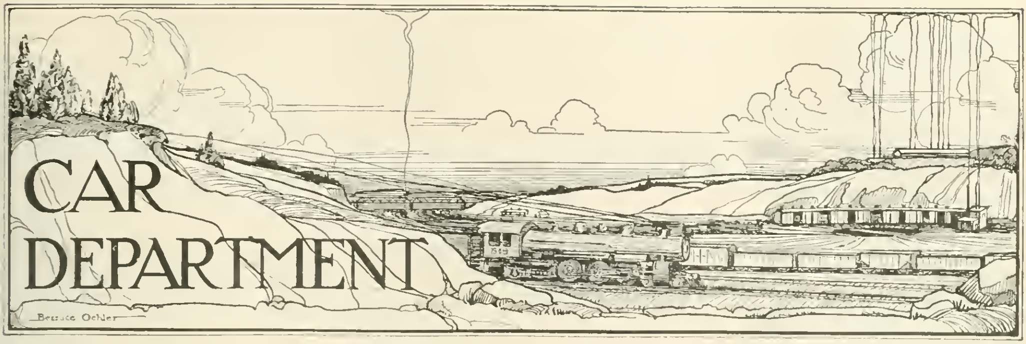
AIR BRAKE CORNER

Failure of Driver Brake to Release After Independent Application

Question.—Would like information on a question raised by several engineers regarding an action which sometimes develops in E. T. operation. In several cases it has happened that when an independent application of the brake is made, the brake will not release when the independent handle is moved to running position, the automatic handle being in that position also. To effect an independent release, it was necessary to place the independent brake handle in release position.—A. W.

Answer.—The action mentioned above is due to the equalizing slide valve of the distributing valve being in lap position. It was moved to this position probably because the distributing valve was overcharged, though possibly, perhaps, by a feed valve fluctuation. The overcharge would have been caused by remaining too long in release position and should be overcome by a kick-off some few seconds after returning from release to running position. Whether the kick-off has returned the equalizing piston to release position can be tested by making an independent application and then placing the independent brake valve in running position. If the driver brakes release, it is evident that the equalizing piston is in release position. If the driver brakes do not release under this manipulation, another kick-off should be given.

If the driver brakes creep on while running along the road, they should not be released by use of the independent brake valve but should be released through the automatic brake valve; that is, make a kick-off which will return the equalizing piston and slide valve to release position. If the driver brakes are released by the independent brake valve, on account of creeping on, they will continue to creep on until the equalizing piston is returned to release position.



Discussion of the New Rules of Interchange

Prices and Labor Rules Given Close Attention at Car Inspectors' and Car Foremen's Meeting

PROCEEDINGS of the Chief Joint Car Inspectors' and Car Foremen's Association meeting at the Great Northern Hotel, Chicago, January 9, were published in the February and March issues of the *Railway Mechanical Engineer*, with the exception of Rules 107, 108, 112 and 120. The discussion of these rules is taken up below.

Rule 107

C. J. Wymer (C. & E. I.): On this journal box here, on this labor, Item 220 says there shall be charged so much labor for renewing journal boxes in connection with certain work. Item 222 says, "Journal box, renewed, in connection with wheel renewals, including lids and dust guards." Nothing is said about the lid on any other combination. I do not understand why it makes specific mention of the lid in this case.

W. J. Owen (Peoria, Ill.): The charge in connection with wheel renewals, including lid and dust guards is for the labor required to get the box, apply the lid and apply the dust guard. If you renew the wheels you have got to remove and replace the old journal box. This .5 hour is for applying a lid and dust guard and getting the new box. Item 220 does not refer to boxes applied when the wheels are renewed. It shows the new boxes applied to the truck.

Mr. Watkins: Referring to Item 223, if you use .3 hour for the journal box lid and if .5 hour is allowed for lid and dust guard, don't you use .2 hour for applying a dust guard?

Mr. Owen: The .2 hour is for applying the dust guard and getting your journal box raised. The Rule 223, .3 hour covers the application of the journal box lid only.

Mr. Jameson (Southern): Item 5B reads: "Altering height of car by shimming springs, charge for material used and labor as per item Number 401 of Rule 107. This charge also applies to the renewal of shims." Turning to Item 401 I find not only 401 but 401A which covers truck springs under different conditions. I would like to ask if it was really not the intention to include reference to both of those items in item 5B. In other words, I should get the same labor allowance for applying truck spring shims that I would have for applying a truck spring.

M. E. Fitzgerald (C. & E. I.): I see no reason why if in the application of shims you find it necessary to remove the bolts you should not charge in that manner. The rule does not say exactly that, but I think anyone would accept the bill. If the construction of the car was such and your original record showed that you removed those bolts, you would be justified in charging according to 401A.

Mr. Owen: That is the manner in which we have handled 401 and 401A since the time it was issued. A number of roads took issue with us on that but they finally conceded that we were right the same as under items 420, 420A, 420B or 420C on the application of wheels.

Mr. Jameson: *I move that it is the consensus of opinion of this association in this session that Item 5B was intended to cover both items* 401 *and* 401*A*.

Mr. Martin (B. & O.): In order to charge according to 401A it is necessary to show that it was necessary to remove the column bolt and that will control your whole charge. I do not think the motion is necessary at all if you have proper information shown on the repair card.

Mr. Fitzgerald: The difference between an ordinary car and a refrigerator car in 401A is 2.5 hours for the ordinary car and 5.2 for the refrigerator car. There would be no difference.

Secretary Elliott: I do not agree that there isn't any difference, because there is a difference.

Mr. Jameson: It is suggested that I should add *"On ordinary box cars"* to the motion. The reason for that is that evidently there must be a misprint in Item 401A because he quotes 2.5 hours for ordinary cars and 5.2 for refrigerator cars, the figures just reversed. I have no other idea than that was just a printer's slip. If we make it ordinary cars that will avoid the question.

President Pendleton: That is added to the motion.

The motion as revised was carried.

Mr. Lennertz (B. & O.): I cannot find any labor for truck spring plank in connection with a bolster, on a swing motion truck, in Item 32.

Mr. Owen: I believe Item 32 has reference to bolster in what is known as a Player truck frame where it is unnecessary to put in springs or anything else, just lift the bolster and apply a new one.

Mr. Morrison: Cases of that sort can be very readily settled on the ground by building up the charge by showing the individual operation where no arbitrary labor charge is given for any particular operation that a man has to cover. You can very readily arrive at a correct total in that manner.

Mr. Fitzgerald: In the case of a spring plank alone he could turn to page 141 (1921 code) and would find labor prices for the spring plank and if that did not cover it then he would have to key it.

Mr. Jameson: Mr. Lennertz should use Item 433, "The R. & R. or R. of all items not specifically covered in these rules, which are secured by bolts, nuts, lags, screws or rivets, to be charged on that basis.

T. S. Cheadle (Richmond, Va.): The spring plank of that construction that I have noticed has neither bolts, rivets nor lag screws.

Mr. Jameson: Item 45 covers labor for renewing or removing and replacing brake beams. It gives us an arbitrary charge of 1.2 hours. It states that it covers the three key bolts. There are a good many of the roads now that are charging an additional key bolt when the beam hung with the live lever is R. & R., stating on the billing repair card that it was necessary to R. & R. one key bolt in the dead lever to obtain slack. I think it is a just charge, but it is not generally practiced.

The same thing applies to a bottom rod. The ordinary thought is that it has two key bolts, one at each end of the bottom rod. If the brakes are adjusted properly it is necessary to obtain slack on the dead lever guide, which brings about three key bolts. In such cases where it is necessary to R. & R. an additional key bolt you should have the right to charge it.

I move that it is the consensus of opinion of this body that where it is necessary to R. & R. an additional key bolt with the application of the brake beam or a bottom rod that such a charge is justified.

Mr. Owen: Item 67 on page 128 reads: "Brake connection pin or key bolt, any length, R. & R. or R., separately, each 0.2 of an hour." If you had to R. & R. any additional key bolts it seems to me that item clears it up so that you will get pay for it.

Mr. Fitzgerald: Rule 107 reads:

The following table shows the labor charges which may be made for performing the various operations shown. The labor allowances include all work necessary to complete each item of repairs, unless the rules specifically provide that in connection with the operation additional labor may be charged.

That article specifically includes the items that you may charge for. You may have to take out the other key bolt but the rule states just what you shall charge and if you are going to make any additional charges you would be letting the bars down for a lot of variations in the prices.

Mr. Martin: I agree with our Southern friend over there. This item states just what it covers and if there is an additional key bolt taken out you are entitled to the .2 hour.

The motion was carried.

Mr. Cheadle: In reference to Item 45, it states that the R. & R. or R. of the safety guards are not included. There are two types of safety guards, so-called by men who repair cars in my territory. There is one that goes around the beam and is fastened with bolts. There is another that goes through the spring plank. Item 51A gives the charge for brake beam safety guards renewed, and makes a charge on a bolt or rivet basis, plus jacking the car if necessary. Some so-called safety guards are not secured by any bolts, rivets or lags. I had in mind that the rule would probably permit a charge for that.

Mr. Owen: The renewal of the brake beam, item 45, would not include the removing and replacing of the safety hanger. That is the way I interpret it.

Mr. Cheadle: In the case of a spring plank guard, there is no charge in the book for one of that kind.

Mr. Fitzgerald: There is no charge in the book for actual labor. The rule tells you that.

Mr. Jameson: Item 89: "Journal box bolts, renewed." These are ordinary journal box bolts. Now we have a kind of journal box bolt that is new to most of us.

Secretary Elliott: The Vulcan truck frame.

Mr. Jameson: The lower part of the journal box is detached from the top part, and is secured to it by four and sometimes six small bolts less than six inches long. I would like to know a repair charge for these bolts. They are not horizontal box bolts, neither are they journal box bolts referred to in Item 89.

Mr. Owen: I believe that Item 90 will cover that.

Bolts, 6 in. or less in length, not otherwise specified R. & R. or R., each 0.2 hours.

Secretary Elliott: The bolt you have reference to is not a journal box bolt as we know it. It is a tie bolt.

Mr. Jameson: It is common practice among the men to call it a journal box bolt. As all our billing clerks are not practical car men they take it as a journal box bolt.

President Pendleton: We will have to educate the clerk.

Mr. Jameson: Item 227, page 137 reads:

Ladder, metal or wooden, complete, renewed; to be charged on bolt or rivet basis.

We have many ladders, both metal and wooden, in which the bolt is put in from the inside of the car and it is only necessary in renewing broken stiles and repairing metal ladders to R. &. R. the nuts, yet according to this item we would disregard the real operation and charge for it on the bolt basis. I think bolts are better put inward in some cases. Perhaps they are going to try to educate us to do it in that way.

Secretary Elliott: The law would not permit you to do that in most cases. The nuts have got to be on the outside.

Mr. Jameson: Then why should I be privileged to charge bolt labor when I only R. & R. a nut?

A. Herbster (N. Y. C.): I think that can easily be explained. They are trying to save all the bolts they possibly can. If they pay you as much labor for the nut as the bolt then you have lost that much material.

Secretary Elliott: A sort of premium for saving the bolt.

Mr. Jameson: Then the committee's real intention was that we should charge on a bolt basis and did not omit the word nut; is that right?

Mr. Herbster: Yes.

Mr. Fitzgerald: In the majority of cases you have to destroy the bolt anyway. Further than that, in handling the ladder, there are many types of ladders and there is additional labor in handling the ladder and this rule I think was written to cover some additional labor. For instance, you look at 211, which covers only a hand hold and where there is a possibility of saving the bolt they refer to the charge on bolt, nut or rivet basis.

Mr. Owen: I think the whole intent of that rule, as far as labor is concerned, is to make that charge in accordance with the number of bolts that you had to remove the nuts or remove the bolts to do that work. If the bolts were not renewed you would not have the privilege to bill for the material that was in the bolt but you would for the labor, whether you removed the bolt or the ladder from the bolt.

Charles Claudy (Grand Trunk): I was on the sub-committee and I think they have omitted the word nut. I think it was overlooked.

Mr. Jameson: *I move that it is the consensus of opinion of this body that Items 227 and 228 mean just what they say, on a bolt or rivet basis and that nuts do not enter into consideration.*

The motion was seconded and carried.

Mr. Watkins: It has been the practice of the Hocking Valley to charge for removing and replacing nuts like that. We have taken exception to bolt charges where the nuts only were removed and received offsets after a time.

The Chair: You should have taken exception to that and gotten off with it. You do not find once in a hundred times a case of that kind would happen.

Mr. Jameson: Referring to Items 5B and 401, I would like to know what the proper labor charge is for the renewal of one or more truck springs, and at the same time, in the same location, the removal of a shim.

Mr. Owen: You can only make the one charge in so far as labor is concerned. You can charge additional for all the material you use.

E. S. Swift (Wabash): Item 18 reads:

Arch bar tie strap, continuous one R. & R. or R., including R. & R. or R. of nuts, only, 1.4 hours.

Suppose we had to remove a column and box bolt in connection with the tie bar from that column and box bolt, they would exceed the charge for the tie bar.

Mr. Fitzgerald: You would not bill for the tie bar. You would charge for the bolts.

Mr. Watkins: In removing journal box bolts and tie bars at the same time, would not 431 apply and reduce the bolts by one-tenth of an hour? Item 431 reads:

When the nut or nuts on any bolt over 6 in. in length is removed in connection with overlapping repairs, the labor charge for that bolt, if renewed, shall be reduced by 0.1 hour.

Mr. Cheadle: Is it permissible to add the jacking of the car to Item 18 when jacking is done? The strap is simply slightly sprung, not enough to require its removal.

Mr. Owen: An additional charge for jacking the car would be permissible.

Mr. Jameson: I have a case of overlapping labor under Items 40, 237A and 416.

Item 40—Body truss rod, perfection, R. & R. or R. (includes handling only, exclusive of turn buckle and nut) 1.6 hours.
Item 237A—Nuts, body truss rod, one or more on same rod, R. & R. or R., empty or loaded car, includes tightening rod, per rod, 0.6 hours.
Item 416—Truss rod or other turn buckles, R. & R. or R., empty or loaded car, includes tightening rod, per turn buckle, 0.6 hours.

I tightened that rod twice, I have been told that was perfectly plain and there wasn't any overlapping labor at all; that you first tightened the truss rod with the nut when you put it on the end, and then you went to the turn buckle and tightened it again. I believe that if you tighten the rod you tighten it both at the nut and turn buckle. I believe there is overlapping labor there. Item 237 should be clarified by inclusion with Item 416. It should be one-tenth of an hour the same as other nuts.

Mr. Claudy: We spent about four days on that body truss proposition and we still have a lot of questions to answer and the question is coming up day after tomorrow. We do not know just where we stand yet. The question is coming up again.

President Pendleton: We will hear further from the committee, then.

Rule 108

No labor to be charged for the inspection of cars, testing or adjusting brakes, adjusting angle cocks, tightening unions, bolts, bolt nuts, lag screws or spreading cotters, sill steps, ladder treads or handholds, tightening or straightening on car; brake shafts, uncoupling levers *or carrier irons* straightened when not removed from car.
No charge to be made for the material or labor of lubrication.

Mr. Fitzgerald: I would like to ask if there is any possibility of us making a charge if we do lubricate and properly stencil as per Rule 66? It does not say in this rule that I cannot charge for stenciling boxes packed.

E. H. Mattingley (B. & O.): I would say if Mr. Fitzgerald repacked all of his boxes and applied the necessary stenciling he would be entitled to a billing charge for the stenciling only.

Mr. Fitzgerald: I do not think you are entitled to any labor charge but I brought it up because we are going to have bills presented.

Mr. Martin: In view of the fact that the committee has not given us a labor charge for the packing, I do not think there is any charge for the stenciling. It does provide a charge for stenciling to preserve identity.

President Pendleton: I do not believe there would be any charge for stenciling if you repacked the box. However, I think that we should live strictly up to the rule and perform that work.

Rule 111

Mr. Jameson: The charge for Item 23 last year was thirty-six cents. The item now as it is revised allows a charge of 25 cents but does not show the R. & R. of retaining valve. It reads: "Retaining valve, cleaned and tested on or off car." I am of the opinion that you would still charge R. & R. of the retaining valve, which would be one connection where the rule raised the price just where it was before.

Mr. McGrail: Supplement number 1, issued in 1920, effective July 1, 1921, reads as follows: "After date July 1, 1921, Item 23 is modified to read as follows: Retaining valve cleaned and tested on or off the car, twenty-five cents." That rule has been in effect since the first of last July.

Mr. Fitzgerald: That does not include the removal and replacement.

Mr. Martin: There was quite a lot of discussion or contention about that charge when it did not show as explicitly as it does now, and the committee in order to clarify it reduced the charge of one connection. Now they have turned around and included it in the rule to make it very plain that the retaining valve on or off the car is a net charge.

Mr. Fitzgerald: Item 4 reads:

Connections: Pipe, pipe fittings, air hose, angle cock, cut-out cock, release valve, retaining valve or strainer, R. & R., for each connection made (disconnected and connected or connected only), eleven cents.

Wherever labor is included it particularly specifies in this rule that it is merely a labor charge for the cleaning. I do not think it includes the R. & R. if you remove the valve.

A. S. Sternberg (Belt Ry. of Chicago): What Mr. Fitzgerald refers to is removing retaining valve to make some other repairs and putting it back. It does not refer to the cleaning.

Mr. Jameson: In the 1920 rules, the item read: "Retaining valve R. & R. and cleaned only, 36 cents." It was the practice in many places to clean the retaining valve without removing it from the car. At that time we made a practice of charging 25 cents for cleaning the retainer on the car when it was not removed, deducting 11 cents, the proper charge for the connection, because we did not perform that part of this item. Now the connection is entirely eliminated.

Mr. Watkins: We have been billing under this rule since the change was made, and we have always added 11 cents for the connection and never had an exception taken.

Mr. Jameson: The note under Item 4 says: "No additional labor charge to be made for lag screws or bolts in retaining valve R. & R. when a valve is renewed, repaired or cleaned," giving you the pipe connection, clearly.

I move that it is the consensus of opinion of this body that one connection should be added to Item 23 when it is necessary to R & R. the retaining valve.

The motion was put and carried.

Rule 112

C. S. Shearman (Chicago): Our line is a switching line and the home of a large number of refrigerator cars. I note the price on the refrigerator car is around $4,400. The present market price on that same class of cars is around $2,750 or $2,800. That places us in a pretty hard position settling for that kind of equipment.

Secretary Elliott: It is that way on all cars.

Rule 120

Mr. Watkins: Interpretation No. 2 under this rule reads as follows:

Q.—In the case of owner's responsibility for repairs where the total labor charge exceeded the limits specified in Rule 120, if in result of an oversight or underestimate the car was repaired without taking up the case with the owner under Rule 120, what settlement should the owner make for the repairs?

A.—In such case the total labor charge should be reduced to the limit allowed on the car by Rule 120, and the same percentage reduction should be made in the total charge for material.

We have a case where the labor limit on one of our cars, under section (b), was exceeded by $500. The car was a 40-ton gondola, with a labor limit of $108. We reduced the charge by figuring the percentage reduction from the total amount of the labor, or $158, which made 31.7 per cent reduction, and the road took exception to that, saying that the percentage should have been figured with $108 as the base, which would have made the percentage 46.1, we applied the 31.7 per cent reduction to the material charge. The repairing line through some oversight, did not estimate it under Rule 120.

Mr. Sternberg: I understand that the bill is $158 and they exceeded the limit by $8. The rule says: "In no case shall the total charge for actual repairs exceed the estimate by more than $50."

J. J. Gainey (Southern): You are getting two cases mixed. In one you write an estimate to the car owner and if you make a mistake in your estimate you have a perfect right to go $50 beyond that and get paid for it. In this other case, if a foreman estimates he can repair a car within $108 labor charge and then runs to $158, he has to take that $50 off the bill.

Mr. Watkins: Then the question is, how should the percentage reduction in the material charge be figured?

Mr. Owen: I think this rule clears that all up at the present time. If you have an overcharge over what Rule 120 allows, you are supposed to reduce your labor charge to the Rule 120 specifications. If it is 35 per cent or 37 per cent then you are to reduce your material charge 35 or 37 per cent.

Mr. Swift: That is not answering the question. I want to know whether the percentage is based on $158 or $108?

Mr. Owen: $158. You would reduce it by the percentage that $50 is of $158.

Mr. Swift: Section (d) says: "In no case shall the total charge for actual repairs exceed the estimate by more than $50 (exclusive of betterments) unless authorized." When you report a car under Rule 120, you report the material and labor separately. Is that rule intended to mean that if the total material and labor charge is over the $50 excess you would reduce it to the $50 even?

President Pendleton: I think that if you exceeded $50 you would have to make your reduction down to that limit.

Mr. Gainey: I do not believe you will have any case of that kind. The trouble I have found is that the estimates always run $200 or $300 above what it costs to actually repair the cars.

R. A. Kleist (B. & O.): The new paragraph added to Section (e) says in part:

Couplers, wheels, axles and journal bearings shall be credited on basis of scrap prices shown in Rule 101 for such items.
renewed, shall be reduced by 0-1 hour.

In Interpretation No. 5, under Rule 101 the question is asked as to what scrap credit should be allowed for couplers removed from dismantled cars. The answer is: "In settling for the salvage of dismantled cars a scrap credit price of one-half cent per pound to be allowed for couplers." I would like to have the apparent conflict explained.

Mr. Wymer: The items in Rule 101 cover repairs to cars. Rule 120 refers to dismantling cars and you follow the interpretation under Rule 101.

Mr. Owen: I believe there is a misinterpretation there. Item 113, Rule 101, covering rough cast steel, has a credit of half a cent a pound. Interpretation No. 5 covering the coupler also says a half a cent a pound. But that is not to be used under Rule 112 in case the car is destroyed on a foreign line; it is to be used in the case of an old car written up for disposition, of which you have to allow for the actual scrap or salvage of the items in the car and not on a pound basis.

Mr. Fitzgerald: I think then that Rule 120, paragraph (e) should read: "Settlement to be made as per interpretation on page 114 of Rule 101."

Mr. Owen: Going over the coupler items in Rule 101 you will find different prices for different size couplers. It appears to me that these prices for scrap couplers are based on a weight basis and that if they were figured out you would find they were pretty close to a half cent a pound, I do not believe there is much variation.

W. M. Herring (Southern): The interpretation as shown under Rule 101 in the new rules on page 114 is obsolete and I am satisfied it was put in unintentionally, because it was based on old Rule 120 which did not make specific reference to couplers in the allowance for credit on dismantled cars.

Mr. Kleist: I think that in putting this new paragraph under Section (e), Rule 120, the committee overlooked eliminating the intepretation which is given on page 114 of the old rule.

I move that it is the sense of this meeting that under Rule 120, second paragraph of Section (e), couplers should be credited on the basis shown in the table in Rule 101.

The motion was seconded and carried.

Resolutions

The following resolutions in tribute to the memory of Henry Boutet were presented by a committee of which T. J. O'Donnell, Albert Kipp and W. P. Elliott were the members:

The membership of the Chief Interchange Inspectors' and Car Foremen's Association in general session in conjunction with the meeting of the Executive Committee in Chicago, January 9, 1922, takes cognizance with profound sorrow of the death of one of our most active and influential members, Henry Boutet, Chief Interchange Inspector of all lines at Cincinnati, Ohio, which recently occurred, and has inscribed in the records of the Association the following tribute to his memory:

Whereas: The Great Creator in his infinite wisdom and mercy, has seen fit to call to his last reward our esteemed associate and beloved friend, Henry Boutet, whose service for upwards of 25 years and untiring efforts has placed the Association on the plane that it has reached and whose never-failing geniality deeply endeared him to each and every one of its members; now, therefore, be it

Resolved: That the membership of the Chief Interchange Inspectors' and Car Foremen's Association of America, very deeply feel the loss sustained in the death of Mr. Boutet and we extend to his bereaved family and relatives our heartfelt sympathy in this their hour of sorrow and affliction, and we earnestly hope that an all-wise Providence may soften the blow which has fallen upon them and that Time, the great healer, will enable them to realize that their loss and our loss has been his gain, in that he has attained that Eternal Home where no suffering or sorrow intervenes.

It is Further Resolved: That a copy of this resolution be submitted to the sorrowing family and that a copy be spread upon the Minutes of our meeting.

Deplorable Condition of Russian Railroads

The Russian railways are in a deplorable condition owing to the lack of supplies. On January 1, 1917, the serviceable mileage was approximately 44,000. On January 1, 1921, it was only about 29,000 miles. The number of locomotives in good condition on January 1, 1917, was 17,012, of which 36 were new. On January 1, 1921, the number was 2,921, of which 35 were new. The percentage of unserviceable locomotives on January 1, 1917, was 16.8 per cent. On January 1, 1921, it was 642 per cent.

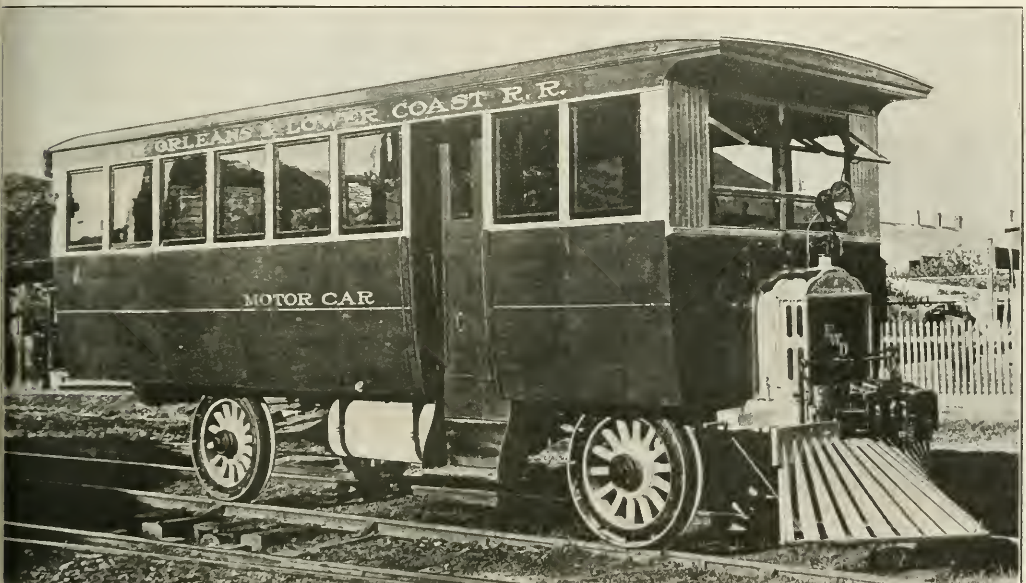
Gasoline Motor Cars with Four-Wheel Drive

For Passenger, Freight and Light Switching; Increased Tractive Effort by Using All Wheels as Drivers

INCLUDED among the rail motor cars now in service are a number manufactured by the Four-Wheel Drive Auto Company of Clintonville, Wis. As the driving power on these cars is applied to all four wheels they have a number of advantages over cars which are driven by only one pair of wheels. Making every wheel a driving wheel and equally distributing the load over the wheels gives the car the greatest possible adhesion and permits the use of high tractive effort. This is important on roads which have numerous steep grades or are located in sections where winter weather is severe and the rails often are covered with snow and ice. In actual operation the cars have travelled over rails covered with snow to a depth of approximately one foot and in places drifted to a depth of two feet. This was done with little difficulty and without falling behind the regular schedule.

Another advantage gained through the application of power to each of the four wheels is that it eliminates the necessity of a pony truck. When rounding a curve, the differentials in the front and rear axles take care of the difference in speeds of the wheels on the inside and outside tracks and do away with the rail climbing action which has given trouble on rear driven rail equipment. At Clintonville, where numerous demonstrations in freight and passenger service have been given, there is a 16 deg. curve at one place in the track. Train operators are warned not to exceed a speed of 15 m.p.h. on this curve, yet during these demonstrations the motor cars have rounded it with ease at a speed of 23 m.p.h.

The increased available adhesion resulting from the four-wheel drive principle peculiarly adapts this type of car to use with trailers or for light hauling and switching. The manufacturer, anticipating its use for such purposes, has applied standard M. C. B. couplers on the front and rear of the car. This enables owners to attach trailers and increase the carrying capacity to meet traffic demands.



Four-Wheel Drive Rail Car Used on a Sixty-Mile Run Between New Orleans and Buras

Details of Design

The standard rail motor car chassis weighs 8,400 lb. and has a 13-ft. wheelbase. The frame is 16 ft. 8 in. long and 3 ft. wide. The wheels are 36 in. diameter with rolled steel rims of M. C. B. contour. Both axles are of the rigid type, full floating. The engine has four cylinders, each 5.1 in. diameter by 5.5 in. stroke, and a power rating of 42 hp., S. A. E. rules, but actually develops 68 hp. on a brake test. The transmission provides for three speeds. There is a choice of five gear ratios ranging between 5 to 1 and 12.05 to 1, which are suitable for speeds in high of 35, 30, 25, 20 or 14 m. p. h. With a gear ratio of 5 to 1 the maximum drawbar pull is 1,968 lb. at 8.7 m.p.h. and 492 lb. at 35 m.p.h. while with a gear ratio of 12.05 to 1 the drawbar pull is 4,755 lb. at 3.5 m.p.h. and 1,189 lb. at 14 m.p.h.

The car is equipped with a high-speed reverse gear which enables it to travel at the same speed in reverse as it does forward. This reverse mechanism is composed of a nest of bevel gears on the order of the conventional bevel gear differential, only much larger and of superior design and construction.

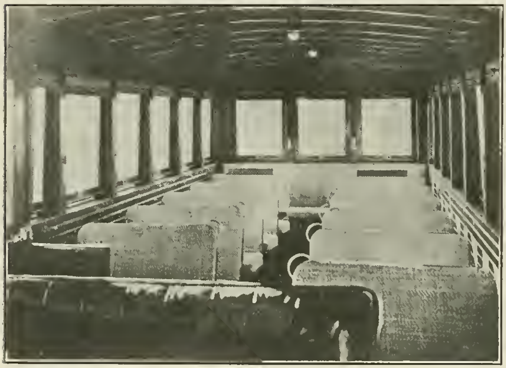
There is a service foot brake and an emergency hand brake, both of the external band type. In addition, Westinghouse air brakes can be applied if desired. Sanders are located at both ends.

An outstanding feature of the FWD design is the readiness and cheapness with which it can be converted from a highway truck to an efficient car for railway service. This fact is borne out by the continual increase in the number operated by the government at various arsenals and proving grounds throughout the country. There is now a total of 28 FWD cars in government service operating on rails, all of which were formerly used on highways and were converted at only the expense necessary to change from rubber tires to flanged steel rims, mount standard M. C. B. couplers front and rear, and install a high-speed reverse gear and a sanding device. Where cars are to be used for passenger service the expense of conversion must include body equipment and is, of course, somewhat greater.

Cars Now in Service

The first truck of this type put into operation on rails was a standard three-ton truck converted by the Northwestern Pacific at San Francisco, Cal., into a car suitable for light switching. A tunnel was being constructed and it was found that a steam locomotive filled the tunnel with smoke and made it impossible for the men to see or breathe after the engine had been inside. After investigation, the FWD truck was decided upon and with little expense one of them was converted into a car which filled the requirements so well that it is still being operated in light switching service.

At New Orleans, La., an FWD rail passenger car seating



Interior of Passenger Car on New Orleans & Lower Coast

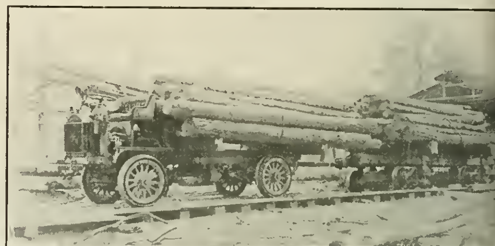
32 persons, operates on a 60-mile run between that city and Buras over the New Orleans & Lower Coast. This car makes one round trip, or a total of 120 miles per day. Latest reports show that the car, during a period of 13 months, operated at an average cost of 15 cents per mile as compared to 90 cents per mile with a steam train. These figures include operator's wages, fuel, lubrication, supplies, maintenance and insurance but do not include anything for depreciation. The motor car averaged 7½ miles per gallon of gasoline. This short line formerly operated a steam train at a loss and was obliged to discontinue service during the war. After the war it purchased a gasoline rail car and resumed operations. It was then found that not only was this car cheaper to operate but, with its weight of 6¼ tons, the depreciation of the track was much less than with the 25-ton locomotive hauling one or two 15-ton coaches.

The New Orleans & Lower Coast Railroad has, with this rail car, operated at a comfortable profit and has since the inauguration of this service enjoyed such a substantial increase in patronage that it has become necessary to increase the capacity by the purchase of a trailer coach, which will seat 40 passengers. This installation is a good illustration of what the rail car can accomplish for short line railroads and on short runs on main line tracks.

The Oil Fields Short Line, which operates from Dilworth, Okla., in the oil fields to Clifford, where it connects with the St. Louis & San Francisco, is at present installing an FWD rail car. This line is only about six miles in length and the traffic is too light to warrant the operation of a steam train. This is typical of numerous short lines throughout the country, which might operate more successfully with a light rail car than with a heavy steam train.

The Ashley Lumber Company of Hamburg, Ark., uses one of these cars for hauling logs from the woods to their mill. The car operates satisfactorily with trailers and gives a cheap and efficient service.

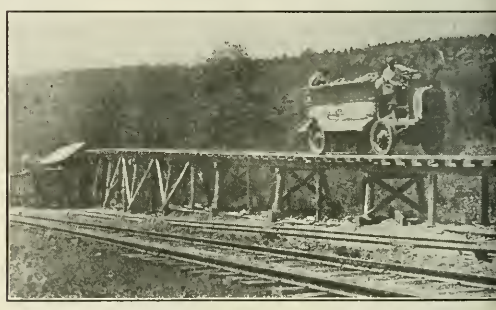
At Rockland, Mich., the Michigan Copper Mining Company operates a rail car which is equipped with a steel side dump body and is used for hauling ore from the mine to



The Ashley Lumber Company Employs a Motor Car to Haul Logs from Woods to Mill

railroad cars, a distance of about one mile. In 1919 when the mine was operating at full capacity this car operated continuously and hauled on an average of 219 tons of ore per day.

The Cripple Creek Consolidated Gold Mining & Milling Company of Cripple Creek, Colo., is operating a motor car on rails between their mines and the city of Cripple Creek. This car was formerly a standard three-ton truck used for road service, but was converted into a rail car and equipped with a passenger body which has a seating capacity of ap-



A Rail Motor Car with Dump Body Hauls Copper Ore from Mine to Main Line Connection

proximately 30 persons. It is used for hauling miners to and from the mines.

Including those operated by the government, there are now over 60 four-wheel drive rail motor cars in freight and passenger service in the United States and foreign countries.

The Province of Alberta announces that 93 miles of new railway was constructed in the province last year, bringing the total mileage up to 4,789, as compared with 1,782 in 1910, and 1,060 in 1905.

The Use of Treated Timber in Car Construction

Wood Preservers' Association Discusses Advantages of Treated Sills and Decking for Stock Cars

THE American Wood-Preservers' Association held its eighteenth annual convention at the Hotel Sherman, Chicago, on January 24-26, inclusive. This organization of men interested in the preparation and use of treated timber includes a large proportion of railway officers.

A number of the reports dealt with tie treatment and the economical benefits obtained, the use of treated marine piling to resist borers, the operation and equipment of treating plants,—including machinery and material handling devices and specifications for different kinds of creosoting oils. One of the many interesting phases of timber treatment taken up was its application to wood used in car construction.

Report of Committee on Treated Timber

The Committee on Car Lumber presented a report on the treatment of timbers used in cars and submitted recommendations on practice applicable to this particular field for the treatment of timber. An abstract of the report follows:

Since decay is responsible for more repairs to wooden cars than any other single factor it follows that a way must be found to prevent decay without retarding the work of shop forces engaged in repairing the cars. The pressure treatment is superior to other known methods of preserving wood and creosote is the best agency by which its physical life may be extended. Zinc chloride and sodium fluoride are also proven wood preservatives of high rank, but to be of any material value they must be applied under pressure, while the application of creosote by means other than pressure will unquestionably add to the life of the timber so treated.

The committee has studied every conceivable method of treating car timbers by the pressure process after they have been framed, and has found them impracticable. In most cases treating plants are located many miles from the car shops, meaning that after the timbers have been framed they must be loaded on cars and sent to the plant for treatment.

There is also the usual objection to the use of creosoted timbers that is always met with on account of refusal of labor, especially the semi-skilled labor, usually employed around car shops, to handle these timbers after they have been treated. However, this feature could be overcome by the use of zinc chloride or sodium fluoride, which are not offensive to handle, and if it were practical to apply either preservative without pressure our problems would be nearer solution.

This committee earnestly desires to see some definite step taken toward preserving car lumber and recommends the very simple method of giving all points of contact a brush treatment, using two brush coats of hot creosote. This should also apply to roofing and in the case of open and stock cars to the decking, posts and entire interior of the car.

This treatment should be applied to all points of contact regardless of whether the timber is green or dry, or whether it is white oak, red oak, pine, fir, or any other species. The best results will be obtained if the timber is dry, but it is not always dry when put in a car and we must face the conditions as they actually exist. It is certainly better to paint creosote on a green piece of timber than to put none on it at all, and this principle if accepted, must be general and cover all lumber used in freight car construction and maintenance.

Results Obtained on the Burlington

Supplemental to the above report, Forrest S. Shinn, supervisor of plant, Chicago, Burlington & Quincy at Galesburg, Ill., presented a statement of the progress in preserving car timbers on that railroad. An abstract of Mr. Shinn's statement follows:

The Burlington has treated 1,297,188 ft. b. m. of car sills and 1,815,804 ft. b. m. of car decking. These were treated with the straight creosote process as follows:

Year	Sills, Board feet	Decking, Board feet
1911	104,700	115,728
1912	409,764	1,087,116
1913	339,720	153,012
1914	223,500	89,892
1915	53,736	56,688
1916	166,068	176,796
1917	......	79,888
1918	......	56,688
Total	1,297,188	1,815,804

We are not in a position as yet to know just what results will be obtained from this treatment, as none of the lumber has been taken out for any cause except on account of being broken; however, in view of the fact that we are taking out yearly a large amount of untreated flooring on account of rot we feel that the money spent for treatment has brought good returns. We have not made any tests on this material, comparing the strength of the treated lumber with the untreated, but from close observation have come to the conclusion that treatment very materially increases the hardness and makes it much more resistant to wear. We find that many untreated planks in cars built in 1911 and 1912 have been worn so thin that they had to be replaced.

In November, 1921, two treated planks were removed for inspection from the end of C. B. & Q. car 67391, built in May, 1912, with treated sills and flooring; two treated gangway planks from C. B. & Q. car 67190, built in February, 1912, with treated sills and flooring; and two treated gangway planks from C. B. & Q. car 68729, built in September, 1915, with treated sills and flooring. There was no sign of decay on either the sills or flooring. The planks were slightly worn but were perfectly sound and, from all appearances, were good for as many years more life as they had already given. On the same day two untreated gangway planks were also removed from C. B. & Q. car 67261. This car was built in March, 1912, with treated sills and flooring, with the exception of the gangway plank which was not treated. These two untreated planks were warped, shattered on the ends, and worn down to less than half the original thickness.

In the last month I have inspected 200 stock cars built in 1914 or earlier, 100 of which were built with treated sills and decking and 100 built with untreated sills and decking. The treated decking is in as good condition as when first laid down, showing no signs of decay, warp, or check, while the untreated decking is badly warped or buckled and all of it is more or less checked, and in a large percentage the ends are badly shattered.

We feel that some time in the future we are going to be able to prove conclusively that the treatment of sills is justifiable. I have seen many decayed sills in cars built 1900 to 1906 and I am sure that everyone will agree with me that a well treated car sill will never show any signs of decay unless it was decayed before being treated.

In addition to the treatment of sills and decking for stock cars we treated, with the Burnettizing process, sub-flooring for one dining car that was placed in service May, 1921, and one that was placed in service June, 1921. We also treated sub-flooring with the Card process (zinc chloride and coal tar creosote) for two dining cars that will be placed in service soon. We have found that sub-flooring in the kitchens of these cars rots quickly and are sure that we can overcome this by preservative treatment.

Vacuum Brake Tests on English Freight Trains

Results of Great Northern Trials Reported by Sir Henry Fowler and H. N. Gresley Before Institution of Civil Engineers

THE use of vacuum brakes both in England and in the United States is almost as old as that of air brakes. In this country the vacuum brake many years ago practically passed out of existence except for a few industrial locomotives. In England the vacuum brake has been continued in service and is even now extensively employed, and the same is also true to a large extent of some other European countries, as well as India, Australia, Africa and South America.

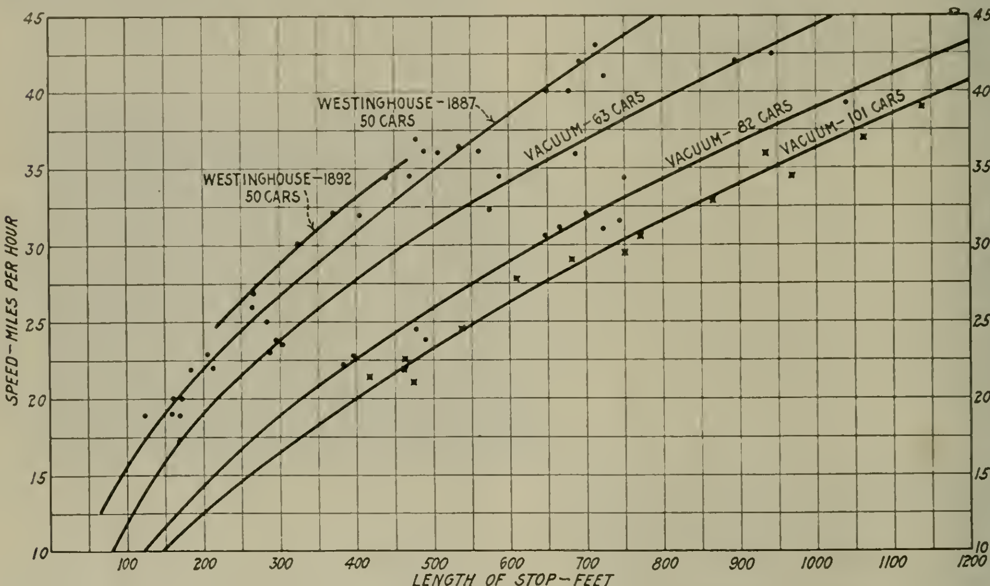
Evolution of the Vacuum Brake

In its evolution during the last 50 years the vacuum brake passed through changes paralleling those which took place in the air brake. At first, a plain vacuum brake met the requirements. The brake pipe was normally open to the atmosphere and an ejector was used to create a vacuum in the brake pipe and diaphragm or cylinder on the various cars when it was desired to apply the brakes, the vacuum being destroyed to release the brakes. This system was long ago superseded by the automatic vacuum brake in which a vacuum is constantly maintained in the brake pipe and in the enlarged chamber or attached reservoir above the brake piston, the vacuum being partially or fully destroyed to apply the brakes and again restored to release the brakes. A combined ejector and brake valve is commonly employed to create the vacuum and to control the admission of air to the brake pipe. This ejector has two nozzles, a large one for creating the initial vacuum and for releasing the brakes and a small nozzle for maintaining the vacuum after the brakes have been released.

Thus far the application of power brakes to freight equipment in England has been quite limited. The steadily increasing length and weight of passenger trains as well as a growing demand for power brakes on freight trains has, however, led to the development of accelerating or rapid action valves for the quicker application of the brakes on longer trains. These, however, have not yet been extensively applied.

Advantages and Disadvantages of the Vacuum Brake

To an American who has been accustomed to the air brake only, or who perhaps recalls the vacuum brake as largely an old experimental device, it is somewhat surprising to learn that the vacuum brake is even more common in England than the air brake. This raises the question as to why the vacuum brake has been able to retain its position and what advantages it possesses. The outstanding reasons appear to be: the simplicity of the mechanism and its low expense of maintenance; the perfect control of braking due to the fact that the braking pressure can be increased or decreased at will without releasing the brakes; and the smoothness of the stops, this last feature being due partly to the use of lower rates of retardation than are demanded by American railroads. There is a distinct disadvantage in the relatively large size of the brake cylinders which is a result of the low cylinder pressure of less than 10 lb. per sq. in. This is only one-sixth of the pressure used in air brake cylinders.



Comparative Stops with English Vacuum Brakes and American Westinghouse Air Brakes

Vacuum Brake Tests on the Great Northern

With a view to ascertaining the suitability of the vacuum brake for long freight trains, a series of trials was carried out during the summer of 1919 on the Great Northern Railway. These tests were under the supervision of Sir Henry Fowler and H. N. Gresley who presented a paper before the Institution of Civil Engineers on January 10, 1922, giving the results of the runs. The facts given herewith are taken from this paper.

The main difference between braking freight trains and passenger trains are briefly as follows.—(*a*) The greater length of freight trains. (*b*) The necessity of running loaded and empty cars together in freight trains. (*c*) Even if screw couplings are used, the need of quickly coupling and uncoupling when switching will probably result in the couplings being screwed up less tightly than in passenger trains. This tendency to couple loosely enhances the need for a smooth and uniform action of the brake throughout the train.

For these tests the following conditions were laid down as a standard of satisfactory performances:

That trains of 100 cars, close coupled, must be stopped:

(1) By emergency applications without shock and without any risk of parting the train.

(2) By service applications without shock or risk of parting, and in such a manner that the train could be restarted immediately after coming to rest.

(3) That the speed of the train could be reduced as required.

The tests were carried out on the Great Northern railway between Petersborough and Firsby, this portion of the line being practically free from grades and curves.

Trains and Equipment

The locomotive was of 2-6-0 type. The weight of the locomotive in working order and the tender two thirds loaded with coal and water was 213,920 lb. All wheels were braked with the exception of those of the front truck. The ejector was a Gresham and Craven combined 20 mm. and a 25 mm. Dreadnaught.

The train consisted of Great Northern railway eight-ton covered vans or box cars, having an average light weight of 16,150 lb. and fitted with the G.N.R. standard vacuum brake, with the Westinghouse Brake Company's accelerators and reducing nipples. In addition to these the train included three Midland railway six-wheeled cars carrying the necessary recording instruments. One of these was placed at the front of the train, one in the middle, and one at the rear.

All the cars were unloaded and provided with screw couplings. The brakes were tested for leakage before the trials, and the travel of the brake pistons adjusted as required. The instruments comprised speed recorders and duplex vacuum recorders. The latter instruments (one of which was placed in the front, middle and rear vans) recorded the pressure in the train pipe and brake cylinder reservoir.

The average retarding force is the basis usually adopted for comparing brake stops. This force is convenient to express as a percentage of the weight of the train, and in the calculations, the weight of the train is taken as the gross weight of the train increased by the equivalent rotary inertia percentage, which was found from calculation to vary from 10.4 to 10.7 per cent of the weight of the train, being about 7.3 per cent for the locomotive and tender and 11.1 per cent for the cars. The forces concerned, inclusive of brake power, friction and gravity, are assumed to be acting uniformly throughout the stop.

The standard vacuum carried in the brake pipe was 20 in. and the average effective vacuum in the car brake cylinders with the brakes fully applied was 17 in. or 8.33 lb. per sq. in. The brake shoe pressure equalled 61 per cent of the weight of the locomotive and tender, 90 per cent for the cars and 86 per cent for the train complete with the locomotive.

Results on Trains of Various Lengths

The first tests were made with a 63-car train, each car being fitted with an accelerator and a standard reducing nipple between the brake pipe and the under side of the piston in the vacuum brake cylinder. The standard size of choke is 3/16 in. diameter for a 15-in. cylinder and 5/16 in. for an 18-in. cylinder. The weight of the 63 cars was 455.25 long tons or 1,019,760 lb. All emergency stops made under these conditions were satisfactory. It was found necessary, in making speed reductions or service stops, to apply the brake gradually, otherwise the accelerators operated, and unless the speed was high, say over 30 miles per hour, the train came to a stand before the brakes could be released.

The 80-car train was made up by attaching nine cars at the front of the previous 63-car train and eight cars at the rear; these cars had no accelerators or reducing nipples. Five emergency stops were made from speeds ranging between 22 and 42 miles per hour, but the shocks were so severe that in one case the train parted. The front nine cars were switched out and another emergency stop made, but the shock was so bad that the train again parted. The records of these stops were spoilt on account of the effect of the shocks on the instruments, and it was decided to abandon further trials with trains not completely fitted with accelerators.

The next tests were made with an 82-car train, fitted with accelerators and standard reducing nipples throughout. The total weight of the cars was 587.5 long tons or 1,316,000 lb. At speeds above 40 miles per hour the stops were fairly smooth, but between 30 and 40 miles per hour there was a rough jerk just before stopping, and for stops from 20 to 30 miles per hour the jerk was very severe just before coming to rest. The stopping distances of this train were almost identical with that of the 63-car train. Emergency stops were then tried with the working vacuum reduced to 16 in. These were fairly smooth except at the lower speeds, but the stopping distance was increased by about 20 per cent.

The next change was to reduce the size of the chokes in the nipples to 7/64 in. diameter for a 15-in. cylinder and to ⅛ in. for an 18-in. cylinder. The train consisted of the same 82 cars fitted with accelerators. The effect of the reduced nipples was to make the stops at all speeds quite satisfactory as regards being smooth, but increased the stopping distance by about 25 per cent.

Following these tests the length of the train was increased to 101 cars, the total weight of the cars being 719.5 long tons or 1,611,680 lb. All cars were fitted with accelerators as well as specially reduced nipples of the same size as those used on the preceding 82-car train. The emergency stops were quite satisfactory as regards being smooth, but compared with the standard of comparison—63-car train—the stopping distance was increased by about 35 per cent. Emergency stops were also made working with a 16-in. vacuum. In this case the stops were very smooth, but the stopping distance compared with the standard was increased approximately by 50 per cent.

General Conclusions

(1) The trials demonstrate that it is practicable with the vacuum brake to work long trains of up to 100 cars, provided that suitable accelerators and reducing nipples are used.

(2) Emergency stops can be made without shock with trains consisting of up to 100 cars.

(3) Service stops and speed reductions can be made and the train restarted promptly, provided that when running at speeds less than 30 miles per hour air is admitted slowly so as not to operate the accelerators. This necessitates the braking being spread over some distance, but allows time to have the brakes partly released when the desired reduced speed is reached, or just before stopping, and thereby en-

ables the train to get under way again almost immediately.

(4) It must be recognized that the provision of reducing nipples results in retarding the action of the brake and increasing the length of stops.

(5) In these trials the smoothest stops were obtained with the comparatively low working vacuum of 16 in. It is also easier to create and maintain this degree of vacuum than the usual 20 in., but the stopping distance in the case of emergency stops, is of course increased.

Comparison with American Air Brake Tests

In connection with the results in these English vacuum brake tests on the Great Northern as outlined in the above paper, it is of interest to compare the length of the stops with those obtained in American brake tests. Soon after the completion of the famous Burlington brake tests in 1887, the Westinghouse Air Brake Company perfected its quick-action triple valve. In order to demonstrate the operation of the device, a train of 50 Pennsylvania Railroad box cars was equipped and exhibition stops were made on a number of railroads in a dozen different cities. The cars were of 60,000 lb. capacity and 38 ft. 4 in. long. The light weight was 30,577 lb. each or a total of 1,528,850 lb. for the 50 cars, exclusive of the locomotive and tender. Including the locomotive and tender the weight was about 2,000,000 lb. The 50 American cars used at that time thus weighed about the same as ninety-five of the English eight-ton cars used in the vacuum brake tests described above.

As a convenient method of showing the results of these tests, the length of the stops has been plotted and a curve drawn for the general average.

In 1892 a series of brake tests was made on the New York Central at Karners in order to compare the Westinghouse and New York air brake systems. These tests were also made on 50-car trains of box cars of 60,000 lb. capacity. The average weight of the cars was 31,960 lb., making the total weight of the 50 cars 1,598,000 lb. The length of the train was 1,940 ft. The braking power on the cars was 70 per cent, calculated on 60 lb. brake cylinder pressure, the brake pipe pressure carried being 70 lb.

Stops were made at speeds ranging from 25 to 35 miles per hour. The average results have been plotted and are shown on the accompanying diagram.

On the same diagram curves have been drawn for the stops made with the English trains. One of the curves shows the stops for the 63-car train with accelerators and standard reducing nipples. Another curve shows the stops for the 82-car train equipped with accelerators and special reducing nipples while the remaining curve shows the results for the 101-car train with the same size special reducing nipples. On all the trains the standard working vacuum was 20 in. Stops have not been plotted for the runs made with a 16 in. working vacuum.

A striking feature brought out in these curves is the fact that air brake stops made in this country 30 to 35 years ago are noticeably shorter than those made in the recent English tests with trains equipped with the vacuum brake. For example, from speeds of 30 miles per hour, the stops for the Westinghouse train of 1892 was 325 ft.; for the Westinghouse train of 1887, 380 ft.; for the vacuum brake train of 63 cars, 465 ft.; for the vacuum train of 82 cars, 645 ft., and for the vacuum train of 101 cars, 745 ft.

In view of the results it would appear that the vacuum brake does not have the retarding effect of the air brake as used in America. It is unfortunate that conditions did not permit of equipping the test train with the type of accelerator valves made by the Vacuum Brake Company although it is probable that the results of the tests would not have been materially different. Had this been done and the tests continued the information obtained would have been an even more valuable addition to the knowledge of braking.

Care of Journal Boxes*

By J. M. O'Connor

General Lubricating Instructor, New York Central

AFTER giving this matter our undivided attention for several years past, we have concluded that the proper method of packing journal boxes is as follows: Back rolls shall be prepared in advance in the oilroom and stored there until required for service. The preparation of the rolls consists of shaping the dry waste, dipping in oil and draining until moderately dry. Place roll in mouth of journal box, work it back under the journal to the extreme back of the box, leaving it in such a position that it does not extend above the center line of the journal. The rest of the packing should then be placed under the journal firmly so as to prevent settling away. This is best accomplished by placing the packing across the full width of the mouth of the journal box and allowing the strands to hang down outside, always adding more packing before placing the hanging strands inside the box. This has the effect of binding all the packing in one mass. The packing must not extend above the journal center line or beyond the inside face of the collar.

Considerable controversy has arisen over the elimination of the so-called front waste plug, and in this connection, insofar as our system is concerned, it is felt that this departure greatly assists the inspector in examining the contained parts of the journal box, particularly the journal, as under this method the end of the journal shows plainly when the bearing is being properly lubricated. When the bearing is not being properly lubricated, the center of the end of journal appears dry, whereas where the front waste plug is used, the end of the journal shows oil at all times. When the packing is applied as outlined there is practically no danger of it working from underneath the journal at the collar. The binding of all the packing as one mass also prevents its working up on the sides of the journal.

The application of packing can only be accomplished by the use of a standard packing iron, which is 26 in. in length. The spoon end of this iron has a curve 3 in. in depth measured horizontally from the handle lug to the fork end.

With reference to the care of packing in journal boxes, the most important part of the work for successful lubrication is intelligent attention to its condition which briefly consists of loosening up the packing to avoid the formation of a hardened and glazed surface from too long contact with the journal. This work consists of first loosening the section of the packing by pulling it forward from the sides and working it back under the journal at the center. Second, if new packing is needed, it should be worked back under the journal from the center, thus raising the portion on the sides—care being taken that it is not lifted above the center line of the journal on either side. This work also can only be handled by the use of the packing iron.

When the care of packing in journal boxes—and this applies particularly to cars in train yards—is handled as above outlined, the oil is automatically forced from the bottom of the box to the surface of the waste, particularly in boxes where all cotton or a mixture of cotton and wool is used.

While we know that the serviceable condition and proper application of packing is not responsible for all journal failures, it has been our experience that a percentage of the hot boxes may be attributed to this feature.

Now that the M.C.B. rules make the car owner responsible for the packing of journal boxes every nine months, when cars are on repair tracks, we should have a uniform method of handling and applying this material, and in talking this matter over with some of the best car men they fully agree that this is a step in the right direction.

*Abstract of a paper presented before the Niagara Frontier Car Men's Association, Buffalo, N. Y.

Practical Education in the Car Department*

Systematic Instruction and Examination of Inspectors and Foremen and Annual Staff Conventions

By C. G. Juneau
Master Car Builder, Chicago, Milwaukee & St. Paul

THE experience of ages has been used to build up and advance most of our methods of transportation, but in railroading we have only the wisdom of a hundred ·ears to help solve our problems. And as the United States ontains some 60 per cent of the railroad mileage of the vorld and the remaining 40 per cent is scattered over the ace of the earth, we cannot even turn for help to others but nust confine our studies to an analysis of our own experinces in the endeavor to solve our difficulties.

Examination of the industry of railroading reveals, first, hat it is immense. Excluding agriculture, it is the largest ingle industry in the country, and it approaches in size a najority of the other industries combined. Its very immensity neans to it many problems. Second, it is very complex in s make-up, including, as it does, large and varied forms of ctivities. Wide experience is a first necessity to a successful ailroad man. Third, it is variable, ever fluctuating in quanty and changing in character. The problem of how to andle a certain quantity of coal today will be replaced tonorrow by a deeper problem, because of the changing of the hief commodity to be moved to wheat, lumber, or oil. There s nothing tangible to guide railroads; and as business conitions change much more rapidly than it is possible to alter xisting equipment or provide new equipment, only by careul study of all forms of industrial and agricultural condiions, politics, money markets, and general world conditions, an an intelligent forecast of demands upon the railroads be rrived at.

The fact that the undertaking is so immense at once sugests that railroad employees should be drawn from parcular schools or universities wherein they would be specially ained for one or another of the phases of railroad work. o educational institution can produce a railroad man for e reason that railroading is complex and fluctuating. His ducation must accompany his experience, and must change conform to fluctuations in railroad conditions.

Lacking centuries of experience on which to base their dgment, unable to use the experience of other countries, nd unable to turn to educational institutions to provide a ained personnel, the railroads' one chance of resurrection ems to lie in the education of their own employees along e lines of their employment.

Railroad education might be divided into three phases, z., (1) education of the men; (2) education of their ficials, and (3) education of the public. I am going to al mainly with the first subject and confine my remarks our own experiences in the mechanical department of the ilroad I serve.

Systematic Education of Foremen and Inspectors

As a prelude to our educational campaign, it was laid down at all officers in the mechanical department should enavor to educate those responsible to them to help in making ilroad service a vital response of human effort and energy. was realized that the first milepost could not be successlly and safely approached unless those interested underok their work seriously, and this could not be brought out until those in charge had created an atmosphere of respect and established the fact that there was need for each employee's best effort.

The multiplicity of instructions and the rapidity with which they were issued during government control made compliance with them almost a human impossibility. Conflict, doubt and confusion existed. Our then master car builder drew up and issued a booklet laying down guiding rules for every phase of work in the car department. This was issued to all supervisory forces, and its effect was electrical. Summed up in the terms of the carman, "it put the car department on the map." The principal parts of this booklet were published in the Railway Mechanical Engineer, commencing in January, 1920. This move may be termed the real beginning of our educational system in the mechanical department. At the present time, a book covering the maintenance of and repairs to locomotives, and instituting standard practices even to the finest detail, is in process of completion. In the meantime the information is utilized by being issued piece by piece in the form of circular letters.

Following the issuance of the first booklet, a concerted move was made to have every foreman or group of foremen provided with a Car Builders' Dictionary and to supplement this later with other books. Those engaged in special undertakings were induced to obtain the most authoritative publications dealing with their particular work, and many of our car department supervisors became connected with institutions and organizations which conducted discussions and issued current literature on terse subjects.

Monthly educational bulletins have been issued which deal systematically with the various phases of the car department work. One series of articles covers air brake work, another safety appliances, etc. The bulletins are furnished in sufficient quantities to make the information available to every employee in the department, no matter where located. Questions arising in connection with the articles are taken up by the men direct with whoever is conducting the publication, without passing through any official channels, and the questions and the answers both appear in the next issue of the bulletin. When necessary, the bulletins are supplemented with blueprints or sketches.

It was realized, however, that results would be derived more from successful application than from any particular virtue of the scheme itself. We therefore arranged for every inspector—freight and passenger—to be examined by our general safety appliance inspector, and later all foremen were similarly questioned. When this questioning was completed, a regular monthly examination system was inaugurated. This is conducted by sending to the district general car foremen 20 questions, based on information previously published in the educational bulletins, which on a given day are distributed to inspectors and foremen. Below each question, space is provided for the answer. When filled in the papers are returned and marked; five marks per question are allowed. The results are systematically recorded in my office and bulletined locally.

As a result of this system we have effected an improvement beyond our most sanguine expectations. The first report on our educational campaign stated that the then existing opinion that bad safety appliance conditions on our cars and locomotives was due to negligence was not correct; it was

* Abstract of a paper read before the Western Railway Club, Chicago, on nuary 16, 1922.

due to ignorance. It went on to say that not more than ten per cent of the inspectors on the system could pass an 85 per cent examination, and not 25 per cent could pass a 50 per cent test. That report was made less than two years ago, but today the number not regularly obtaining 90 per cent is negligible. Of course there has been quite a little transferring of men to other work, and in some instances inspectors have had to be taken out of service. But our inspectors today—the men we regard as of primary importance to the movement of our equipment—wear an air of confidence born of knowledge. Our derailments and accidents have decreased, and our percentage of on-time trains has risen to a very pleasing degree.

The examinations so far have been confined to safety appliances and matters connected directly and indirectly therewith. Extension to air brakes is being made, and we propose gradually to include questions concerning wheels, axles, general repairs, etc. Now no carman is appointed an inspector unless he can pass the necessary practical examination. Men desirous of promotion are voluntarily taking the monthly examinations, and we have at present a considerable number of men fast qualifying for positions of responsibility. The enthusiasm alone displayed by the men has been full reward for the effort necessary to inaugurate and sustain the campaign, but I feel that the big harvest is yet to be reaped.

Annual Department Staff Meetings

It was realized that as a group railroad employees attained a tremendous measure of experience, due to the large scope of the work, but that failure resulted from lack of opportunity for exchanging ideas. Accordingly, it was arranged to hold annual staff meetings of the car department and the locomotive department at Milwaukee. Later we inaugurated conventions of the blacksmiths, traveling engineers, and others interested in a particular phase of railroad work. At these staff meetings and conventions, prepared papers are read and discussed. The keen interest of the management in the meetings has been evidenced by the attendance of the president, vice-president, general manager, general superintendent of motive power and other officers. Such meetings as these wherein matters are discussed without restraint are most valuable educational schools. Foremen or master mechanics opposed to a scheme proposed by the management will leave such meetings enthusiasts for the scheme by virtue of knowledge of the other man's viewpoint; or, on the other hand, modification and even withdrawal of schemes may result from cold facts produced by unrestrained discussion.

At these staff meetings supervisors are educated as to how to deal with their men, to lay out their work, to handle their material. The papers and the discussions are printed and circulated, so that every foreman on the system may obtain the fullest possible benefit from the meetings. The papers are not contributed wholly by men within the mechanical department, but also by those in other departments, and even by persons entirely outside of the railroad field. Our aim is to secure as authentic articles as possible, to spread their contents by means of discussion, and then to make them available as guides for the following year's work.

Special instructions prepared and issued for various classes of service include, in addition to safety appliances and air brakes, already mentioned, valve motion for locomotives, electricity, and the federal locomotive inspection law. Monthly reports covering all phases of the department's operations are issued to principal supervisors and, in condensed form, to every foreman on the system.

Education of Operating Officers

Because the mechanical side of railroading has never ceased to advance, there arises the necessity of educating those we serve in the operating department to the viewpoint resulting from our experience and experiments. This tas is simplified somewhat where officials have served in th ranks, or made more difficult where they have not. It is nc an easy matter to impart one's knowledge to another, an the added handicap of lack of time and opportunity ofte makes it a difficult problem. The need of having those ad ministrating a department made aware of all that is involved however, stands out very clearly in my mind. The mean we endeavor to employ to attain the desired result is dis cussion of each problem by the men on the spot. This ad mittedly does not entirely serve the purpose, and greate education in this direction is much to be desired.

Education of the Public

Although the railroads are servants of the public, it i astonishing what colossal ignorance exists in regard to eve the simplest phases of their operation. This alone is a sever handicap to railroads in their present dilemma; but whe public opinion is fed by contributions to a vicious press b authors often ignorant of anything beyond the most ele mentary railroad matters, they are even further harassec I do not refer to the press as a whole, but to a certain sectio of it which allows its remarks on railroad problems to tak the form of destructive criticism. Such articles are not prc ductive of any good, but do the railroads much damage. I the section of the press referred to is attempting to harm th railroads, its attitude is a great success. If it is trying t better conditions for the public, it is a drastic failure.

Partially as a result of the attitude referred to, we occup the very unpleasant position of having a portion of the publi believe that the railroads are nothing but a network c intrigue—rotten in morals and with only sordid aims i view. To those who have devoted the best part of their live to the work, not because they received adequate monetar or other reward, but because the word "service" meant t them what the colors mean to a regiment in battle, this i indeed their cup of bitterness. It is time for action. Let u concert our efforts to have the public know that the railroa man is not a rotter, not an ignoramus, but their efficier most loyal servant, and a worthy citizen of this great republi

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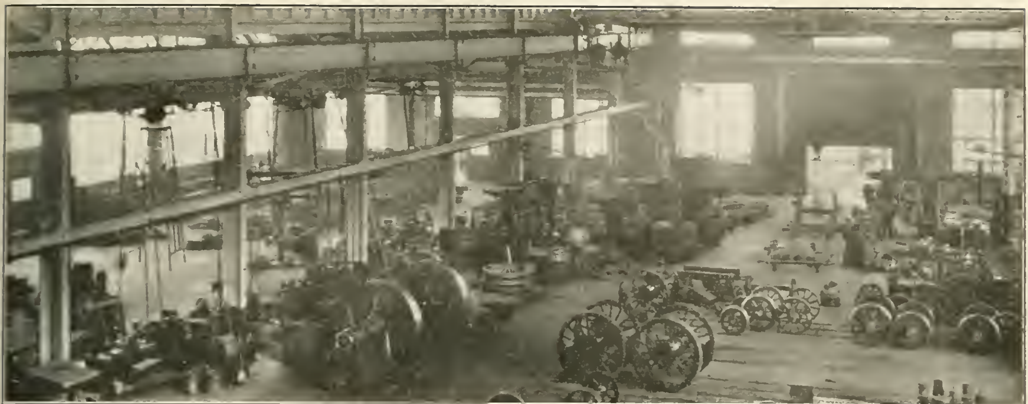
Exports of Apples from Halifax, N. S., this season hav amounted to 613,886 barrels, 5,635 boxes and 3,739 half barrel These apples have gone to Liverpool, London, Manchester, Gla gow, Hull, Avonmouth, Cardiff, Newfoundland, West Indies, Ne York and Boston.

Photo by Kadel & Herbert

Fighting the Snow in Norway



What Shop Equipment Means To a Railroad*

Central Railway Club Discusses Relation of Maintenance and Repair Facilities to Equipment Owned

By V. Z. Caracristi
Consulting Engineer, New York

RAILROAD motive power departments are continually being pressed for reasons why they demand from the higher officials appropriations to cover machine tools and shop facilities, and the repetition of statements that these facilities are required to take care of current work is usually countered by explaining that the need for such facilities will have disappeared by the time the equipment and facilities can be received and installed. Operating revenue, having so many mouths to feed, must be largely conserved for purposes which cannot be deferred, and in the face of the large demands, the weak voice of the motive power department is drowned by the clamor of what at the moment appear to be more important demands.

Starting out on the basis that there can be no question as to the necessity for providing facilities of some nature to take care of each unit of power or equipment acquired, I am endeavoring to crystallize the tangible requirements and to point out the reasons why such requirements exist. Eliminating the equally important necessity for yard and terminal facilities, I would like to offer a chart (Fig. 1) showing the expenditures which experience has led me to believe necessary to take care of the locomotives and cars coming immediately under the jurisdiction of the motive power department.

To summarize, the object of this paper is to point out briefly the reason why equipment is compelled to stand idle when it should be at its best condition to meet operating demands, as well as to endeavor to create as a basis for further discussion the actual capital requirements in terms of equipment owned or in future to be purchased

Available Hauling Capacity Not Utilized

As a matter of interest the data (Tables 1 and 2) on actual locomotive operation are submitted, locomotives being selected for the reason that they offer a well defined measuring stick to compare relatively what is being accomplished by them in repayment for the labor, material, and money which have gone toward their creation. This measuring stick can best be expressed by their hauling capacity. The relation between weight, hauling capacity, and cost is practically constant. A definite amount of weight is necessary for each pound of hauling capacity available, and the locomotives are themselves purchased indirectly on a weight basis.

The purchase of additional hauling capacity immediately entails an obligation on the part of the purchaser to utilize such facilities, and to secure revenue therefrom through the handling of freight or passengers.

The uniform system of accounting used by railroads, based on regulations of the Interstate Commerce Commission makes available as a whole the total tractive power and ton-miles of freight hauled.

In order to make a division line between the freight and passenger service, it is necessary to convert passenger earnings into ton-miles. In my opinion this conversion can best be made on a basis of earning capacity, for which purpose the equated ton-miles on passenger basis can be obtained by multiplying the ton-miles of freight by the total passenger revenue and dividing this figure by the total freight revenue, the underlying thought being that the decreased tonnage will be offset by the increased rate. Such figures, although perhaps of no other value, will result in a ton-mile basis which is comparative from year to year. A comparison made on this basis, using Interstate Commerce Commission statistics of Class I railroads for the years 1902 to 1919 inclusive, brings out startlingly the fact that in spite of advanced facilities in design during the 18-year period the amount of work performed by the locomotive was seriously decreased, as is evidenced by the fact that the increase in tonnage available was 233 per cent; the increase in the number of locomotives was 173 per cent, with an increase in the hauling capacity of 299 per cent. The efficiency of the 1902 locomotive being used as a basis, the railroads during the year 1917 could have

*Abstract of a paper read before the March 9, 1922, meeting of the Central Railway Club at the Hotel Iroquois, Buffalo, N. Y.

handled 56,000,000,000 more revenue ton-miles than they did; in 1918, 76,000,000,000 more revenue ton-miles, and in 1919, 139,000,000,000 more revenue ton-miles.

In other words, had each pound of tractive power been utilized at the same efficiency as in 1902 there would have been a large surplus of locomotives during these peak periods.

These analyses cover totals for the 12 months of each year, and it may be claimed that peak traffic demands during individual months produced conditions not reflected by the yearly average. However, it should be remembered that the relative peaks which existed during 1902 also existed in 1919. In other words, seasonal demands will not startlingly increase without reflection in the traffic during those months of lesser traffic movement.

Lack of Repair Facilities Decreases Net Returns

The reasons for the decrease in economic returns are a little complex, but they can be roughly analyzed as follows:

(a) The increased ratio of the power available does not appear to be serious.

(b) The lack of corresponding increases in terminal facilities in the way of increased length of receiving tracks, etc., as well as lack of expenditures for increased passenger facilities, are serious.

(c) The dominating influence affecting the decrease in work performed per unit of power available lies in the lack of capital expenditures for maintenance of equipment purposes. Individual road performance and increase in tonnage per locomotive mile run has been more than offset by motive power delays brought about by inadequacy of repair shop facilities. Power of sizes and weights out of line with shop equipment result not only in increased repair expense but what is more serious, in great delay in getting power back into service.

TABLE I—COMPARATIVE ANNUAL STATISTICS OF LOCOMOTIVE OPERATION ON CLASS I ROADS

Year 1	No. locomotives, total 2	Tractive power total pounds 3	Revenue ton miles 4	Total passenger †revenue, dollars 5	Freight train revenue, dollars 6	Equated ton ‡miles passenger 7	Equated ton miles, total freight and passenger 8
1902	37,516	768,502,779	157,289,370,000	$392,963,248	$1,207,228,000	51,109,045,250	208,398,415,250
1903	43,290	941,915,540	173,221,278,000	421,704,592	1,338,020,026	56,296,915,450	229,518,193,450
1904	46,146	1,052,307,260	174,522,089,000	444,324,991	1,379,002,000	56,196,112,658	230,718,201,658
1905	47,696	1,123,771,082	186,463,109,000	472,694,732	1,450,772,833	62,036,276,364	248,498,385,364
1906	50,954	1,260,633,673	215,877,551,000	510,032,583	1,640,386,655	67,116,330,605	282,993,881,605
1907	54,563	1,409,006,658	236,601,390,000	564,606,343	1,823,651,998	73,133,489,649	309,734,879,649
1908	56,867	1,498,793,551	*218,381,554,000	566,832,746	1,655,419,108	74,795,682,245	293,177,236,245
1909	56,468	1,503,971,444	*218,802,986,000	563,609,342	1,677,614,678	73,496,922,997	292,299,908,997
1910	58,240	1,588,894,480	*255,016,910,000	628,992,000	1,925,553,036	83,298,522,706	338,315,432,706
1911	60,162	1,681,495,905	*253,783,701,839	657,638,291	1,925,950,887	86,743,271,288	340,526,973,127
1912	61,010	1,746,964,128	*264,080,745,058	660,373,176	1,968,598,630	85,919,493,672	350,000,238,673
1913	62,211	1,847,798,393	*301,398,752,000	695,987,817	2,198,930,565	96,748,999,392	398,147,751,392
1914	61,442	1,886,549,588	*288,319,890,000	700,403,353	2,114,697,629	92,752,508,613	381,872,398,613
1915	61,882	1,970,295,300	*273,913,000,000	629,237,464	1,977,933,275	87,121,727,208	361,034,733,208
1916	60,790	1,989,132,700	*339,870,323,000	673,806,175	2,402,210,993	95,153,690,440	435,024,013,440
1916	60,990	2,024,118,700	*362,444,397,000	722,359,371	2,631,091,957	99,489,886,876	461,934,283,876
1917	61,533	2,087,949,700	*394,465,400,493	825,211,593	2,819,965,215	115,420,566,166	509,885,966,659
1918	63,531	2,223,246,296	*405,379,284,206	1,030,964,999	3,440,792,218	121,492,271,414	526,732,555,414
1919	64,983	2,301,602,581	*364,293,063,017	1,175,035,413	3,543,329,921	120,799,579,684	485,092,642,701

*Does not include returns from terminal and switching companies.
†Excluding mail, express, milk, parlor cars, switching and special train income.
‡Equated ton miles — passenger = ton miles (freight) X passenger revenue / Freight revenue

TABLE II—SUPPLEMENTARY DATA ON CLASS I ROADS' LOCOMOTIVE OPERATION

Year	Ton miles per lb. tractive power 9	Ratio of passenger to freight earnings 10	Capacity at 1902 efficiency 11	Surplus capacity, ton miles 12	Per cent 13	Earnings per lb. tractive power available — 5+6÷3 14
1902	271.2	.325	208,398,415,250	....	...	$2.08
1903	243.7	.3152	255,447,494,448	47,049,079,198	20.9	1.87
1904	219.1	.3222	285,375,728,912	54,657,527,254	23.2	1.73
1905	221.1	.3327	304,796,717,438	56,298,332,078	22.7	1.80
1906	224.5	.3109	341,883,852,117	57,889,970,712	20.5	1.78
1907	216.3	.3091	382,122,606,649	72,387,727,000	23.4	1.69
1908	195.8	.3425	406,472,811,103	113,295,574,786	38.6	1.48
1909	194 4	.3359	407,876,956,612	115,677,047,635	39.3	1.49
1910	212.8	.3266	431,108,182,976	92,792,750,270	27.4	1.61
1911	202.5	.3418	456,021,689,436	115,494,716,309	33.9	1.53
1912	200.0	.3405	475,776,671,513	125,776,432,841	35.7	1.50
1913	215.4	.321	501,022,924,381	103,875,172,989	26.0	1.56
1914	202.0	.3217	511,632,348,265	130,559,949,652	34.2	1.49
1915	183.2	.3181	534,344,085,360	173,309,352,152	48.0	1.32
1916	218.7	.280	539,450,788,240	104,426,774,800	24.0	1.54
1916	228.0	.2745	548,940,991,440	87,006,707,564	18.8	1.65
1917	244.2	.2926	566,151,958,640	56,275,991,981	11.0	1.74
1918	236.9	.2997	602,944,395,475	76,211,840,061	14.4	2.01
1919	210.7	.3316	624,194,619,967	139,101,977,266	28.6	2 05

Adequate provisions in the way of machine tools will have a great influence on recovering, if not passing established records previously made in ton-miles per pound of tractive power available.

Capital account expenditures cannot be made to better advantage at this time in any direction by the railroads than through provisions for modern repair shops and equipment.

The selection of machine tools, traveling cranes, small tools, jigs and fixtures can easily be made to meet any motive power requirements. The principal danger in the selection of machine tools is in giving undue weight to maximum performance of individual items.

The purchase and installation of special high-powered individual-purpose tools should be made only after the most minute analysis of the actual immediate and prospective requirements. Each expenditure in the way of machine tool facilities should be made so as to give the maximum return in the way of plant output and not considered on the basis of the output of the individual unit. Over-equipment of individual departments does not assist either the time or cost element of a locomotive which has to be passed through all the departments of the repair terminal.

Equipment Maintenance in Slack Periods

It is well to point out the fact that the railroads of this country have been, and now are, compelled to operate under serious handicaps in order to meet the current financial requirements necessary to keep them out of the hands of receivers.

A more specific explanation for the reasons resulting in this condition is readily found in either one or a combination of the following facts, all of which are subject to correction either by the railroads or the Interstate Commerce Commission.

First. The railroad companies appear to have purchased power at a higher ratio than the normal increase in tonnage available justified, causing power to remain idle.

Second. In the efforts of railroad officials to maintain a uniform ratio between income and expense, it is customary to reduce the maintenance of equipment appropriations during the slack months, thus causing the power in many cases, to be unavailable to take care of the peak load transportation in the fall and winter months without the assistance of the locomotive builders

Third. Unfortunately, it has been the custom of motive power and transportation officials when purchasing new power, to endeavor to "keep up with the Joneses" by purchasing power in large sizes, and in a number of cases the tonnage available, yard facilities, bridge, and right-of-way limitations, and other local causes have prevented the full utilization of all of the extra drawbar pull available.

Fourth. Labor conditions, both in the transportation and motive power departments, have tended to decrease power and operating efficiencies.

Fifth. The amount of money expended by the railroads for logical repair shop facilities has been lamentably out of proportion with the amount of money expended for motive power and cars, resulting in inadequate facilities for needed repair and modernizing work. The reason for this is probably due somewhat to the fact that it is easier to secure financial assistance through car or locomotive trust certificates than it is to secure money on blanket or other mortgages to be used for the purpose of shop extensions or construction.

Sixth. The analysis of data from individual railroads shows that the purchase of power has in some cases been

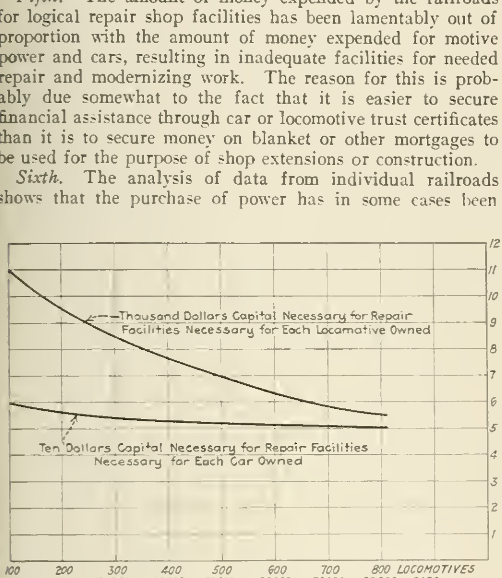


Fig. 1—Chart Showing Desirable Relation of Repair Facilities to Equipment Owned

justified and that the tons hauled per pound of available tractive power show decreases not out of line with changes in operating and labor conditions.

Taken as a whole, however, the figures clearly indicate a tendency to purchase power in advance of traffic requirements and further show inadequate provision for the roundhouse and general repair work necessary to keep the investment for power active.

Lack of Shop Facilities Delays Improvement Programs

The lack of adequate shop facilities is the greatest factor obstructing the purchase and application of modern fuel saving or other devices which would permit the increase of revenue ton-miles per pound of tractive power available. Lack of facilities to take care of such equipment when installed, and the fact of additional engine failures and delays has naturally resulted in the motive power department's being averse to take on additional obligations for maintenance with the fore-knowledge of inability properly to care for the same. As a matter of self-defense this tendency is a natural one, and as long as reasonably adequate supplies of tools and facilities are not available the position is well justified.

When the fact is taken into consideration that progress in locomotive development in the past few years has been almost entirely in the direction of devices which can be applied to existing power, and that the application of such equipment will make any existing locomotive as efficient as one of equal power just out of the builder's shop, the enormous size of the economic loss to the railroads can be visualized.

I am not an advocate of the attachment on the locomotive of every piece of apparatus that presents itself which theoretically might affect savings in operation, and I do not belittle the value of cold-blooded analysis of what the over-all economic results of each individual application will mean to the railroad organization as a whole. There are so many conditions of local operation which affect and govern, that each proposal can only be made the subject matter of intelligent decision by those intimately familiar with the governing factors.

A locomotive, when out of service for the most trivial cause, is just as expensive to the property as a whole as one legitimately tied up waiting for periodical over-hauling, and too much attention cannot be devoted to the necessity for adequate facilities. Each railroad should have every locomotive surveyed to determine if its useful life is actually finished through use or inadequacy, and if there is not the possibility of placing this engine on an equal basis with an engine just received from the builder, through application in its own shops of such modern improvements as superheaters, feed water heaters, cut-off indicators, brick arches, power reverse gears, valve gears, etc.

Trust Certificates Suggested for Betterment Work

Full capital account credit should be given for all betterment work and additions made to old power, and a new value placed on the entire locomotive after the completion of such betterments, in line with its ability to compete with a new unit of equal capacity, irrespective of its old arbitrary or book value. A market might be created for equipment betterment trust certificates to cover a proportion of the capital account betterment cost. Such certificates would have more equity behind them than if applied against new units, and would make available the necessary capital to rehabilitate railroad property with the advantage of utilizing in full capital previously expended.

Repair work should be equalized over the 12-months' period by arbitrary charges against income in the months of great business for credit and use during periods of revenue depressions.

Each purchase of new locomotive equipment should be made the subject of special study by the accounting, motive power and transportation officials assisted by outside advice if necessary, to determine: (a) Actual necessity, (b) size and capacity which will give the greatest net returns to the company, (c) type.

Locomotive purchases are in nearly all cases made at a time when erecting shop space is at a premium. This condition could be obviated by cold-blooded expenditures for repair facilities in combination with the scrapping of all papers relative to monthly budget allowance for maintenance of equipment work.

The railroad repair shops are usually operated at their peak during those months in which the cost of doing the work is at its highest, and what little organization remains in the spring time is engaged in hoeing the grass between the stones of the shop highways. The fluctuations in the pay-roll of both the classified and running repair shops are appalling, and these fluctuations are largely brought about by the month-to-month method of accounting and record keeping in vogue by the transportation systems. Expending freely for maintenance account when earnings are temporarily good, at the expense of a starvation policy when earnings fall off due to natural seasonal conditions, is not a good business policy.

Explanation of Chart

This chart (Fig. 1) represents the amount of capital necessary for repair facilities, including yard, track, and other work, for every locomotive added to the property.

For instance, a property having 500 locomotives should have, in the way of facilities for the repair and upkeep of these locomotives, property having a value of $3,500,000, and if 50 additional locomotives were purchased, the amount of money which should be expended for addition to the repair facilities is $6,700 for each locomotive, or $325,000 for 50, thus making the amount of money expended in facilities for the repair and upkeep of 550 locomotives $3,825,000.

Fig. 1 also shows the amount of money which should be expended for capital account purchases in the way of repairs, tracks, and facilities for the running and heavy repairs of freight cars. It will be evident that a property having 20,000 cars should have an investment of this nature having a value of $1,140,000 and in the event of the addition of 2,000 cars, $56.00 represents the amount of investment necessary to take care of each car, or a total of $112,000, thus making the total investment to take care of 22,000 cars $1,252,000.

Discussion

G. M. Basford (G. M. Basford Company): To me this paper seems one of the most important documents that has been presented before a railroad organization in many years. It calls attention in a marked way to the business question involved in taking care of equipment. The presiding officer spoke just now about the length of time required in getting up a new shop. That reminded me that my first important railroad work was laying out a shop in the drafting room. It was 26 years after that before the shop was built and during that time the particular railroad, the name of which I will not mention, did not have a real good shop. The locomotive deserves better care than that.

What are we going to do about it is a proper question at this point. Difficulty in raising capital for shop equipment prevents some roads from keeping up their machinery. Reluctance to invest their capital prevents financially comfortable roads from doing it. But the roads that become or remain strong financially will be the ones that keep a continuous flow of new shop equipment into their plants to protect their enormous investment in locomotives. These will be the roads that reduce operating costs by keeping up the condition of their engines.

C. B. Peck of the *Railway Mechanical Engineer* in a paper read before the Western Railway Club last month, supports the speaker by showing the relation between shop equipment and locomotive repair costs. As I remember the figures he shows that road B can afford to invest $9,000,000 in shop equipment to get its locomotive repair costs down to the figures of road A. He gives detail figures for both. But it is extremely difficult to find such a huge lump sum. The thing might be done in another way. It need not be done all at once. If road B had established a machine tool policy which for years past had added a few machines each month; if a plan and program had been made and each addition of equipment had been part of that policy, the savings each year would go toward an expansion of the policy the next year and road B would not be running away from the sheriff as Mr. Peck says it is right now.

There is nothing we need with respect to locomotives as much as we need policies, plans and programs. Three great operating items are affected and as indirectly suggested by the speaker of the evening are controlled by the facilities for locomotive maintenance. They are train crew wages, fuel and locomotive maintenance costs. The condition of locomotives directly affects fuel efficiency, overtime on the road and ton mileage. Locomotive condition is controlled largely by the equipment available to maintain the engines. These things are mentioned to show the necessity for a maintenance-of-equipment policy. How many roads have such a policy? Do they not wait and wait and then put in a lump of additional machinery after the head of the organization has been argued with and finally convinced? The cost is most prominent in his mind and he trims the list to bring it down. The thing is done and is regarded as finished.

As in many other business matters would it not be wise to make an annual budget and keep new machines coming regularly, uniformly and fast enough to be assimilated in the shop routine? In dull times machine prices fall. Machinery business like the locomotive business is a famine or a feast. Some day railroads will follow in machine purchases the plan followed by J. J. Hill as to cars. He kept a car plant going for years in dull times and when business came on he was ready to take business from his competitors.

It is my opinion that the officers of the railroads who have directly to do with locomotive and car maintenance have a great opportunity to put this idea into the form of a policy. I believe they can frame it with sufficient strength of argument to put it through right on up to the top and to make executives listen.

If these immense appropriations could be displaced by very much smaller ones providing systematically and regularly for steady improvement at frequent intervals, road B would not be in its present fix; another road would not let sixteen years pass without substantial additions to the machine equipment of a large terminal and another road would not allow ten years to pass without an adequate addition to the machine tool equipment at any of its shops. Another road would not require four months to repair an engine and perhaps would not now be in receivers' hands.

A little expense every year keeps a house in order. Waiting until it is a ruin keeps it always in bad order. Is it different in a shop?

E. L. Woodward (*Railway Mechanical Engineer*): I was impressed with the chart showing the relation between necessary maintenance and repair facilities and road equipment. Take for example a railroad having 800 locomotives and possibly 40,000 cars. On the basis of these curves, locomotive repair facilities should exceed $4,000,000 in value and car repair facilities $2,000,000. In far too many cases a railroad will have more equipment than that indicated above and fewer repair facilities. Added evidence of the lack of the proportion between present repair facilities and equipment on the road is given in Mr. Peck's paper previously referred to by Mr. Basford. In one instance mentioned the book value of the road was set at $400,000,000 and the total amount of shop and terminal facilities, including equipment, not over $16,000,000.

The lack of necessary repair facilities is a great detriment for several reasons, including (1) excessive cost of repairs, (2) equipment held out of service waiting repairs, and (3) delayed improvement programs. An important part of the cost of repairing cars and locomotives is labor cost, and it has been shown that this item practically equals the cost of fuel or the cost of crew wages in freight train operation. In order to decrease the cost of repairs to the point where it ought to be, labor-saving machinery must be installed.

Examples may readily be found illustrating how inefficient machinery decreases shop output. I was in a shop recently where an old wheel lathe was being used to turn tires, the feed being about 3/16 in. per revolution. The depth of cut was so small that several cuts had to be taken and it required seven hours to turn the pair of tires. A modern wheel lathe under the most favorable conditions can turn a pair of driving wheel tires in 30 minutes and an average of one pair an hour can easily be maintained. It is not infrequent to find truck wheels turned on large engine lathes, in which case one tire only can be turned at a time using small cutting feeds and speeds. Old planers are still in operation with no side heads and sometimes with only one cross rail head. I was in another shop not long ago where tube holes in a front flue sheet were being cut on an ancient radial drill. This machine was badly worn, of low power and was not forcing the high speed cutters to anywhere near their capacity.

Not only are inefficient machines being used, but in many cases modern methods of machining cannot be utilized for the lack of necessary tools. For instance, many shops are not adequately equipped with grinding machines. These machines have already demonstrated their value and are now made powerful enough to machine parts from the rough stock in a short time. The work is exceedingly accurate, rapidly finished and smooth enough to form the best of bearing surfaces. Similarly with milling machines, important economies can be effected by their more general use in railroad shops. Engine lathes also should not be forgotten and on account of being so much more commonly used than turret lathes, special lathes, etc., they should be of the latest and most efficient design. Centralized production departments should be developed and facilities provided for repairing steel cars. Railway power plants in the United States are variously estimated at from 1,200 to 1,800 in number, and we all know how infrequently they benefit by new equipment or modern testing apparatus.

The present relatively high wages make improved shop machinery and equipment absolutely essential to economical shop operation. In 1912 I began work at 28 cents an hour in an air brake room on the Boston & Maine. Even should the present machinists', boilermakers' and blacksmiths' rate be decreased from 77 cents to 67½ cents as proposed, this rate will still be 100 per cent higher than it was in 1912. Are present shop facilities 100 per cent better than in 1912?

Who is to blame for the present lack of repair and maintenance facilities? It is easy to blame the Interstate Commerce Commission or the public or business conditions, but the trouble is not entirely there. The mechanical department itself is to blame in no small measure for present conditions because its needs are not sufficiently emphasized. Mr. Caracristi refers to the weak voice of the mechanical department. The voice of the mechanical department is not only weak, but it is not heard often enough.

What is the remedy? The mechanical department has a good case which should be presented forcefully and continuously until results are obtained. The savings possible by additional repair facilities, including new machinery and equipment, should be estimated accurately with recommendations based on specific and comprehensive data from which no factor is omitted. Present the recommendations without fear and push them on every possible occasion. If possible, get the higher officers out in the shop or roundhouse and show them actual conditions, pointing out the needs. A much stronger impression will result.

Bad shop and terminal conditions in this country are considered a necessary evil and taken too much for granted. I feel that the lack of money for shop improvements is also sometimes taken too much for granted. Prompt improvement would follow a more careful and more frequent expression of shop needs. Tell the boss. I would suggest that this paper by Mr. Caracristi be taken home and given serious attention in the hope that we may all realize more fully how important a factor shop operation is in railroad operation and what a direct influence it has upon the general business prosperity of the country.

F. C. Pickard (D. L. & W.): How to go after machine tools? Take your labor charge together with your time element and if you can show from 15 per cent up in savings and put your argument up to the right people on the job in the shop, you usually get results. Recommendations mold, get dusty and go into the waste basket I find that if you can take the man who has the authority to fix the A.F.E. right down in the shop and talk to him and show him where it is a profitable investment, you can usually get the tool you want. We replaced a machine the other day that took two men two eight hour tricks to keep up with our daily routine. The installation of the new machine paid 24 per cent on the investment. We now do the job in three eight-hour days and when that argument was presented it was not very hard to get our people to purchase the new tool. We have practically a definite plan throughout the year on expenditures for machine tools.

Important economies are derived from laying out a yearly program. Our forces are adjusted so that the horizontal line will just about neutralize the up and down peaks of high and low business and when the year is over, we have a uniform force of men in the shop. We have had about a uniform distribution of material for the year and this plan is more successful than that of making appropriations based on monthly business. The average railroad makes a large appropriation proportional to the volume of business and it should be reversed so that the amount of money for shop operation should be low when the business is high. You want your locomotives on the road and your cars moving when business is good and when it is poor they ought to be repaired and put in shape to care for the business when it comes along.

I have watched a large number of shops throughout the country and it has been my observation that the shop with about 15 pits shows a better operation than one with 35 or 40 pits. A good deal of the heavy expenditures in the large shop are due to overhead. You can talk of the hourly rate of mechanics and its relation to shop production, but the biggest thing that I see and that we have got to deal with is classification and a stipulated amount of work to be done in a shop. I would just as soon pay a dollar an hour if I get the work done, but I don't want to pay a dollar if I only get 25 cents' worth of work. There must be some plan laid down whether you call it a bonus system, piecework or something else, so that you can tell a man he has got to go from "A" to "B" for a day's work. In other words, mechanical men would produce a whole lot better results if they didn't have both hands and feet tied with labor together with labor contracts, laws and regulations, as they have at the present time. We have got to the regulating point with our labor contracts where it is strangulation.

H. C. Woodbridge (Rochester, N. Y.): Unfortunately, it seems to fall to my lot to be a crepe hanger or a critic. The author says, "In other words, had each pound of tractive effort been utilized at the same efficiency as in 1902, there would have been a large surplus of locomotives during these peak periods." Mr. Caracristi spoke of the opportunity for criticizing that word efficiency. Personally, I am sorry that he used it. I am afraid that such paragraphs coming from members of the railway clubs, and especially perhaps from a consulting engineer, will furnish material for those who are are belittling the efforts of railroad officers. I do not like the word and I wonder how much is taken into consideration in developing that efficiency.

The writer and Mr. Pickard hit the anvil on the head when they said, "Get the line uniform and let the peaks up and down balance each other." This is a wonderful paper but we ought to be careful how we talk before these trouble makers who take our words and twist them.

Mr. Caracristi: I agree thoroughly with Mr. Pickard with regard to large shops, but do not agree that 15 pits is the economical limit. A shop can be made unwieldy in size and I think a lot of trouble with the large shop has not been on account of the shop itself, but on account of the lack of rounding out requirements. We all know of shops with good machine tool equipment but lacking in jigs and fixtures necessary to get the work out of them.

I regret that Mr. Woodbridge did what I was afraid a lot of you would do—take a wrong slant at my comparison on the basis of efficiency. I pointed out in another portion of my paper that the 1902 locomotive based on its tractive power could be made just as efficient as the 1920 locomotive and that is the basis on which the whole paper is written. Given the proper repair facilities, your locomotives can be made as efficient. There has not been a thing developed which has increased the efficiency of the locomotive from a fuel consumption standpoint that cannot be put on an old locomotive just as it can be on a new one.

A Successful Welding Job

By Charles A. Norton
Moncton, New Brunswick

THE following is a description and illustration of an acetylene welding job which was successfully completed in the shop here a short time ago the details of which may be of interest as showing the possibilities of acetylene welding. The work was done by welders from the boiler shop.

Reference to *A* in the illustration shows the broken cylinder and in the lower left corner the patch which was carefully machined and shipped ready to be put in position and welded. The patch is shown on a somewhat smaller scale in the picture but its proportion and general design are plainly indicated. The cylinder flange was put in place and the patch applied in the correct position for welding. The outside of the cylinder was then cased with thin sheet metal as shown at *B* and the space between this casing and the cylinder proper filled with asbestos. A four-pipe gas heater was then placed inside the cylinder and the patch and cylinder end allowed to heat slowly. The time taken to preheat the job was about three hours.

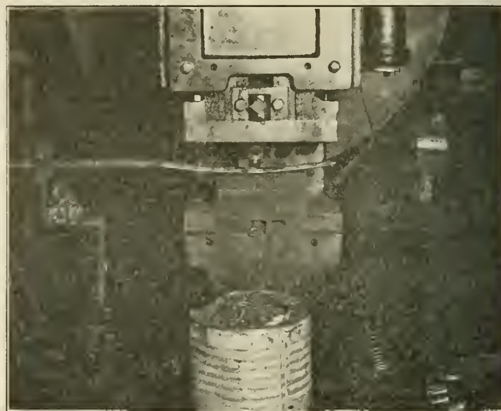
After the heater was withdrawn two welders began work and by working alternately they were able to keep the metal running continually which prevented any void being formed by a stoppage of work for one cause or another. The acetylene gas welding tanks are shown at the right of *B*, mounted on a truck for convenient movement about the shop.

The patch weighed 140 lb. and four hours of continuous welding was required to apply it to the cylinder. Approximately 38 lb. of welding rod was used, and the cylinder as finally rebored ready for application is shown in *C* in the illustration. Inasmuch as the crack came directly in one of the cylinder stud holes it was necessary to apply two additional studs one on either side of the crack and drill corresponding holes in the cylinder head.

Making Washers from Old Flues

By S. J. C.

The illustration shows an interesting method of utilizing scrap boiler flues in the manufacture of washers at a relatively low cost. Dies have been made for punching ½-in., ⅝-in., ¾-in. and ⅞-in. washers of which many hundred pounds are used in railroad shops annually. The old flues are flattened out under a steam hammer and punched, two



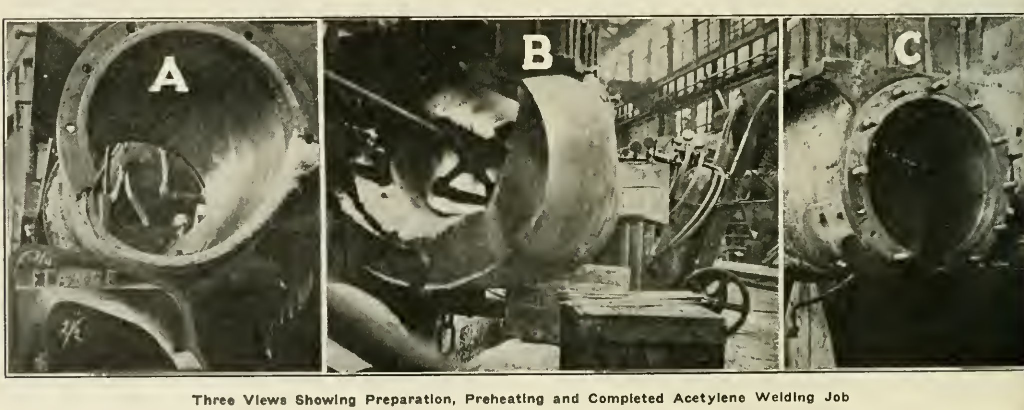
Two Washers Are Formed at Each Stroke of the Punch

washers being secured with each revolution of the punch. The cost of producing washers by this method is as follows:

Labor to handle and flatten flues	$0.30 per 100 lb.
Labor of cutting and handling flues	.31 per 100 lb.
Labor or punching washers	.55 per 100 lb.
Scrap value of flues	.50 per 100 lb.
Total cost	$1.66 per 100 lb.
25 per cent overhead	.415
Grand total	$2.075 per 100 lb.

This figure effected a very satisfactory saving in washers compared with the price during 1919 and 1920, which was an average of $5.425 per 100 lb. In July, 1921, the price of washers went down to a point where it was inadvisable to continue manufacturing them from scrap stock and the present quotation on washers averages $1.84 per 100 lb.

The worker flattening out flues and punching washers is paid a mechanic's rate on account of the rules handed down by the United States Labor Board and while this work is relatively unskilled and could be performed by laborers as well as mechanics, the latter must be employed. If it was permissible to use laborers, washers could be cut from scrap stock with a saving below even the present market price.



Three Views Showing Preparation, Preheating and Completed Acetylene Welding Job

Fig. 1—View of Well Organized Flue Shop

Installing and Maintaining Charcoal Iron Locomotive Boiler Tubes

By G. H. Woodroffe* and C. E. Lester†

THERE is a correct way to apply a boiler tube, and an incorrect way. With certain tools the necessary operations may be performed efficiently, with minimum time and labor costs. Done with tools less suited to the work, the application is not only unsatisfactory but the service life of the tubes is materially shortened.

In the interest of better tube service and lower tube costs we have prepared the following recommendations for the application and maintenance of charcoal iron boiler tubes, arch tubes and superheater flues. From the standard practices of a number of railroads we have taken what we believe to be the best and have incorporated it in this recommended practice. In this work we have been guided by the suggestions of practical railroad men, whose cheerful assistance and valuable co-operation are gratefully acknowledged. Methods of applying boiler tubes, and the tools employed, vary considerably on the different railroads. Whatever the procedure the various operations must be performed with care and thoroughness. The tools used must be properly maintained.

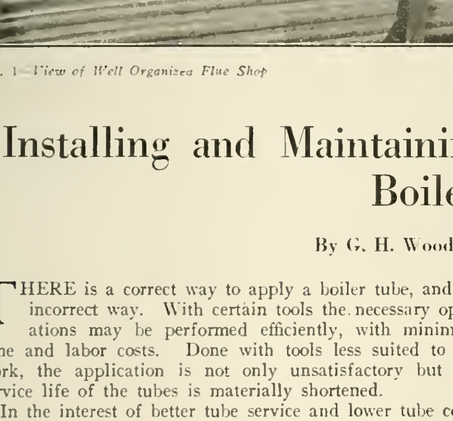


Fig. 2—Setting Copper Ferrule in Tube Sheet

Tubes should be made tight in the flue sheet with the least possible working. Once a tube is really tight, excessive working will not make it more secure. On the contrary, it will injure the metal and adversely affect the service life of the tube, making early renewal necessary.

A roller expander is not recommended for use on the firebox end of tubes, except possibly for a light finishing hand operation. The roller crushes the metal of the tube, thinning it out and reducing its resistance to the demands imposed by service.*

Application of Body Tubes

Preparation of Back Tube Sheets—Holes for body tubes in the back tube sheet should be the same diameter as the outside diameter of the tube, both edges being rounded to a radius of 1/16 inch.

Preparation of Front Tube Sheets—Holes in the front tube sheet should be 1/16 inch larger than the outside diameter of the tube except that two holes, 5/16 inch larger than the outside diameter of the tube should be left about 12 inches above the bottom row of tubes in the center, in order to facilitate the removal of badly scaled tubes. All holes should be clean and the outside edges rounded to a radius of 1/16 inch.

Ferrules for boiler tubes should be soft copper, 1/32 inch longer than the thickness of the back tube sheet.

Ferrules must be of the same outside diameter as the tube and should be 0.0625 (1/16 inch), 0.08 and 0.09 inch thick. For new work, ferrules should be 1/16 inch thick, the heavier copper being used after the tube holes have become enlarged through service. This practice permits the use of a standard swage. Copper ferrules may be softened by annealing.

Reaming Tube Holes—When a firebox sheet tube hole becomes 1/8 inch out of round, ream it with a straight

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†Formerly General Superintendent, 19th Division, Transportation Corps, A. E. F., and Superintendent of Nievre Locomotive and Car Shops.

*The word tubes, used in the following pages, refers to body tubes. By flues are meant "superheater tubes or flues."

reamer. When it becomes enlarged through service to 3/16 inch above outside diameter of tube, scrap the sheet.

Preparation of Firebox End of Tubes—Swage the firebox end of the tube with a slight taper toward the end of the tube to 1/8 inch less than the outside diameter of the tube, so as to drive snugly in the ferrule after the ferrule has been tightened in the sheet. Length of swaged end should be the thickness of the tube sheet plus 1/4 inch.

Preparation of Front End of Tubes—Cut tubes to length. The front ends should be expanded hot, to such a size that when placed in the boiler they can be driven snug in the front tube sheet. This should not be done to tubes that are to be transferred (put through one hole and set in a different location) in the boiler.

The ends of the two tubes that are to be placed in the enlarged holes may either be expanded hot to the required

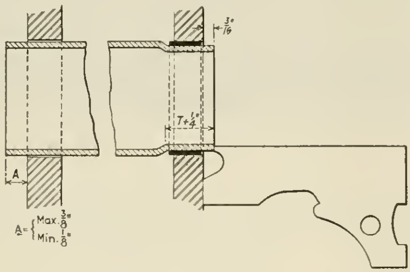


Fig. 3—Proper Position of Tube in Sheet

diameter or have a piece of tube of larger size, 12 inches long welded on.

Setting Ferrules—Place ferrules in the tube holes in the firebox sheet, 1/32 inch from the fire side. Tighten with straight sectional expander, Fig. 2, or roll with roller expander.

Placing Tubes—Clean the firebox ends of the tubes and place them in the tube holes in the firebox sheet, fitting them neatly into the copper ferrules.

Be careful not to injure or displace the ferrules.

Tubes should project through the firebox sheet 3/16 inch, as measured by the gage, Fig. 3. The projection through the

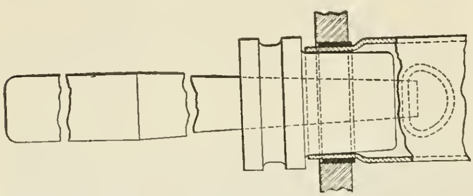


Fig. 4—Method of Tightening Tube in Back Tube Sheet

front tube sheet should be 1/4 inch. It must not be less than 1/8 inch nor more than 3/8 inch.

Tightening Tube in Sheet—Tighten tubes in the firebox sheet with a straight sectional expander, Fig. 4.

Tightening Front End of Tubes—Next tighten the front end of the tube with a standard roller expander, Fig. 5.

Flaring Tubes, Preparatory to Beading—The firebox end of all tubes, and on superheater engines the front ends of the two rows of tubes just below the superheater flues and all tubes above these two rows, should be opened with a flaring tool, Fig. 6. Use a long stroke pneumatic hammer.

Expanding with Lipped Sectional Expander—Expand the firebox ends of the tubes with the lipped sectional expander shown in Fig. 7. Drive the expander pin lightly until it is fairly solid. Draw out the pin. Give the expander a turn equal to half a section of the expander. Drive the pin a second time. Withdraw it, and turn the expander a distance equal to one-quarter of a section. Drive the pin a third time. Care should be exercised in the use of the expander in the outer rows of tubes near the heel of the flange to avoid cracking the sheet. Use a long stroke Boyer No. 60 pneu-

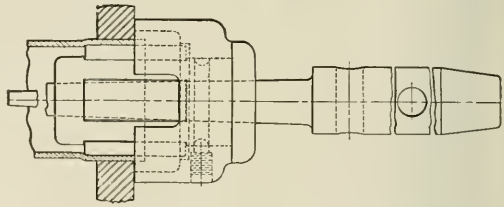


Fig. 5—Rolling the Tube in the Front Tube Sheet

matic hammer (a heavier hammer is not recommended) in driving the pin or its equivalent.

Inspection for Split Tubes—After expanding, examine the tubes carefully. Those which have split in the shoulder formed by the lip of the expander, and tubes that have opened from the end back to the sheet, should be removed and replaced before beading.

Opening Front End of Tubes—If the front end of the tube has not been opened hot before placing in the boiler, a straight sectional expander should be used to tighten the tube in the sheet. The tube may then be rolled with a standard roller expander.

If the finger type roller expander is used, the use of the straight sectional expander is not required.

Beading—Firebox ends of all tubes must be beaded, Fig 9.

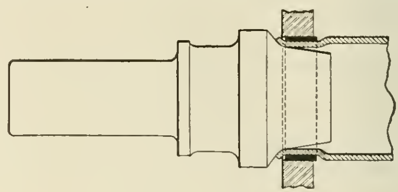


Fig. 6—Method of Flaring Tubes

Use a short stroke pneumatic hammer. Take care that nothing enters between the bead and the tube sheet. In superheater locomotives the front ends of the two rows of tubes just below the lower row of superheater flues and all tubes above these rows must be beaded similarly.

Hold the beading tool so as to give the bead an outward set and get it down to the sheet without raising a burr on the inside or marking the outside of the sheet with the heel of the beading tool. The center line of the beading tool should always be inside the line of the tube. Remove any burrs that may be raised with a small chisel and hand hammer. If necessary, the firebox ends of the tubes may be rolled lightly after beading.

Tools—All beading tools must be maintained within the limits of standard gages. Lipped expanders should be stamped to show the thickness of sheet on which they are to be used and should be taken out of service when worn or distorted to such an extent that they will not force the tube squarely against the sheet.

Application of Superheater Flues

Preparation of Back Tube Sheet—Holes for superheater flues in the back tube sheet should be 4 5/8 inches, both edges being rounded to a radius of 1/16 inch.

Preparation of Front Tube Sheet—Holes in the front tube sheet should be 3/32 inch larger than the outside diameter of the flue and the outside edges should be rounded to a radius of 1/16 inch.

Copper Ferrules—Ferrules must be made of soft copper, 1/32 inch longer than the thickness of the tube sheet. Ferrules must be of the same outside diameter as the holes in the tube sheet and should be 0.0625, 0.08 and 0.09 inch thick. For new work, use ferrules 1/16 inch thick, the heavier copper being used after the holes become enlarged through service.

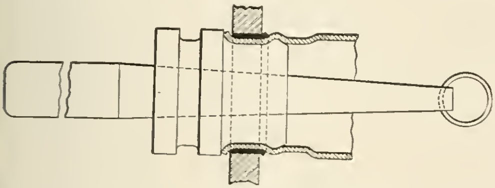


Fig. 7—Lipped Sectional Expander Used to Expand the Firebox End of Tubes

Preparation of Firebox Ends of Flues—Firebox ends of flues should be swaged to a diameter of 4½ inches. The straight portion should be 5 inches and the tapered portion 3 inches long, as in Fig. 10. Remove all scale and burrs before placing the ends in the tube sheet.

Preparation of Front End of Flues—Cut flue to length. Expand front end, hot, to a diameter 1/16 inch greater than the outside diameter of the flue, as in Fig. 10.

Setting Ferrule—Place the ferrules in the flue holes in the back tube sheet 1/32 inch from the fire side and tighten with the roller expander, Fig. 11.

Placing Flue—Place flues in the holes in the back-tube sheet, fitting them neatly into the copper ferrules. In placing flues, be careful not to displace copper ferrules. Flues should project through both sheets ¼ inch to allow for beading, Fig. 10.

Rolling Flue in Back Tube Sheet—Tighten flues in the back tube sheet with a roller expander. The roller expander shall have not less than 5 rollers, Fig. 12.

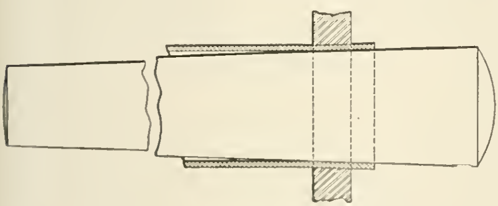


Fig. 8—Pinning Out the Front End of a Tube

Flaring Flues in Back Tube Sheet—A flaring tool, because of its size and weight and the force necessary to drive it, is not recommended for superheater flues. Superheater flues should be flared by a four-pound peining hammer.

Expanding Flues in Back Tube Sheet—Expand firebox ends of flues with lipped sectional expander of not less than 12 segments, Fig. 13.

Drive the expander pin until it is fairly solid. Draw out the pin and give the expander a turn equal to one-half of a section of the expander. Drive the pin a second time. Withdraw it. Turn expander a distance equal to one-quarter of a section. Drive the pin a third time. Use a long stroke pneumatic hammer in driving the pin.

Rolling Front Ends of Flues—Tighten the front ends of flues with a roller expander, Fig. 14.

Flaring Front Ends of Flues—A flaring tool, because of its size and weight and the force necessary to drive it, is not recommended for front ends of flues. Front ends of flues should be flared by careful blows of a four-pound peining hammer.

Beading Superheater Flues—Bead the flues at both ends, Fig. 15, using a short stroke pneumatic hammer. Take care to see that nothing enters between the bead and the sheet. Hold the beading tool so as to give the bead an outward set and get it down to the sheet without raising a burr on the inside, or marking the sheet with the heel of the tool on the outside. The center line of the beading tool should always be inside the line of the flue. Remove any burrs that may be raised with a small chisel and hand hammer.

Tools—All beading tools must be maintained within the limits of standard gages. Lipped expanders should be stamped to show the thickness of sheet on which they are to be used and should be taken out of service when worn or distorted to such an extent that they will not force the tube squarely against the sheet.

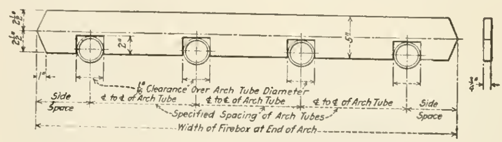


Fig. 18—Template for Gaging Arch Tubes

Application of Arch Tubes

Preparation of Sheet—Sheets must be properly straightened. Holes for arch tubes must be circular and drilled 1/32 inch larger than the outside diameter of the arch tube. Outside edges should be rounded to a radius of 1/16 inch.

If the arch tube hole has become enlarged above normal size in service, measure it carefully, so that the tube can be heated and enlarged to fit the hole snugly before being applied. If this is not possible a copper ferrule may be used extending ¼ inch on the water side and flush with fire side of the sheet.

Preparation of Arch Tubes for Setting—Cut arch tubes to proper length, with an allowance of ½ inch at either end for flaring. They should be smooth at the ends and free from burrs. They should be formed in accordance with drawings for the various classes of locomotives. Particular attention should be given to bending, in order to prevent the formation of steam pockets in service due to improper bends to make certain that the arch tubes enter the sheets at an angle of 90 degrees, Fig. 16, and to avoid flattening which would not only weaken the tube but might cause an obstruction and keep the turbine cleaner from going through.

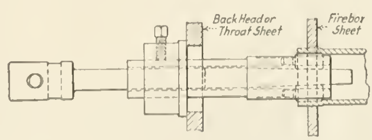


Fig. 19—Clamping Device for Arch Tubes

Setting of Arch Tubes—Arch tubes should be set in position, the proper amount projecting through the sheet for flaring and held with a clamp similar to Fig. 17.

It is recommended that a spacing gage, Fig. 18, be used to insure correct alinement of arch tubes.

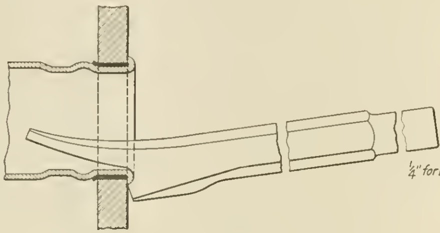


FIG. 9

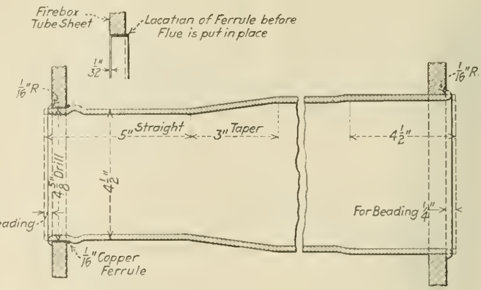


FIG. 10

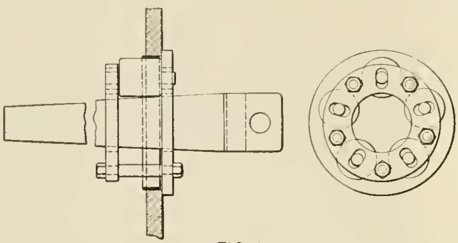


FIG. 11

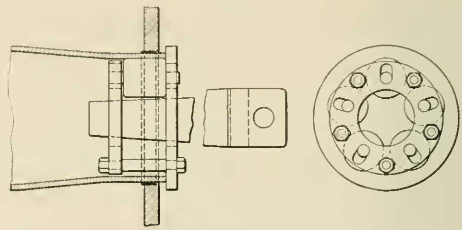


FIG. 12

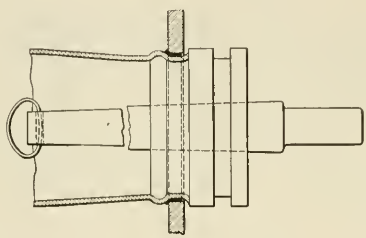


FIG. 13

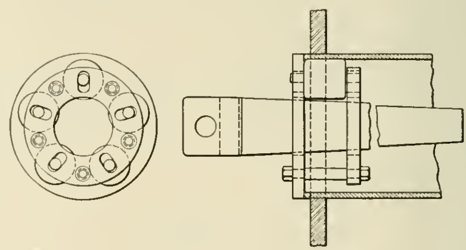


FIG. 14

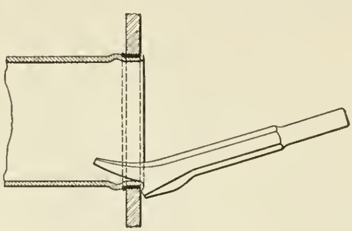


FIG. 15

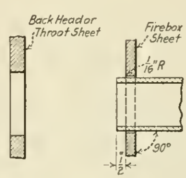


FIG. 16

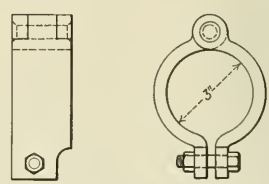


FIG. 17

Fig. 9—Beading Tubes. Fig. 10—Correct Application of Superheater Flues. Fig. 11—Setting Ferrules. Fig. 12—Setting Superheater Flues. Fig. 13—Expanding Flues. Fig. 14—Rolling the Front End of Flues. Fig. 15—Beading Large Flues. Fig. 16—Proper Position of Arch Tubes Entering Firebox Sheet. Fig. 17—Arch Tube Clamp.

Rolling—Arch tubes should be rolled into the firebox sheets, this operation being performed at the bottom end first. By using a collar on the housing shaft, as shown in Fig. 19, proper location of the rolls can be insured.

Flaring—Arch tubes should be flared on both ends. The tool shown in Fig. 20 is recommended for this operation.

Inspection—When the engine is in service the arch tubes should be inspected every trip. At every boiler washout the arch tubes should be washed out, bored out with a turbine cleaner, and the ends in the water space inspected for possible defects.

At any time should an arch tube be found to have a pocket, or warped to any extent, the arch tube should be removed. Whenever a clinker or other substance is found attached to an arch tube the clinker should be removed and a careful inspection made of both the outside and inside of the tube.

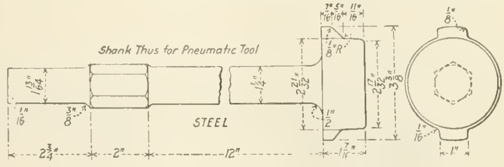


Fig. 20—Arch Tube Tool Recommended for Flaring Ends

Specialized Training Versus Apprenticeship

"Railroads Cannot Be Run Without Men. They Are Not on the Market. They Must Be Made."

By L. E. Gardner

In an editorial in the December, 1921, issue of the *Railway Mechanical Engineer*, under the title of "Specialized Training vs. Apprenticeship," you suggest that if apprentice courses cannot supply the required number of skilled mechanics for railway service, "some other means, such as part-time instruction, should be provided for training employees in order to develop efficient workers in each special field." This suggestion would be most fitting and opportune if it were possible to give shop employees such specialized training. But it is not clear to the writer what class of shop employees are to be given this training. As we understand it, the United States Labor Board has divided railway shop employees into the following classes: supervisory forces, skilled mechanics, apprentices, helpers and common laborers.

Foremen Should Be Trained

If you have reference to training of supervisory forces, your point is well taken. "Increased output and the flexibility of the organization" would more than "justify the small expenditure necessary to carry out such a plan." In too many shops insufficient care is taken in the selection of foremen and no effort is made to develop the latent talents such men possess. There is a mistaken belief that foremen are born, not made. It is true that some men are born and grow up with characteristics which give promise of leadership just as other men are born with characteristics, or grow up in an environment, that gives promise of the man becoming a successful lawyer or a skilled surgeon or physician. But no one would think of trusting his legal affairs to a "natural born" lawyer who had not received special training to develop his latent natural talents or to enable him to profit by the experiences of others of his profession. Certainly we could not conceive of turning a "natural born" surgeon loose in a hospital to work out his own salvation, or our destruction.

Is it not equally true that the "natural born" foreman should receive training that will develop his latent talents and enable him to profit by the experiences of other foremen. A man is not permitted to run a machine without first receiving instruction and training. There is more to learn about handling men than about handling machinery. Railways have much to learn about the possibilities in foremen training.

Skilled Mechanics Should Not Be Neglected

But I do not think you had reference to training of supervisory forces. Possibly you had in mind specialized training for the skilled mechanics, men already receiving full rate of pay in the various crafts. There is a much greater field here than is generally supposed. Many of these are very inefficient and poorly prepared. Particularly those whom the Railroad Administration made mechanics overnight by a stroke of a pen. But not only these but all others have much to learn. Just as a competent physician learns something every day of his practice, so can the skilled mechanic learn something every day he works at his trade. It is to the interest of his employer that he keep abreast of the times and learn of improved methods. Money spent in his training will bring ample returns, but it must be spent judiciously owing to the restrictions of the seniority rule adopted by the Labor Board, which prevents employers from placing these men in work for which they are best fitted.

But I do not think your editorial had reference to men already classed as skilled mechanics, but rather to methods of recruiting mechanics and increasing the supply. So let us consider the remaining classes of shop employees whom you may have had in mind for specialized training.

Helpers and Common Labor

Passing over the apprentices, the only other classes to be considered are the helpers and the common laborers. Under the rulings of the Labor Board, these men are not permitted to do, or to learn how to do, any phase of mechanics' work. They may carry the mechanics' tools and do the lifting, but must not be permitted to screw on a nut, or perform any work whatsoever that is classified as mechanics' work. Except for the few advanced to apprenticeships, "once a helper always a helper."

There was a time when the brighter and more capable helpers might be advanced to handymen and eventually to mechanics. At such a time specialized training for this class of employees was in order and likewise very profitable. But under present rules and working conditions it is absolutely tabooed. Unless possibly for some physical training to develop the muscles of his back, the helper of today, if not given an apprenticeship, has no need of and would be unable to use either to his own or the company's advantage any other training given him.

Where Will Future Mechanics Come From?

This leaves no other possible way of developing railway mechanics except through the training of apprentices, either regular or helper apprentices. This should be clearly understood. The situation is a serious one. It is absolutely impossible under present rules and working conditions to recruit mechanics through any form of specialized training of any class of employees other than apprentices. The day of the specialist is past. No one can be employed as a railway mechanic who has not had four years' experience on mechanics' work unless he first serves an apprenticeship. Railway officials should realize this and prepare to meet the situation. Those who fail to do so are not only leaving to others a duty they ought to perform but are themselves committing industrial suicide. Where are future railway mechanics to come from, if they do not come through apprenticeships?

Statistics issued by the Labor Board show the number of mechanics in railway shops to have doubled in the four-year period in which a mechanic could be developed through an apprenticeship. Similar increase in the number of mechanics exists in other lines of industry. If the supply of mechanics is to be maintained, some means must be devised for recruiting not only enough new material to take the places of those dropping out but also to take care of the constantly increasing number needed. The most casual study of labor turnover will show the number dropping out each year to be much greater than generally recognized. Some die or are incapacitated on account of illness or other physical disability. Others go back to the farm or choose some other occupation. Still others, while continuing to work at their trade, go into other lines of industry. The drain to the automobile industry has been most noticeable. With the increased number of automobiles, the development of aviation and the further use of farm tractors and other machinery, the drain on the limited supply of skilled all-around railway mechanics will be even greater. The places of these men must be filled. But how, and by whom?

Labor Board Is Wrong

We have shown the only available source is through the training of apprentices. But even here there are unfortunate restrictions. Although the survey made by the Railroad Administration showed a very low ratio of apprentices to mechanics throughout the country, the Labor Board has ruled that not more than one apprentice may be employed for each five mechanics in service on any division of any railroad. This means much less than a ratio of "one to five" in the total number to be employed, for many divisions will necessarily fall far below the established quota, and their allotment cannot be employed elsewhere.

But let us consider this ratio of one to five further. We wonder where it originated and in what way this ratio was determined. Certainly it was not calculated to supply a sufficient number of mechanics. More likely the aim was to create a corner on the market. A ratio of one to five means 20 apprentices for each 100 mechanics of the craft. It would take each of these 20 apprentices four years to become a mechanic. If everyone of them completed his course, this would provide only five mechanics each year; that is, five per cent of the total number of mechanics employed. But it can no more be expected that all of these apprentices will complete the course than that all entering high school or college will complete their course. It would be a conservative estimate to say that at least half of them will drop out for one reason or another. This would leave an average of only 2½ mechanics to be recruited each year for each 100 mechanics in service. Does anyone think a supply of 2½ per cent each year will begin to take care of the labor turnover, to say nothing of the increased number needed each year in any growing industry?

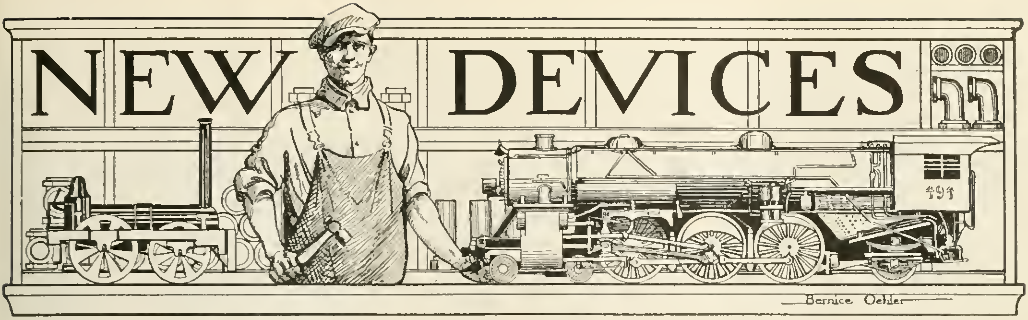
But in order to prepare even this small percentage of mechanics each road must employ its maximum number of apprentices. Think it over, men. If you can't get good material for apprenticeships, you had better take what you can get and do your best to make something out of them. But do not be discouraged if the majority of applicants are foreigners. Many of these if rightly trained will develop into the very best of mechanics and amply repay the effort necessary to develop them.

Remember, too, that the quality of applicants attracted to your courses will be in direct proportion to the opportunities offered towards developing them into skilled all-around mechanics. Those roads which have maintained up-to-date modern apprenticeships have experienced no difficulty in securing desirable applicants but instead have a lengthy waiting list from which to choose. The thing is contagious. As one boy finds that he is being well treated, given thorough instruction, regularly advanced from one class of work to another and all-in-all is being taught a worthwhile trade and being thus fitted to earn a comfortable livelihood, with opportunities for promotion, he tells his friends and they tell theirs. Soon there is no longer a dearth of competent applicants but instead an abundant supply from which the most promising may be selected.

We could go further and show that in addition to recruiting mechanics for future needs, the increased output in work performed by apprentices together with the numerous other benefits derived from a thorough course of training will more than justify the cost of the training given. But when it is understood the supply of railway mechanics cannot be maintained through specialized training of any class of employees other than apprentices, and that at best even when the full quota of apprentices is employed not more than two or three per cent of the total number of mechanics can be trained or developed each year, surely it will be seen that every effort should be made to maintain at all times the full quota of apprentices in all trades.

Neither is it sufficient merely to *employ* these apprentices. They must be kept in service and graduated. They cannot take the place of the mechanics who drop out unless they themselves remain in service and complete the course. They cannot perform the work unless they have been properly trained. Railroads cannot be run without men. The right kind of men are more difficult to obtain than are materials or machinery. They are not on the market. They must be made. Each road must do its part and do it thoroughly. The Labor Board should be persuaded to remove its obnoxious restrictions. Meanwhile the railroads should make full use of the limited opportunities offered for developing these men. Otherwise, effiecient transportation will be endangered.

Elwell-Parker Electric Station Truck in Use on Government Railway, Japan



Ingersoll Adjustable Rotary Milling Machine

A VERTICAL milling machine with longitudinal, transverse and rotary milling feeds, and vertical spindle feeds for boring and drilling has been placed on the market for the Ingersoll Milling Machine Company, Rockford, Ill. This machine has been developed especially to handle the general class of rod end work usually performed on slotters and embodies a rigidity of construction, plainly indicated in Fig. 1, which insures smooth operation under extremely heavy cuts. It consists of three major parts; the bed, the table saddle and rotary table, and the spindle housing. The bed is a one-piece casting of box section with two sets of ways at right angles of each other, one for the table saddle and one for the spindle housing. It is open at the rear to receive the motor which is enclosed under the housing, thus making the machine entirely self contained.

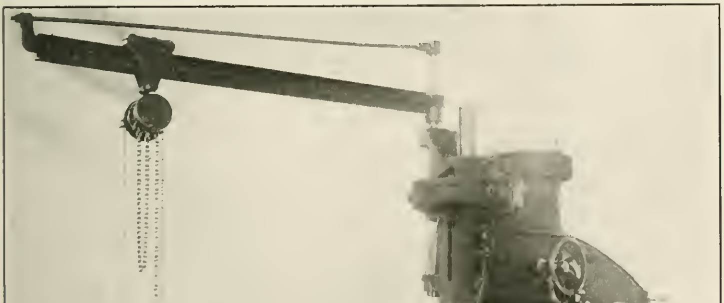


Fig. 1—Ingersoll Vertical Milling Machine with Longitudinal, Transverse and Rotary Feeds

The machine is conveniently controlled by the operator from a position where he may closely watch the progress of the cut. This is particularly important in profiling irregular surfaces such as are encountered in rod end work. The rotary table feed, the saddle feed and the spindle housing feed all receive their power from a single take-off from the main shaft, thus making it possible to control the starting, stopping and quick return for all these feeds with a single lever. This lever, which is mounted on the spindle housing, has three positions: the direct feed, neutral and quick return. The movement of the lever from the feed position through neutral to the quick return position automatically reverses the direction of travel and causes the cutter to move away from the work at the rate of three feet per minute, making it impossible to jam the cutter into the work in the ordinary operation of the machine. The direction of the feeds is reversed by a double clutch operated by a lever mounted on the bed under the forward end of the housing way. Another lever at this location controls the housing feed through a clutch, while the engagement of the table and saddle feeds is controlled by a lever located below the end of the saddle way. The spindle is provided with power feed downward only and a quick return through operation of the main feed control lever. The hand feeds of the spindle and the housing are controlled by hand wheels mounted on the housing. In the case of the latter, the hand wheel rotates the nut on the power feed screw through a worm connection which automatically locks the nut against turning when the power feed is in operation. A dial gage on the hand feed makes possible the adjustment of the housing to .001 in.

The illustrations show a number of typical operations for which the machine is particularly adapted. In milling out the jaw in the side rod knuckle connection (Fig. 2) a solid cut was taken at a cutting speed of 100 r.p.m., using a three-fluted helical milling cutter 2¼ in. in diameter. This cutter was fed into the solid metal at the rate of ⅝ in. per minute, the face of the cut measuring 12¾ in. over all at the widest part. On this cut the motor delivered a maximum of 24 hp. The roughing cut left ⅜ in. of stock on each face which was removed in finishing cuts feeding at the rate of 1 11/16 in. per minute. On another lot of eight rods this operation required a cut 10⅜ in. deep with a maximum face across the full diameter of the rod ends of 11⅝ in. The entire lot was finished in 16 hours, including set-up time.

The sides of the knuckle joint tongue on four main side rods of heat treated alloy steel, requiring two cuts per rod ⅛ in. deep by 10⅜ in. wide with a maximum travel of 11½ in., were finished with a feed of 2½ in. per minute for the body cut and ¼ in. per minute for the radius at the base of the tongue. The four rods were completed in 3 hours and 45 minutes, including the set-up time, and the spiral cutter was operating at a speed of 60 ft. per minute.

The inside faces of a heavy main rod strap (Fig. 3) were rough milled from the solid block with the 2¼-in., three fluted cutter at the rate of one inch per minute. The face of the cut was 5½ in. deep and the total length of the cut in along one side, across the end and out along the other side, was 74 in. In finishing the outside faces of these straps, with a depth of cut varying from ¼ in. to 1⅜ in. the work is performed with a feed of from 1 in. to 1½ in. per minute. In these heavy cutting operations the lower end of the cutter is supported in an outboard bearing mounted on a bracket which in turn is bolted to the end of the spindle housing.

In machining the openings in the crosshead end of main rods the cut is prepared by setting up the rods on the miller, drilling a single hole at one corner of the opening, large enough to receive the helical milling cutter and milling around the edges as laid out. The solid block is then removed without further drilling, leaving sufficient stock on the surfaces for a smooth finishing cut. This operation was performed on a pair of heat treated chrome vanadium steel rods, machined together, in 4 hrs. 30 min., including set-up time. The opening for the wrist pin brasses was 6¾ in. wide by 8 in. long and the wedge slot 2¼ in. wide by 4¾ in. long. The face of the cut on the two rods was 10¼ in. The roughing cut progressed at the rate of ¼ in. per min. and the finishing cut at the rate of 1½ in. per min.

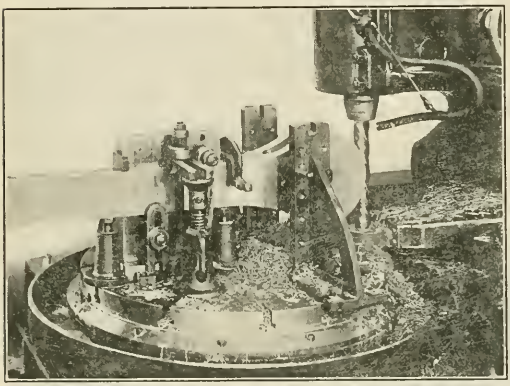


Fig. 2—Milling Jaw in Side Rod Kncckle Pin Connection

In profiling circular surfaces of rod ends (Fig. 4), the rods are drilled and mounted on mandrels centered on the table and machined by the use of the rotary feed.

The principal features of the construction of this machine are clearly indicated in the illustrations. In the interest of rigidity and accuracy the longitudinal and cross feeds have been separated and both are guided directly on the bed. The table saddle is carried on 7-in. horizontal bearing surfaces with a spread of 40 in. over the shears. The alinement of the table is maintained by a single inside gib, and two clamps bearing on the under side of the ways are provided on each side. The table illustrated is 42 in. in diameter but as the result of extensive service trials this diameter has been increased to 54 in. The diameter of the table bearing on the saddle is equal to that of the table and is four inches wide radially. A ring clamp, completely surrounding the table and bearing in a recess in its edge, secures the table to the saddle when the rotary feed is not in use, thus in effect providing the rigidity of a one-piece casting for straight work. The hole in the center of the table is bushed to provide a boring bar guide when taking heavy boring cuts. The table saddle has a longitudinal travel of 44 in. from a position with the center of the table 16 in. to the right of the spindle center to a point 28 in. to the left of the center.

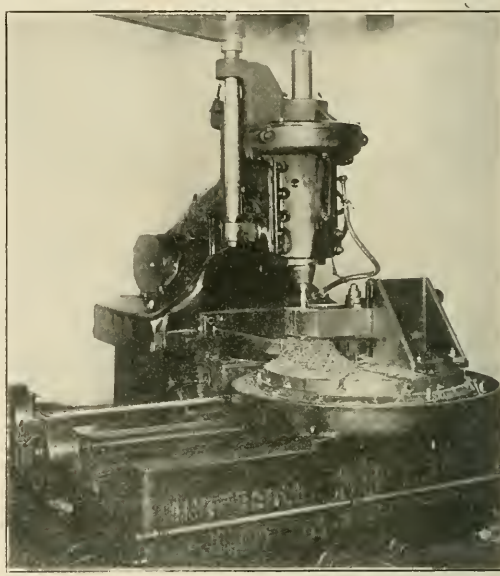


Fig. 3—Finishing Inside Surfaces of a Main Rod Strap

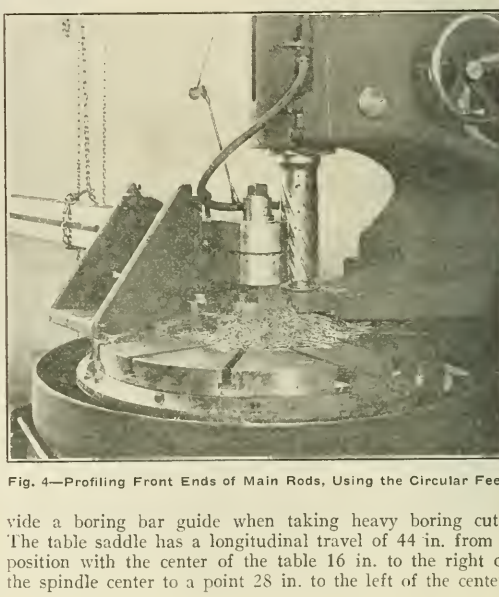


Fig. 4—Profiling Front Ends of Main Rods, Using the Circular Feed

The cross feed is effected by the movement of the spindle housing on 8-in. ways with a spread of 46 in. over all. The alinement of the housing is maintained by two gibs, one on each way, and one clamp, bearing on the under side of the bedway, is provided on each side. The total travel of the housing is 30 in.; the center of the spindle at the forward limit is one inch in front of the center of the table. The spindle housing carries all of the speed and feed changes, with the gears located in two oil tight pockets in the casting. The spindle is 6 in. in diameter at the largest taper and has a 10-in. flange. It is carried in a 10-in. quill which has a vertical movement of 21 in. The spindle is driven by a herringbone gear 20 in. in diameter and 3¼ in. wide. This gear is specially heat treated and runs in grease. The lower face of the spindle housing is 25 in. above the top of the table and when extended to the lowest position the spindle is 4 in. above the table.

The machine has an operating range of nine spindle speeds and nine feeds. The spindle speeds progress at a ratio of 1.4 from 10 to 120 r.p.m., and the feeds range from ¼ in. to 10 in. per minute at a ratio of 1.6. In each case three mechanical changes are provided and two sets of feed change gears and two sets of speed change gears are furnished with the machine. For the three medium speeds and the three medium feeds the gears in each set bear a one to one ratio. In each case the ratio of the other set is reversible and this set is used for both the high and low ranges. The feed gears operate in conveniently accessible compartments on the back side of the housing. An additional set of change gears doubles the feed range of the rotary table. These gears are enclosed in a box at the rear end of the saddleway. Large size shafts have been used throughout the feed mechanism in order to reduce to a minimum the possibility of chatter under cuts which approach the capacity of the cutter.

The machine is driven by a 25-hp. General Electric alternating current motor, operating at 1,160 r.p.m. It is also fitted with a pump for the circulation of the cutter lubricant, carried in a tank of 30 gallons capacity built in the bed.

New Crane Truck and Charging Plug

The Elwell-Parker Electric Company, Cleveland, Ohio, has recently developed an electric truck with a carrying capacity of 3,000 lb. and revolving counterbalanced crane of unusual length. The crane is a handy, portable device for hanging smoke box doors, or air pumps on locomotives in shops or engine houses. It is also adaptable to use in storerooms to handle castings, lighting generators and other parts which can be safely and easily stacked, reducing the storage space usually required.

Fig. 1—Elwell-Parker Truck with 8-Ft. Outreach Power Crane

The heavy vertical steel column, shown in Fig. 1, has a long bearing in a pedestal bolted to the steel platform on the truck, and supports a 12-ft. boom which may be racked in or out by the operator without leaving the driving position. The hoist is operated by a separate motor direct connected to an enclosed hoist mechanism. The controller is located on the dash in front of the crane operator. The hoist is mounted on a steel frame which houses the battery, the battery, hoist and motor all acting as a counterbalance. A special trip switch mounted on the front of battery box stops the inward motion of the boom as set.

The crane is designed to pick up 1,000 lb. at an 8-ft. outreach, or with outriggers in position as shown 3,000 lb. at 6-ft. outreach. The boom may be lowered to permit entrance of doorways. The outriggers are quickly adjusted, folded and swung in beside the crane column when not in use.

The truck is equipped with 21½ in. by 3½ in. drive wheels and 15 in. by 3½ in. trailing wheels, all four of which steer. Large wheels permit use in yards. A coupler is furnished on the rear to permit using the unit for intermittent tractor service. Motors, differential worms, wheels and crane pillar column are all fitted with ball bearings. A single battery furnishes power to propel the truck as well as to operate the crane.

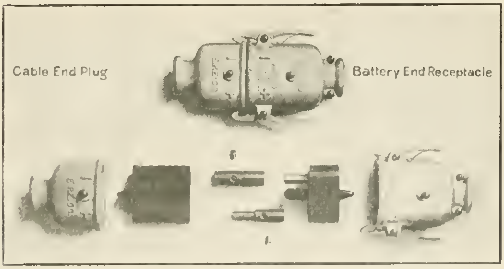


Fig. 2—Improved Battery Charging Receptacle and Plug

One of the smaller though important details of a truck is the attachment or charging plug. Every battery is equipped with the receptacle or battery end of this plug and interchangeability is of prime importance.

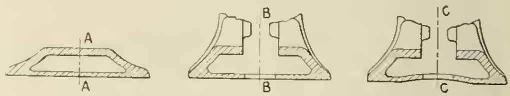
The Elwell-Parker Electric Company has recently made improvements in these charging plugs, as shown in Fig. 2, without interfering with their interchangeability.

The new charging plug shells or cases are equipped with latches for holding the two halves rigidly together while the truck is in motion. The addition of these latches prevents bending or loosening of the telescoping terminals with consequent burning or arcing.

Moulded Bakelite insulation is used in making up the inserts. The terminals are removable and are held in place by filister head screws, so that terminals can be furnished separately, for use in an old insert. Wires are soldered into the terminals, thus forming a perfect electrical connection, whereas previously wires have been clamped in place by machine screws and connections sooner or later come loose causing heating and arcing. This heat was transmitted to the telescoping end of terminals, thus effecting the current carrying capacity of the plug as a whole. New inserts can be used in old shells, thus assuring interchangeability.

Jack Base Designed for Maximum Safety

UPON the ground bearing or foundation of a jack depends the safety of the men who are using it. If through constant use under heavy loads a jack base becomes set upward at the circumference, the jack has a tendency to kick out under the load and is a menace to safety. In an effort to overcome this condition many jacks have been built with extra heavy bases but the resultant uneven distribution of metal often produces checks and stresses in the castings during its cooling or annealing. With the idea of correcting these defects Templeton, Kenly & Company, Ltd., Chicago, have developed the base illustrated for use on Simplex jacks. In this case the base instead of being a heavy solid section is cored, or made hollow, without increasing its height or weight. Being made of malleable iron cored, it presents a comparatively thin base section which conforms to the line of pressure and forms a concave base transmitting to its rim the burden of the load. The illustration shows a section through the base at the toe *AA* and



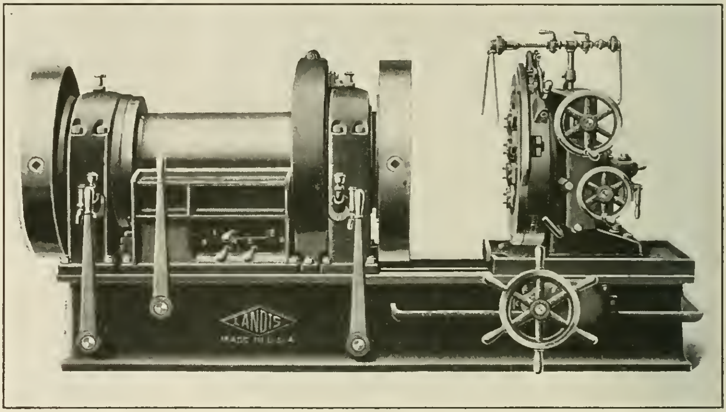
Cross Sections of Simplex Jack Base Showing Improved Design

also through the center at *BB* together with a view of the base *CC* after continued use and pressure have produced a permanent set.

Pipe Threading and Cutting Machine

A PIPE threading and cutting machine has recently been added to the line manufactured by the Landis Machine Company, Waynesboro, Pa. This machine embodies important features of modern machine tool design and has a range from 4 in. to 12 in. It may also be equipped to thread and cut pipe as small as 2½ in. Two die heads are employed, a 6-in. die head for a range from 4 in. or 2½ in. to 6 in., and a 12 in. head for a range from 6 in. to 12 in. The entire range of each of these heads is covered by but one set of chasers. The length of the machine is 11 ft. and the extreme width is 5 ft. It weighs 13,000 lb.

The carriage which supports the die head, the cutting off tool, and the reaming tool are moved either by power or by hand. The power traverse or movement is both forward and backward and is controlled by a lever located on the operating side of the carriage. In advancing the carriage toward the chuck, the lever is pulled and held until the threading position for the die is reached. In reversing the movement of the carriage, the lever is pushed forward and held. Releasing the lever stops the carriage at any point within its travel.



Landis Pipe Threading Machine with Range from 4 to 12 In.

Automatic stops prevent the die head from coming in contact with the chuck in the forward movement and the carriage from running off the guides of the machine in the backward movement. The reaming tool is quickly set to position and locked with a lever.

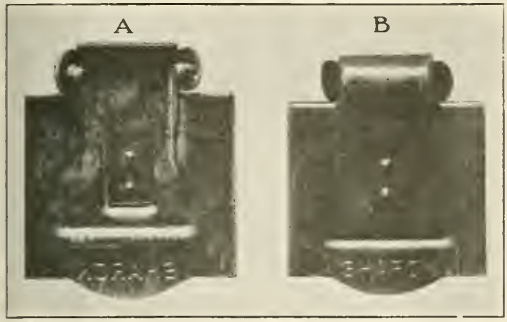
The machine has a single pulley drive and is started and stopped through a friction clutch by either one of two levers located at the extreme ends of the head stock. This enables the operator to start or stop the machine when threading or when fitting up flanges. Eight speed changes are available. A lever is located midway between the starting and stopping levers for reversing the machine.

The chucks for gripping the pipe have three geared jaws with universal adjustment. Chucks are also self-centering to the pipe, the rear one being equipped with flange grips for fitting up flanges. All gears are fully enclosed and, with the exception of the main drive gear and its pinion, all gears run in oil. The main bearings are lubricated with flat link chains which run in oil contained in large reservoirs. The driving pinion shaft as well as the reverse shaft are lubricated by sight feed oilers.

The machine can be converted to motor drive by replacing the pulley with a sprocket and fitting a plate to the side of the machine for mounting the motor. A silent chain is employed to drive from the motor to the sprocket.

Pinless Type Journal Box Lids

THE journal box lid illustrated is a new product of the Sharon Pressed Steel Company, Sharon, Pa., being made of cold drawn steel and furnished in two types, outside and inside. The outside type of lid with flanges has a groove across the face and hood and is pressed from one piece of material, thus tending to give it great strength, as well as affording maximum protection from dust and moisture. The inside type of lid without flanges has a depressed groove fitting within the box opening, designed to give it strength equal to the outside type of lid.



Sharon Pinless Journal Box Lid Which Can Be Applied with a Hammer

Both types of lid have a hook notch at the bottom to facilitate raising for the inspection of journals and both lids are fitted with flat springs, shown at *A*, designed to hold the lid securely closed under all ordinary operating conditions. The pinless feature of these lids provides a convenient and easy method of attaching without the use of pins or bolts. When such are used, lids are frequently applied by the use of a smaller bolt than is intended for the purpose, thereby giving a loose fit and improper spring action. The new construction also does away with the usual scrolls at the top of the lid.

The pinless type of lid is attached by means of a strap, stamped and formed from a single piece, as shown at *A* and *B*, having lugs extruded to fit the standard bolt holes in the top lug of the journal box. These lids are supplied with the lugs in extended position and, being fitted by a car repairman, are secured in place by forming over the two projections on the hood with an ordinary hammer. When this type of lid is struck by some obstruction, the strap will be deformed and the lid proper, undamaged, can be easily salvaged by fitting with a new strap.

Wire Brush Cleaner for Removing Paint

THE increasing use of air-driven wire brushes for cleaning metal surfaces has demonstrated the need of high rotative speed. Especially has this been true on such cleaning work as the removing of paint, rust, dirt and scale from tanks, steel cars, structural steel forms, etc., where the area to be cleaned is large and a fast rate of work is required. It has been found that a wire brush turning at high speed cleans faster and also stands up to the severe service much better than if only revolving at 2,000 or 3,000 r.p.m.

The Ingersoll-Rand Company, New York, has recently brought out a high speed cleaner (Fig. 1) known as the No. 601 Little David wire brush, which has a maximum speed of 4200 r.p.m. This machine is said to be unusually successful in operation, effectively cleaning surfaces such as mentioned above and also iron and steel castings. It is designed to do a first-class cleaning job and effect a considerable saving of time and labor as well.

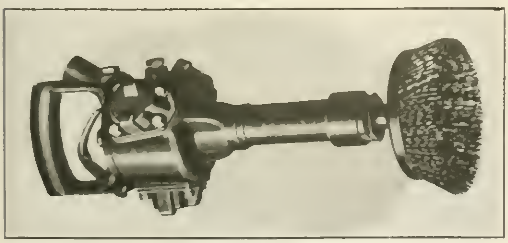


Fig. 1—No. 601 Little David Wire Brush

On a six weeks' test this machine cleaned steel gondolas, each averaging 540 sq. ft. of surface, in 3½ hours. All-steel box cars (Fig. 2) each averaging 1,400 sq. ft. surface were cleaned in 7½ hours. The air motor is of the three-cylinder type such as used in the Little David portable grinder which has been thoroughly tested out in the severe service to which pneumatic grinders are subjected. The machine is designed to be simple in construction, well balanced and operate without vibration. Light weight has been attained by using an aluminum casing reinforced with cast-in steel bushings. The weight of the complete machine is 14 lb.; the average free speed at 90 lb. air pressure, 4,200 r.p.m.; the length overall, 17½ in. and the diameter of the wire brush, 6 in.

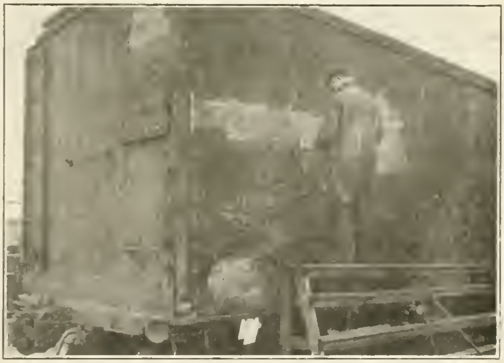


Fig. 2—Example of Method of Using Pneumatic Wire Brush Cleaner

In many of the larger car shops the use of sand blasting equipment has been developed as an economical method of removing paint but where this equipment is not available the wire brush, rotating at high speed, is an effective method of cleaning off paint.

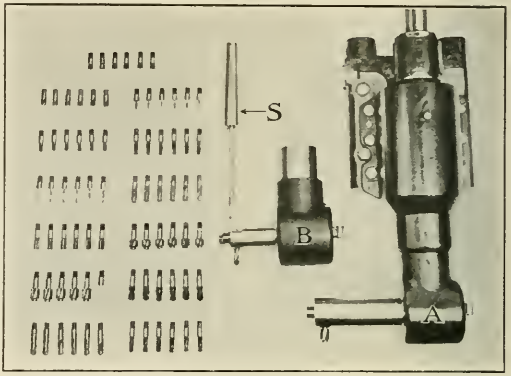
Interesting Development for Offset Drilling

The Harris Engineering Company, Bridgeport, Conn., has developed recently an offset drilling attachment for drilling, milling, countersinking and counterboring port holes and grooves in air tools, such as pneumatic hammers, drills and riveters. This attachment is made to reach into the main bore and drill or mill the vents or ports from the inside. It is possible to drill to a specified depth; also to counterbore or mill circular, transverse or longitudinal slots. Special shank drills, mills and counterbores are ground and lapped to fit the spindle in the outer end of the arm and run true, they are readily changed and have a limited adjustment for depth to allow for grinding, setting, etc.

In the illustration is shown an offset drilling attachment *A* mounted in a special bracket on the vertical slide of a Becker vertical milling machine. Just to the left is another attachment *B* with a smaller arm for use on smaller work. This is interchangeable in the special bracket with the arm shown in the bracket.

The driving spindle *S* has a taper shank fitted to the machine spindle and at the lower end it is squared to drive the offset attachment. It will be noted that this is necked down in diameter between the squared end and the taper shank. This is to give increased elasticity and also to provide a point of failure to prevent jamming of drills, mills or fixtures due to accident or carelessness.

These offset attachments may be efficiently used for other purposes requiring inside drilling or milling, such as oil grooves, straight or spiral holes for holding babbitt in bearing boxes, end milling blind keyways to retain a feather or key in a hub sliding on a shaft, etc.



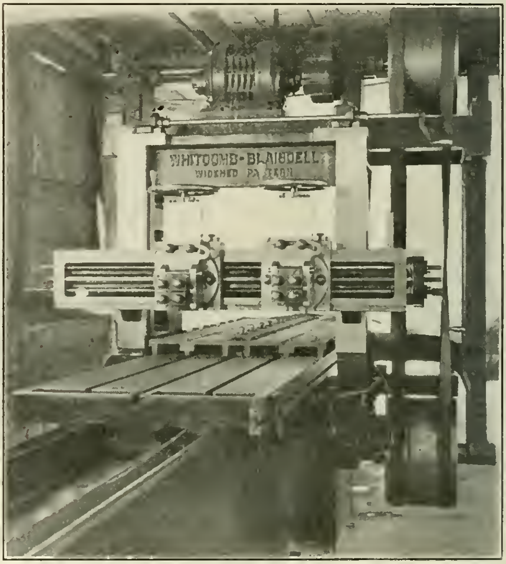
Harris Offset Drilling Attachments and Tools

At the left of the photograph is shown a varied assortment of drills, end mills and counterbores for use in these fixtures.

High Speed Second Belt Drive Planer

The illustration shows a 26-in. by 32-in. by 18-ft. planer, recently brought out by the Whitcomb-Blaisdell Machine Tool Company, Worcester, Mass., and designed to operate at unusually high speeds by means of a second belt drive feature. Equipped with a 30-in. driving mechanism this machine operates at a cutting speed of over 100 ft. per min. Planers from 17 in. up to and including the 30-in. machine are provided with this feature, the object of which is to simplify construction, maintain as nearly as possible a direct drive without sacrificing power and thereby increase the machine efficiency. The pulley shaft carrying the tight and loose pulleys extends clear through the bed to the opposite side of the planer. Mounted on the end is a small pulley known as a second belt pulley. Forward of this and running on a hardened steel stud is a larger pulley carrying a spiral pinion, known as the intermediate pulley and pinion. On the end of the driving pinion shaft is mounted a spiral gear which meshes with the intermediate spiral pinion. Power is conveyed between the two pulleys by means of an endless double belt known as the second belt which is kept taut by an adjustable idler pulley.

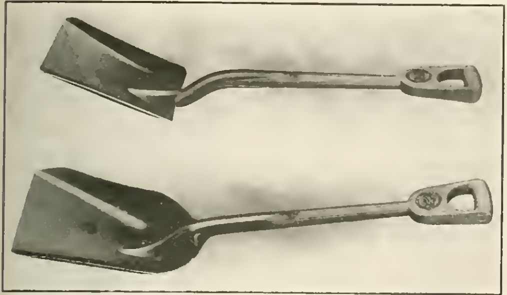
By this construction the bull wheel and usual trains of gears inside the planer bed are eliminated, with the exception of the pinion driving the table rack. The advantages are the elimination of noise and wear due to rapidly running gears and a more smooth action imparted to the planer. Also the use of the second belt allows unusually high cutting and return speeds. The new planer is said to run quietly and easily and reverse gently yet promptly. Elimination of the gear train does not reduce the ratio of drive belt speeds to table speeds, which is still maintained at a high ratio. There is a considerable saving of power due to eliminating the friction in a train of gears and machine efficiency is thereby increased. In numerous cases where brass, copper or other soft material is to be planed the machines are said to have run at 150 ft. per min. cutting and return speeds. The resultant increase in production is self evident and the high table speeds are accomplished without sacrificing quiet, smooth action.



Whitcomb-Blaisdell Planer Featured by Second Belt Drive

Molybdenum Steel in Shovel Construction

A MOLYBDENUM steel scoop for firing locomotives and stationary boilers has been placed on the market by the Wood Shovel & Tool Company, Piqua, Ohio.



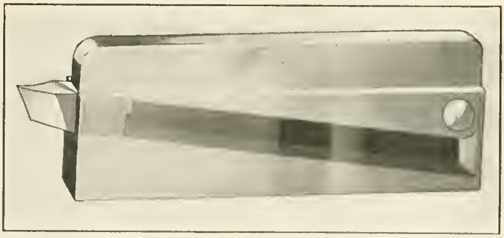
Track Shovel and Fireman's Scoop Made of Molybdenum Steel

The blade of the scoop is made of molybdenum steel, especially treated to give great hardness combined with remarkable toughness. The greater strength of molybdenum steel permits lighter construction with its resultant saving of energy for the worker. A feature of the new scoop is the welding of the straps to the blade, making the two parts virtually one. The bolts are countersunk into the handle which is of seasoned second-growth northern ash. The rigidity of this construction assures long life in actual service.

The molybdenum shovel is made in different types, one being designed for track maintenance and similar work. In designing the track shovel, the manufacturers recognized the fact that it is frequently used in place of a sledge or a crowbar in addition to its normal function, hence, a shovel was constructed designed to stand up under the gruelling strain and abuse of track maintenance service. Shovels made of the new alloy have been subjected to rigid tests by the Wood Shovel & Tool Company and demonstrated conclusively the value of molybdenum steel for shovel construction.

Holder for Short Cutters of High Speed Steel

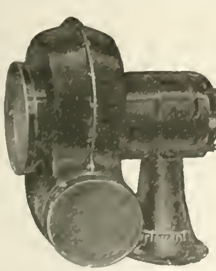
THE tool holder shown in the accompanying illustration has been developed by the Lovejoy Tool Works, Chicago, for using up the short ends of high speed steel cutting tools. The device, known as the Use-Em-Up tool holder, is made up of two parts hinged together with a pin at the rear end. The lower part or base of the holder is channeled out to receive the tool bits, the bottom of the channel being considerably deeper towards the rear end than at the forward or cutting end. The top member fits in this channel, the clearance between it and the bottom of the channel being such that when clamped in the tool post the bit is held near the front end. This permits the bit to be used up until its length does not exceed 3/4 in., but does not interfere with the use of bits of any greater length desired. The holder as shown is 4 in. long and 1 1/2 in. in height, designed to take bits 3/8 in. square. It can be used in the tool posts of lathes, shaper, planers and other tools, affecting important savings over the cost of solid high speed steel tools.



Lovejoy Holder for Long or Short Tool Bits

Efficient Locomotive Cab Ventilating Set

THE problem of locomotive cab ventilation is a more or less serious one, especially on roads where steam locomotives are required to operate in tunnels. An unusually interesting method of solving this problem has been developed by the B. F. Sturtevant Company, Boston, Mass., the essential part of the apparatus being the ventilating set illustrated. These sets have been applied in one case to the locomotive cabs of Mallet locomotives operating in districts where tunnel clearances are close and the grade adverse to the movement of trains. According to a prominent officer on the road in question the transfer of Mallet locomotives to one of the branch lines where the conditions described above existed resulted in forcing attention to the problem of locomotive cab ventilation. Experiments were conducted in an effort to provide better ventilation and it was found by using the Sturtevant electrically-driven ventilating sets, two units to the locomotive, the atmospheric conditions in the cab could be materially improved.



Sturtevant Cab Ventilating Unit

The ventilating sets were operated electrically by an electric headlight turbo-generator installed for the purpose. Two sets were applied to the locomotive, located under the boiler ahead of the firebox. The intake from the fan gathered the air at a point about 6 in. above the track. One fan delivered air to the right side of the locomotive immediately in front of the engineman and the other to the left side. In order to get the best results, it was found necessary to make the cab as nearly airtight as possible so that the fresh air delivery inside the cab would create a pressure in excess of that surrounding the cab, thus preventing the foul gases from entering.

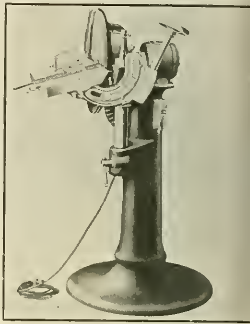
Sturtevant portable ready-to-run ventilating sets are made in five sizes running at speeds up to 3,400 r.p.m. and delivering from 58 to 1,440 cu. ft. of free air per min., depending upon the size.

Disk Sander Saves Time and Labor

FOR accurately sanding pieces such as segments, angles for built up work, core prints, taper work and sanding and fitting small pieces in pattern and cabinet shops, the disk sander illustrated is well adapted. This machine is direct motor-driven with a capacity to sand circular work up to 15 in. in diameter and has been placed on the market recently by the Oliver Machinery Company, Grand Rapids, Mich.

The machine is portable, can be placed near the operator and is featured by ease of operation, rigid construction and adaptability to a wide range of work. It makes bevel joints and fits faster than can be done with a chisel and plane. It is used for sanding leather and compositions, for metal grinding and polishing. An exhaust system deposits dust within the column. The 15-in. diameter steel plate is turned true and carefully balanced and is mounted on a disc shaft hub. It is movable for renewing sandpaper by loosening a clamp on the swivel post, swinging the table to the right, and slipping off the center pin. The speed is 1,725 r.p.m.

The disk head is a one piece iron casting containing the disk, disk shaft, ball bearing end thrust and exhaust fan in one complete unit. The table is 9¼ in. wide by 21 in. long and 37 in. above the floor. It is arranged as indicated to tilt 45 deg. down and 25 deg. up by means of a handwheel, worm, worm segment and segment which is self locking. The table has vertical adjustment of 6 in. and will swing to the right to take off the disk. With the combination gage provided, circular, segment and duplicating work can be readily performed. A suitable 1, 2 or 3-phase, 110 or 220-volt motor. running on ball bearings, is arranged to drive the disk shaft but does not take the thrust load. The machine is operated by a push button.



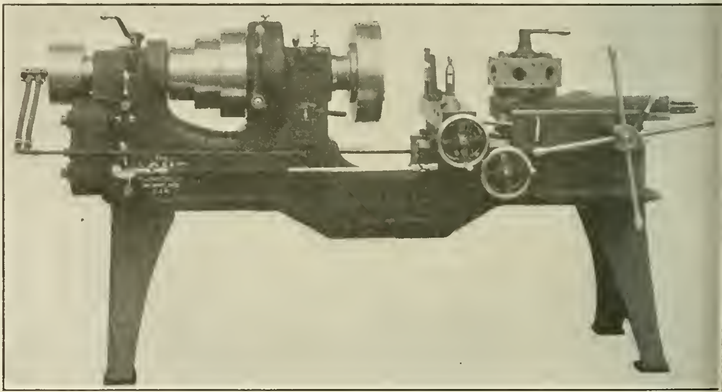
Oliver Disk Sanding Machine

Gap Feature Applied To Turret Lathe

AN interesting departure from the standard design of turret machinery has been made by the Acme Machine Tool Company, Cincinnati, Ohio, in developing the gap turret lathe illustrated. This particular machine has all the regular dimensions of the 20-in. Cincinnati Acme turret lathe except that the gap provides for a maximum swing of 28 in. over the bed, the length of the gap from the end of the spindle being 9⅛ in. This machine has been equipped with an air chuck, also power feed to the cross cut-off slide travel and power feed to the longitudinal turret travel. The machine can also be furnished in any combination of hand and power feed that may be desired.

The primary purpose of the gap lathe is to provide a machine of large swing yet not requiring the proportions of a large lathe. There are many instances in which the use of a large lathe is necessary in order to swing the work, while the actual turning is on a small diameter. In the lathe illustrated it is possible to swing a wheel or piston up to 28 in. in diameter, whereas the actual work to be performed in facing and boring the hub or turning the piston rod is on a small diameter. There are quite a number of large jobs where there is no turning required on the outside diameter and only very small boring and facing near the center. For work of that character the gap turret lathe is especially adapted.

The lathe bed is cast with the gap, being reinforced with heavy ribbing underneath in order to maintain practically the same box section throughout and the same rigidity. The cut-off slide is provided with hand longitudinal and power cross feed obtained from the feed box shown in the front of the machine. The turret slide is also provided with power feed so that the boring and facing operations are both performed through power feed. The chucking and unchucking of the work is accomplished rapidly by means of the air chuck.



Acme Gap Turret Lathe with 28-In. Maximum Swing

General specifications of this machine are as follows: The minimum distance from the end of the spindle to the turret face is 14¾ in. and to the inside edge of the cross slide 8½ in. The feeds to the cross slides are 40, 70 and 120, those to the turret being 24, 43, 37 and 123. The cross movement of the cross slide is 7 in. and the lateral movement 4 in. The maximum distance from the inside of the cross slide to the end of the spindle is 12 in.

GENERAL NEWS

The Chicago, Burlington & Quincy will soon start using oil burning locomotives entirely on two divisions from Guernsey, Wyo., to Billings, Mont.

The shops of the Pennsylvania at Olean, N. Y., were damaged by fire on March 5; estimated total loss including some damage to 25 locomotives $100,000. The number of men at work in these shops was about 300.

Fire, of unknown origin, at the car shops of the Atchison, Topeka & Santa Fe, in Chicago (West Thirty-eighth street and South Central Park avenue), destroyed two freight cars on February 25. Estimated loss, including part of car repair shed, $65,000.

Representative Beck has introduced in the House of Representatives a bill authorizing the Interstate Commerce Commission to approve or disapprove contracts involving the construction or repair of locomotive engines, cars and maintenance work for railroads engaged in interstate commerce.

T. H. Davis, general chairman of the Association of Shop Craft Employees, Eastern Region, Pennsylvania Railroad, in a letter sent to all shop craft employees in his territory, says: "The railroad officials have many troublesome questions confronting them, but they have shown every disposition to try to strain a point in our favor when we were able to show them the justice of our claims; and, as co-operation is a two-sided thing, we feel that we ought to show our appreciation by helping them in every way we can. . . . What we need now is good business, to enable us to improve our conditions, and if every employee would just speak a good word for the old P. R. R., it would mean more business, and more business means more money to all of us. . . . It would be a very short time until the Pennsylvania could pay better wages and have better conditions than any other railroad in America." . . .

National Engineering Standards

The movement to develop national engineering standards sponsored by the American Engineering Standards Committee has made considerable progress during the past year. Among the standards approved during 1921 are a method of sampling coal, a safety code for the protection of the heads and eyes of industrial workers, specifications for steel automatic screw stock and specifications and tests for Portland cement. Standards before the committee at the close of the year included a national electrical safety code, specifications for car and locomotive forgings and a safety code for abrasive wheels. Numerous other projects of direct interest to railroads are now in the hands of committees.

Equipment Program of the St. Louis-San Francisco

The St. Louis-San Francisco has authorized the expenditure of $7,766,000 in 1922 for new equipment, the repair and improvement of old equipment and other improvements; included in the amount is $1,260,000 for 8 steel coaches, 6 steel chair cars and a 150-ton steam derrick; $360,000, for rebuilding 250 steel coal cars; $300,000 for rebuilding 9 locomotives, $1,431,000 for bettering existing equipment; $205,000 for new power plants; $35,000 for new water treating plants; and $87,500 for improvement of coaches in branch line service. All mail and mail apartment cars are to be entirely rebuilt; baggage cars are to be improved; 7,000 freight cars rebuilt; 1,150 furniture and vehicle cars to be improved; and electric lights to be installed in coaches on branch lines and steel under-frames to be placed in all wooden coaches.

Locomotive Defect Chart

In July, 1920, the *Railway Mechanical Engineer* issued a chart showing the locomotive defects listed in the Interstate Commerce Commission's inspection rules. Many requests for additional copies of the chart have been received and it has been revised since the first publication and made more complete. Copies of the chart, twenty-two inches by thirty-four inches, printed on tough white paper, will be mailed to readers of the *Railway Mechanical Engineer* for the nominal sum of 15 cents to cover printing and mailing. Requests should be addressed to the circulation manager, Simmons-Boardman Publishing Company, Woolworth building, New York.

University of Illinois—Research Graduate Assistantships

The University of Illinois announces that there are 10 vacancies for the position of research graduate assistant in the Engineering Experimental Station and also one position for a man who wishes to specialize in gas engineering. These positions are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics and applied chemistry. Appointments are made for two consecutive years, at the expiration of which period, if requirements have been met, the degree of master of science will be conferred. Not more than half of the time of the assistant is required in connection with the work of the department, the remainder being available for graduate study. Research work and study may be undertaken in railway, mechanical, electrical or civil engineering and also in other branches.

Attached to the position is an annual stipend of $600 and freedom from fees except those in connection with matriculation. Additional information and application blanks can be obtained from the Director, Engineering Experimental Station, Urbana, Illinois.

The Government's Use of Jersey Central Locomotives

W. G. McAdoo, former director general of railroads, when making a recent statement before the Senate Committee at Washington quoted, with inferences unfavorable to the road, from a letter written by President W. G. Besler of the Central of New Jersey to the superintendent of motive power, directing the latter to have certain locomotives repaired as quickly as possible, so that a bill for the repairs could be presented to the government. Writing to the Newark Morning Ledger Mr. Besler replied to Mr. McAdoo in part, as follows:

"One side of the story is good until the other is told. Mr. McAdoo glibly states that the railroads, on return to private operation, endeavored to put through bills and charge them to the government, and he cites the Jersey Central as a particularly horrible example.

"Of course the railroads did so, for the reason that, under the contract, the government was obligated to return the properties in as good condition as when taken over, and when, as in the case of the Jersey Central, there were upwards of 100 engines disabled, worn out, and out of service, which should have been repaired by the director general, but which had been set aside and were not so repaired, why should not the railroads send such engines to engine builders for rebuilding and to be placed in working condition? They had been worn out in 26 months of government operation and had not been repaired. Is there anything improper in the thought that the government should repair them, or at least pay the bills on account of such repairs? These bills have not yet been paid! It is one of the claims against the government for failure in the matter of maintenance and upkeep which we hope and intend, if possible, to make the government pay as required by its obligation in the contract."

Interpretation of Existing Standards for Freight Car Trucks

The Committee on Car Construction of the Mechanical Division of the American Railway Association has sent out the following circular, No. 176:

According to the votes by the members of the American Railway Association, all of the fundamentals in the recommendations made by the Committee on Car Construction at the June 1920, convention are now standard.

As it is very desirable that all new construction shall be uniform and in accord with these fundamentals, it is intended that new designs for truck side frames and bolsters, in fact for the complete truck, be made, but in order to provide the best that can be obtained some time will elapse. Until such designs have been prepared, and adopted as standard, it is recommended that for new construction and for replacements the truck side frames be made to conform with A. R. A. Sheet "B," as limiting dimensions, that the tension and compression members be U-section, and that the dimensions relating to trucks, which are given below, be adhered to:

	Inches
Height from rail to center of brake shoe	13
Height from rail to bottom of truck springs	10 3/8
Height from rail to brake beam hanger fulcrum	24 7/8
Height from rail to top of springs—empty car	18 1/2
Height from rail to center plate bearing surface	26 3/4
Height from rail to top of truck side bearings	27 5/8
Distance from center to center of side bearings	50

The use of either U. S. R. A. or A. R. A. standard bolsters is recommended, provided that such modifications in the shape are introduced that the truck heights as given in the foregoing are maintained. This involves making the vertical distance between center plate bearing surface and bolster spring bearing surface 8 in. The bolster sections should remain as before, or if slightly modified to provide sufficient clearance between bottom of bolster and spring plank, the section moduli should remain as before.

Purdue University's Experimental Locomotive

The Purdue testing locomotive, Schenectady No. 3, will soon be placed in the shops of the Monon railway at Lafayette, Ind., to undergo a general overhauling and receive the application of several new parts and economy devices. The placing of this locomotive (in 1897) in the locomotive laboratory at Purdue was primarily the result of the efforts of W. F. M. Goss, then Dean of the Schools of Engineering. Co-ordinating with Dean Goss in his efforts was the generous interest manifested by the Schenectady Locomotive Works and various other manufacturers, chief among which were the following: Bethlehem Steel Company, American Steel Casting Company, Ashton Valve Manufacturing Company Detroit Lubricator Company, and the Keasby and Mattison Company. The product, known as Schenectady No. 2, was a saturated steam locomotive with a boiler designed to carry a pressure of 250 pounds per square inch.

In 1910 certain modifications, including new flue sheets, were made to provide for the application of a Schmidt superheater by the American Locomotive Company. The designation of the locomotive was then changed to Schenectady No. 3, the locomotive as it stands today in the locomotive laboratory.

The new work contemplates chiefly the application of new cylinders and outside valve gears. Donations toward this work have either been received or promised as follows: Baldwin Locomotive Works, new cylinders and piston valves, outside steampipes, pistons, crossheads and guides, main crank pins and Walschaert valve gear complete; Locomotive Firebox Company, thermic syphon; Sunbeam Electric Company, complete headlight and cab lighting equipment; Nathan Manufacturing Company, injectors, boiler checks and water glass; Locomotive Fuel Economizer Company, Boyce fuel economizer; and Southern Valve Gear Company, complete valve gear.

Plans for June Convention

Details of the annual meeting of the Mechanical Division of the American Railway Association to be held in Atlantic City, N. J., June 14 to 21, 1922, are now being formulated. The association has announced that the reports of committees investigating car matters will be received and discussed on Wednesday, Thursday and Friday, June 14 to 16, inclusive, and the reports of committees investigating locomotive matters on Monday, Tuesday and Wednesday, June 19 to 21, inclusive. A circular has been issued giving a list of hotels in Atlantic City and the rates.

Air Brake Convention Program

As previously announced, the annual convention of the Air Brake Association will be held at the Hotel Washington, Washington, D. C., May 9, 10, 11, and 12, 1922. In addition to accommodations, headquarters and convention hall at the Hotel Washington, provision has been made by the Committee of Arrangements for further accommodations of members at the new Ebbitt Hotel in the adjoining block.

The complete program is not yet available. The following papers will, however, be presented for discussion:

Recommended Practice; Committee report, H. A. Clark, chairman.

Air Consumption of Locomotive Auxiliary Devices; Committee report, C. H. Weaver, chairman.

Recent Tests of Steam Heating Apparatus; C. W. Hunter, Montreal Air Brake Club.

Terminal Tests to Insure Effective Grade and Operative Brake; Pittsburgh Air Brake Club.

Triple Valve Repairs; Northwest Air Brake Club.

Brake Pipe Vent Valves; W. W. White, Central Air Brake Club.

Schedule "UC" Brake Equipment; J. C. McCune.

International Railway Congress

The Ninth Congress of the International Railway Association will be held in Rome, Italy, from April 18 to April 30. Besides the meetings of the five sections into which the Congress is divided the program includes the following: Banquet by the Italian government April 19; reception at the Capitole April 21; excursion to the Terni Hydro-Electric Works and various establishments April 22; excursion to Naples and Pompeii April 29 and 30; departure from Genoa on May 1, and excursion to the electric traction installations in special train to Modane.

The sections of the Congress are as follows: 1. Way and Works; 2. Locomotives and Rolling Stock; 3. Operation; 4. General; 5. Light Railways.

The following who have been appointed as delegates of the American Railway Association have arranged to attend the Congress: L. A. Downs, chairman, Division IV—Engineering (vice-president and general manager, Central of Georgia Railway); D. Z. Dunott, chairman, Medical and Surgical Section (chief surgeon, Western Maryland Railway); J. E. Fairbanks, general secretary; T. De Witt Cuyler, chairman, Association of Railway Executives; W. W. Atterbury, vice-president, Pennsylvania; George Gibbs, chief engineer electric traction, Long Island; W. J. Tollerton, general mechanical superintendent, Chicago, Rock Island & Pacific.

The following who have been appointed reporters for the American Railway Association on the subjects indicated also will attend: W. J. Tollerton, chairman, Mechanical Division, A. R. A. (general mechanical superintendent, Chicago, Rock Island & Pacific Railway); "Passenger Carriages," Earl Stimson, chief engineer, Maintenance of Way, Baltimore & Ohio Railroad, "Maintenance and Supervision of the Track;" Samuel O. Dunn, editor of the Railway Age, "Net Cost Rates."

The following will go as delegates of their respective railways: Delaware & Hudson, W. H. Williams, vice-president; Illinois Central, A. S. Baldwin, vice-president, Hugh Pattison, electrical engineer, Donald Rose, European traffic manager; Lehigh & New England, William Jay Turner, vice-president and general counsel; Rollin H. Wilbur, vice-president and general manager, Henry H. Pease, secretary and treasurer; Long Island, Ralph Peters, president, George Gibbs, chief engineer electric traction; Pennsylvania System, J. V. B. Duer, electrical engineer, W. B. Wood, general superintendent, Illinois division; R. C. Morse, Jr., superintendent freight transportation, Eastern region, J. O. Hackenburg, superintendent, Schuylkill division; Philadelphia & Reading, A. T. Dice, president, F. M. Falck, general manager; Pittsburgh, Shawmut & Northern, H. S. Hastings, receiver.

George Gibbs is the American reporter on "Electric Traction," A. S. Baldwin on "Terminal Stations for Passengers," W. H. Williams on "Slow Freight Traffic."

Besides those mentioned above, the following American railway men have prepared reports: C. H. Ewing, vice-president, Philadelphia & Reading, "Construction of the Roadbed and of the Track;" W. C. Cushing, engineer standards, Pennsylvania System, "Special Steels;" G. A. Haggender, bridge engineer, Chicago, Burlington & Quincy, "Reinforced Concrete;" Howard G. Kelley, president Grand Trunk Railway, "Freight Stations." C. W. Crawford, chairman, General Committee, Section 5—Transportation, American Railway Association, "Interchange of Rolling Stock;" A. F. Banks, president, Elgin Joliet & Eastern, "Workmen's Dwellings;" H. B. Spencer, former director of purchases, United States Railroad Administration, "Special Methods of Traction on Light Railways."

The headquarters of the American delegates will be at the Grand Hotel, a short distance from the Fine Arts Exposition Palace in which the sessions of the Congress will be held.

Labor Board to Investigate Erie's Contract with Meadville Company

The Labor Board has ordered a thorough investigation of a contract for shop work which the Erie has made since the subject of contract work came before the Board and has authorized a member of the Board to make an investigation and "invoke the aid and counsel of the Department of Justice." The resolution ordering this investigation specifically mentions the contract made recently with the Meadville Machinery Company for the operation of the Erie's shops at Meadville, Pa., and says in part:

"Since the hearing (of the contract cases, reported recently in the Railway Age) information has come to the Board that the Erie without awaiting the decision of the Board upon said contract cases has entered into a further contract by virtue of which all the shops of the entire Erie system, including those involved in the above cases, have been contracted to a newly incorporated company called the Meadville Machinery Company. Public announcement has been made of the fact that the officers of the Meadville Machinery Company are the recent officers of the Erie.

"The principal question involved in the above cases is whether or not the employees of the companies to which certain shops had been contracted are in law and in fact the employees of the Erie and therefore still subject to the rules, working conditions and wages established by the order of this Board.

"Said employees having now been shifted a second time before the Board had rendered its decision in said pending cases and said contract system having been extended so as to embrace all other shops on the road it becomes the duty of the road upon its own motion to investigate the facts surrounding this alleged contract of the carrier with the Meadville Machinery Company.

"The Board therefore orders: 1—That the contract cases be reopened for the purpose of taking additional proof as to the issues involved in said cases; 2—That a thorough investigation be made of all the facts and circumstances surrounding said alleged contract and the operations being conducted thereunder; 3—That a member of this Board accompanied by such expert and stenographic assistance as may be deemed necessary be authorized and directed to go on the property of said carrier to conduct said investigation and to institute such legal proceedings as may be deemed necessary to effectuate this order after having first secured all the information possible here in Chicago; 4—That the member of the Board conducting said investigation be and is hereby authorized to invoke the aid and counsel of the Department of Justice at Washington if he deems advisable."

Labor Board Decisions

Representation of Mechanical Supervisory Forces To Be Determined by Ballot.—On May 4, 1921, a communication was addressed to A. P. Titus, general manager of the Chicago & Alton, by a committee representing the International Association of Railroad Supervisors of Mechanics requesting a conference for the purpose of negotiating rules and working conditions in accordance with the provisions of Decision No. 119. The carrier maintained that the organization did not represent a majority of the subordinate officials as designated by the Interstate Commerce Commission and the organization submitted the question to the Labor Board, filing a petition bearing the signatures of 90 foremen, authorizing it to represent them in agreement negotiations. The carrier also made a canvass of the foremen and 98 men, or 76 per cent of the supervisors of mechanics in the maintenance of way, locomotive and car departments signed a petition signifying their desire either to deal with the company direct or through a committee named in the petition. The organization took exception to the method followed by the carrier in canvassing the foremen. The board has decided that the method followed by both parties was inconsistent with the intent of Decision No. 119 and that a conference shall be held between representatives of the carrier, of the International Association of Railroad Supervisors of Mechanics, of any other organization representing mechanical foremen, and of 100 or more unorganized employees, for the purpose of arriving at a clear understanding as to the details of taking a ballot by which the foremen, by a majority vote, may designate their choice of representation. Separate forms of ballots for the foremen in the mechanical and bridge and building departments are specified.—*Decision No. 629.*

Foremen Need Not Be Employed for the Full Time Laborers Are at Work.—A case was presented to the Labor Board with respect to the question of employing a coal chute foreman for a less number of hours and days than the laborers he supervised. Evidence shows that he was employed with a gang of laborers for 365 days a year and ten hours a day. On March 6, 1920, he was instructed to work only on week days and nine hours a day, the laborers continuing on the old schedule. The United Brotherhood of Maintenance of Way Employees and Railway Shop Laborers contended that in Supplement No. 8 to General Order No. 27 no change in hours was authorized and that the foreman must be permitted to work the same number of hours as the men. The carrier contended that this provision of Supplement No. 8 was canceled by the National Agreement with the Brotherhood and that there is nothing in this agreement which requires the carriers to employ a man in excess of eight hours on regular week days, if his services are not required. The contention of the carrier was sustained.—*Decision No. 713.*

Classification of Chauffeur as Mechanic Denied.—A chauffeur employed by the maintenance of way department of the Terminal Railroad of St. Louis, to operate a truck used to transport maintenance materials, asked for a reclassification as a mechanic, because he made minor repairs on the truck, the railroad having applied increases and decreases in accordance with Order No. 2 and No. 147 respectively on the basis of "laborer employed in and around shops and roundhouses." The claim for reclassification as a mechanic was denied.—*Decision No. 711.*

Basis of Monthly Rate for Track and Shop Laborers.—An engine watchman was, on January 1, 1918, paid the rate of $67.50 a month. On September 1, 1918, the effective date of Supplement No. 7 to General Order No. 27, an hourly rate of 38¾ cents was established and it remained in effect up to March 1, 1920, when it was changed to a monthly rate of $145 a month, in accordance with Section a-12, Article V of agreement between the Director General of Railroads and the United Brotherhood of Maintenance of Way Employees and Railway Shop Laborers. This rate was increased to $165.40 a month on May 1, 1920, the effective date of Decision No. 2 of the Labor Board, and was reduced July 1, 1921, to $145 in accordance with Decision No. 147 of the Labor Board.

The employees contended that the watchman should have received a monthly rate of $189.64, under Decision No. 2 of the Labor Board, on the claim that he worked 12 hours each night, 365 nights a year at straight time for 10 hours 365 days a year, and two hours' overtime for 365 days plus 12 hours' overtime for 52 Sundays. The carrier maintained that the actual time put in by this employee and the amount allowed on the hourly basis from August 31, 1918, was slightly less than $145 a month, and that when the national agreement of the maintenance of way employees, effective December 16, 1919, was received the employee was placed on a monthly rate of $145, predicated on the average earnings on the hourly basis, that, effective with Decision No. 2 of the Labor Board, the position was increased to $165.40 a month, and was again reduced to $145 under the provisions of Decision No. 147 of the Labor Board.

The Labor Board decided that under Section a-12, Article V, of the United Brotherhood of Maintenance of Way Employees and Railway Shop Laborers' agreement, the monthly rate should be predicated on the hours for which payment was allowed, when rated on the hourly basis.—*Decision No. 714.*

Freight Car Orders

The Great Northern has ordered 500 refrigerator cars from the General American Car Company; also 500 all steel gondola cars from the Pressed Steel Car Company, and 500 stock cars from the Pullman Company.

The Chicago, Burlington & Quincy has ordered 500 automobile cars from the Pullman Company.

The Fruit Growers Express is building 100 refrigerating cars in its shops at Alexandria, Va.

The Pacific Fruit Express has ordered 700 refrigerator cars from the General American Car Company in addition to the 2,600 cars ordered from the Standard Steel Car Company as noted in the March issue.

The Norfolk & Western has ordered 1,000 cars from the Standard Steel Car Company, 1,000 from the American Car and Foundry Company, and 2,000 from the Pressed Steel Car Company.

The Atlantic Coast Llne has ordered 450 steel underframes and superstructures from the Pressed Steel Car Comuany and 50 from the Chickasaw Shipbuilding Corporation. These are for box cars to be rebuilt in the railroad company's shops.

The United Fruit Company, New York, has ordered 25 ballast cars of 30 tons capacity from the Magor Car Company for export to Honduras.

The Westmoreland Coal Company has ordered 100 55-ton hopper cars from the Cambria Steel Company.

The Tennessee Coal, Iron & Railroad Company has ordered 150 ore dump cars from the Chickasaw Shipbuilding Company.

The New York Central has ordered 250 steel underframe, double sheathed box cars of 40 tons capacity from the American Car & Foundry Company and has equally divided an order for 750 steel hopper cars of 55 tons capacity between the Pressed Steel Car Company, the Standard Steel Car Company and the Pullman Company.

Freight Car Repairs

The Delaware, Lackawanna & Western has given an order to the American Car & Foundry Company for the repair of 985 steel hopper cars, of 40 tons capacity.

The Gulf, Mobile & Northern is having repairs made to 100 steel underframe box cars, at the shops of the Anniston Electric Steel Corporation, Anniston, Ala.

The New York Central is placing contracts for the repair of a large number of freight cars, including 300 cars to the Ryan Car Company; and a number to the Streator Car Company, the Buffalo Steel Car Company and the Euclid Steel Car Company, for the Michigan Central; also 500 to the Ralston Steel Car Company for the Toledo & Ohio Central. All the cars for repair are steel gondola and hopper cars.

Passenger Car Orders

The Central of New Jersey has placed orders for a total of 70 cars as follows: 20 coaches and 10 combination passenger and baggage cars to the American Car & Foundry Company, 30 coaches to the Standard Steel Car Company and 10 baggage cars to the Bethlehem Shipbuilding Corporation, Harland Plant.

The Southern Pacific has ordered 50 steel cars for service on its Pacific Electric division from the St. Louis Car Company, the electrical equipment to be furnished by the Westinghouse Electric & Manufacturing Company.

Locomotive Orders

The Chicago, Burlington & Quincy has ordered 47 Mikado, Santa Fe and Pacific type locomotives from the Baldwin Locomotive Works and 8 Mountain type from the Lima Locomotive Works.

Locomotive Repairs

The Southern Railway is rebuilding 25 consolidation type and 20 Pacific type locomotives in its own shops. These locomotives will be equipped with superheaters and Chambers throttle valves. Outside valve gear will be added to the locomotives not yet equipped with this device.

Shop Construction

Great Northern.—This company has awarded a contract for the construction of a 30-stall roundhouse, shop buildings, storehouses and other terminal facilities at Minneapolis Junction, Minn., to A. Guthrie & Co., St. Paul.

Atchison, Topeka & Santa Fe.—This company, which has four small store department buildings at Topeka, Kan., estimated to cost $15,000.

Atchison, Topeka & Santa Fe.—This company, which has been contemplating the construction of extensions and improvements to its machine shops at San Bernardino, Cal., the work to include a one-story building 65 ft. by 510 ft., equipped with machinery and cranes, of which the entire cost is estimated at $250,000, has awarded the contract for this work to C. A. Fellows, Los Angeles, Cal.

Texas & Pacific.—This company is constructing a three-story building at Marshall, Texas, to be used by its apprentices for their instruction and study of car and locomotive work.

Gulf & Ship Island.—This company is constructing a new engine house 105 ft. by 220 ft., and a new machine shop of steel frame and brick construction, 75 ft. by 200 ft., to replace property destroyed by fire on February 25, of which a loss was estimated at $75,000

Meetings and Conventions

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

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City. Annual convention May 9, 10, 11 and 12, Hotel Washington, Washington, D. C.

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

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Next annual convention June 14 to 21, 1922, Atlantic City, N. J.

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

Division VI—Purchase and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio. Meeting June 19, 20 and 21, Atlantic City.

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

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York, Railroad Division, A. F. Stuebing, 2201 Woolworth Building, New York.

American Society for Steel Treating.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention and exposition postponed until October 2-7, 1922, Detroit, Mich.

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

Canadian Railway Club.—W. A. Booth, 53 Rushbrook St., Montreal, Que. Regular meeting second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal.

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

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

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y.

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

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio.

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

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich. Convention Hotel Sherman, Chicago, August 15, 16 and 17.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill. Next annual meeting Auditorium Hotel, Chicago, May 22 to 25, 1922.

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

Master Boilermakers' Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y. Next annual convention Hotel Sherman, Chicago, May 23 to 26, 1922.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Annual entertainment and banquet at Copley-Plaza Hotel, Boston, April 11.

New York Railroad Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y.

Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Regular meetings fourth Thursday in each montb, except June, July and August, at Fort Pitt Hotel, Pittsburgh, Pa.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo. Next meeting April 14. Paper on the Railroad Situation will be presented by Z. G. Hopkins, assistant to the operating officer, Missouri, Kansas and Texas. Annual election.

Traveling Engineers' Association.—W. O. Thompson, Marine Trust Building, Buffalo, N. Y.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Regular meetings third Monday in each month, except June, July and August. Next meeting April 17. Paper on Locomotive Types from a Transportation Viewpoint, to be presented by J. F. Porterfield, general superintendent of transportation, Illinois Central. Annual meeting and dinner at the Drake hotel, May 15.

PERSONAL MENTION

GENERAL

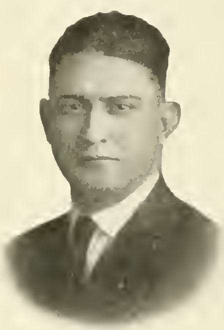
F. S. Brown, mechanical engineer of the Erie, with headquarters at Meadville, Pa., has been appointed chief mechanical engineer with headquarters at New York and G. T. Dupue has been appointed mechanical superintendent of the Ohio and Chicago regions, with headquarters at Youngstown, Ohio, to succeed Charles James. Winfield S. Haynes, formerly master mechanic, with headquarters at Dunmore, Pa., has been appointed superintendent of shop operation with headquarters at New York. He will report directly to the general manager.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

George E. Lund has been appointed master mechanic of the Mahoning division of the Erie with headquarters at Youngstown, Ohio.

D. J. Durrell is master mechanic of the Pennsylvania Railroad at Cincinnati, Ohio. Mr. Durrell has not been transferred to Lancaster, Ohio, succeeding R. J. Sponseller, as inadvertently announced in the March issue of the *Railway Mechanical Engineer*.

Walter L. Barr has been appointed master mechanic of the Kent and Cincinnati Divisions of the Erie Railroad with headquarters at Marion, Ohio. Mr. Barr was born at Quachita, La., on September 26, 1888, and graduated from the Louisiana Polytechnic Institute in 1911. He entered the employ of the Erie Railroad on June 26, 1912, as a special apprentice at Dunmore, Pa. On November 4, 1915, he was transferred to Port Jervis, N. Y., as an apprentice instructor and in November of the following year was appointed roundhouse foreman. From November, 1917, until October 24, 1918, he was night general foreman at Port Jervis and from the latter date until his appointment as noted above, was day general foreman of the shops at Meadville, Pa.



W. L. Barr

C. M. Starke has been promoted to master mechanic of the Illinois Central with headquarters at Centralia, Ill., succeeding J. W. Branton, deceased. Mr. Starke entered the employ of the Illinois Central on April 18, 1891. From April, 1893, to April, 1897, he was a machinist apprentice and from April, 1897, until September, 1901, a machinist and gang foreman. He then became night roundhouse foreman at Water Valley, Miss., and in June, 1902, was appointed day roundhouse foreman. In 1905 he was made erecting shop foreman; in 1909 was transferred to the Indianapolis Southern as a general foreman at Indianapolis, Ind., and from September, 1911, until September, 1912, was general foreman at Champaign, Ill. He was then appointed master machanic of the Mississippi Division with headquarters at Water Valley and from June, 1913, to November, 1917, was master mechanic of the Louisiana Division at McComb, Miss. Resigning from this position, he became superintendent of motive power of the Missouri, Kansas & Texas, later becoming supervisor of locomotive maintenance in the Allegheney Region of the United States Railroad Administration at Philadelphia, Pa. On March 1, 1920, he returned to the Illinois Central and was assigned special duties in the office of the general superintendent of motive power.

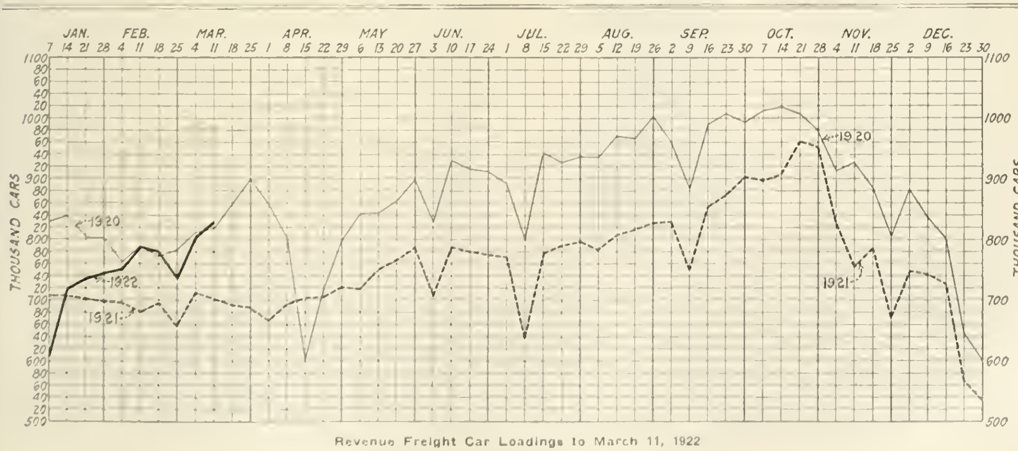
PURCHASING AND STORES

A. J. Mello has been appointed purchasing agent of the San Diego & Arizona, with headquarters at San Diego, Cal., succeeding S. P. Howard, resigned.

C. C. Kyle, acting general storekeeper of the Northern Pacific, with headquarters at St. Paul, Minn., has been promoted to general storekeeper with the same headquarters, succeeding O. C. Wakefield, deceased.

D. V. Fraser has been appointed assistant to the purchasing agent of the Missouri, Kansas & Texas, with headquarters at St. Louis, Mo., succeeding H. H. Kahrs, resigned to enter other businesss.

Edwin H. Gaines, Jr., whose appointment as purchasing agent of the Tennessee Central, with headquarters at Nashville, Tenn., was announced in the March *Railway Mechanical Engineer*, was born at Nashville, on November 8, 1887. He entered railway service in September, 1905, as a file clerk in the passenger traffic department of the Nashville, Chattanooga & St. Louis at Nashville, and was successively chief file clerk, secretary to the chief clerk and advertising agent in the above named department of that road until February 1, 1909, when he left to become associated with the Charleston Mining & Manufacturing Company. He entered the service of the Tennessee Central at Nashville in July, 1913, since which time he has been invoice clerk in the receivers' office, secretary to the receivers, secretary and chief clerk to the general superintendent, and chief clerk to the receivers, which latter position he was holding at the time of his recent promotion to the position of purchasing agent.



Revenue Freight Car Loadings to March 11, 1922

SUPPLY TRADE NOTES

J. W. McCabe, of the Chicago Pneumatic Tool Company, New York, has returned from a three years' tour aound the world.

The Ryan Car Company has increased its capital stock from $2,500,000 to $6,000,000, by the issuance of 35,000 shares of additional common stock with a par value of $100 per share.

The United States Cast Iron Pipe & Foundry Company, Burlington, N. J., has opened a new office in the Interstate building, Kansas City, Mo., in charge of D. W. Pratt, sales agent.

The Stowell Company, South Milwaukee, Wis., has moved its Chicago office from 509 Monadnock Block to 628 McCormick building. E. B. Hansen will continue as manager of the Chicago office.

The United Alloy Steel Corporation, Canton, Ohio, announces that John McConnell, who was formerly in the service of the corporation has again entered its service as vice-president, in charge of operation.

The O'Fallon Railroad Supply Company, Arcade building, St. Louis, Mo., has been appointed sales agent for the Standard Railway Equipment Company, and the Union Metal Products Company for the St Louis district.

Stewart J. Dewey, assistant signal engineer of the Cleveland, Cincinnati, Chicago & St. Louis, has resigned to enter the service of the Electric Storage Battery Company, Philadelphia, Pa., in the railway signal department of its Chicago branch

Pendleton E. Lehde has been appointed a special representative in the State of Louisiana and the southern part of Mississippi of the Roller-Smith Company, New York City. Mr. Lehde's headquarters are at 609 Whitney central building, New Orleans, La.

Ross E. Willis, formerly sales engineer of the Lakewood Engineering Company, Cleveland, Ohio, in the southern Michigan territory, has become associated with William F. V. Newmann & Sons, Detroit, Mich., representing the Baker R. & L. Company in the Detroit territory.

Don H. Amsbary, Pittsburgh district manager of the Dearborn Chemical Company, Chicago, died on January 25 at his home in Pittsburgh, Pa. Mr. Amsbary was born on March 3, 1869, at Pekin, Ill. In 1907 he entered the employ of the Dearborn Chemical Company, in the Pittsburgh district, and for the past seven years was district manager of that company.

C. R. Naylor, of the western sales office of the T. H. Symington Company, at Chicago, has been appointed manager of sales of the Forged Steel Yoke Corporation, with headquarters in the Peoples Gas building, Chicago. The output of the Forged Steel Yoke Corporation will be sold and distributed by the T. H. Symington Company, which still retains Mr. Naylor's services.

William C. Sargent for 22 years secretary and also a director of the Chain Belt Company, Milwaukee, Wis., died on February 5. Mr. Sargent was born at Troy, N. Y., on February 2, 1849. In 1871 he went to St. Paul, Minn., and in 1900 became secretary and later a director of the Chain Belt Company, Milwaukee. He was also a director of the Federal Malleable Company, West Allis, Wis.

William Boughton, district representative at Detroit, Mich., of the Superheater Company, New York city, died at his home in Detroit on March 8, of heart disease. Mr. Boughton was born in Ontario county, New York, in 1861. He went to Saginaw, Mich., in 1876, and a year later began his railroad career with the Pere Marquette as a machinist apprentice. Two years later he was advanced to brakeman, later to fireman, and in 1882 to engineman. In 1898 Mr. Boughton was promoted to road foreman of engines, and seven years later he was appointed master mechanic of the Saginaw division. In 1909 he became general master mechanic of the entire system and later was promoted to superintendent of motive power. He resigned from the service of the Pere Marquette in 1912 to become district representative at Detroit of the Superheater Company, New York city, which position he held at the time of his death.

A. W. Brown has been appointed assistant to the vice-president of the western district of the T. H. Symington Company, New York City. Mr. Brown will make his headquarters in the Peoples Gas building, Chicago. He was born on February 6, 1881, in New York City, and was educated at Trinity College of New York and Andover Academy of Mass. Mr. Brown was connected with the Griffin Wheel Company from 1913 to 1919 and was then appointed manager of railway sales of the Air Reduction Sales Company, New York City, which position he now leaves to take up his new duties with the T. H. Symington Company.

The Combustion Engineering Corporation, New York, has opened its own office in the First National Bank building, Pittsburgh, Pa., and will soon open an office in Cleveland, Ohio, both of which will be in charge of W. C. Stripe, former manager of the Philadelphia office, arrangements having been made between this corporation and the George J. Hagan Company of Pittsburgh, whereby the Hagan Company discontinues representation of the Combustion Engineering Corporation. The Hagan Company will retain the exclusive agency for the type H stoker, formerly known as the American stoker, for use in industrial furnaces.

C. W. Holt, secretary and general manager of the Curtain Supply Company, Chicago, has been elected a vice-president in charge of all operations of the company; Ross F. Hayes, eastern sales manager, with headquarters at New York City, has been appointed general sales manager, with headquarters at Chicago; T. P. O'Brien has been appointed district sales manager, in charge of the eastern office at New York City, and Ralph Brown has been appointed district sales manager of the western district with headquarters at Chicago; G. B. Allison has been appointed assistant to Mr. O'Brien and Edward E. Whitmore assistant to Mr. Brown.

William A. Barstow, president of the Union Tank Car Company, New York, died at his home, Hutton Park, West Orange, N. J., on February 10. Mr. Barstow was born on September 27, 1877, at Cleveland, Ohio, and was educated at the Dearborn Morgan School, Orange, N. J., and at Yale University, graduating from the latter in 1899. The same year he entered the employ of the Atlantic Refining Company at Franklin, Pa. He subsequently served in many branches of the oil industry and in October, 1914, resigned as vice-president of the Imperial Oil Company at New York to become assistant to president of the Union Tank Car Company. Later he was promoted to senior vice-president and since 1919 served as president of the same company.

The Whiting Corporation, Harvey, Ill., has established its own branch sales office in New York City at 136 Liberty street, having discontinued its agency agreement with the Wonham, Bates & Goode Trading Corporation, New York City, who formerly represented the Whiting corporation in the East. J. Ross Bates, now a vice-president of the Whiting Corp., is in charge of the new office and will be assisted in the New York territory by D. Polderman, Jr. In the New England states he will be assisted by R. C. Maley, who will open an office at Springfield, Mass. All of these men were formerly associated with the Wonham, Bates & Goode Trading Corporation. The Whiting corporation has opened a branch office in Indianapolis, Ind., 305 Merchants Bank building, in charge of S. E. Stout, formerly at the main office, in Harvey. Mr. Stout will cover southern Indiana and adjoining cities in Ohio and Kentucky. The corporation's Detroit office has been moved from Penobscot building to 206 Stahelin building, 3000 Grand River avenue.

Merger of Machine Tool Manufacturers

Negotiations to merge a number of machine tool manufacturers are said to have been completed, according to recent announcement. The name of the new corporation has not yet been decided upon. The companies included in the merger are the Lodge & Shipley Machine Tool Company, Carlton Machine Tool Company, Newton Machine Tool Works, Inc., Betts Machine Company, Colburn Machine Tool Company, Hilles & Jones Company, Modern Tool Company, and the Dale Machinery Company.

John D. Ristine, manager of sales of the Chicago Crucible Company, has been appointed manager of sales of the railroad division of the Service Motor Truck Company, Wabash, Ind. Mr. Ristine has been with the Chicago Crucible Company for the past two years. Previous to that time he served as assistant to G. B. Robins, vice-president of Armour & Co., before which he was engaged in railway supply work, having been at one time secretary of the Union Draft Gear Company.

The Warren Tool & Forge Company, Warren, Ohio, has purchased the American Block & Manufacturing Company and the General Malleable Company, both of the same city. The American company manufactures malleable unions with bronze inserted seats, for the production of which the plant has a capacity of about 250,000 per month. The General Malleable Company manufactures malleable castings, a large proportion of which are used by the railroads and the total capacity for the production of which is about 600 tons per month. These companies will henceforth be operated as a part of the Warren Company, the capitalization of which under the merger is $1,800,000. The company will continue to operate under the present management.

Ross F. Hayes has been appointed general sales manager of the Curtain Supply Company, Chicago. Mr. Hayes was born at Lewiston, Me. He entered business with the Boston Woven Hose & Rubber Company in 1888, and was in the service of that company for 16 years, during which time he served as salesman in the rubber goods department in New England and New York state and in 1893 was transferred as city sales manager to St. Louis, Mo. After two years' service at that point, he was appointed New England representative of the mechanical rubber goods department and two years later manager of the Philadelphia office, where he remained until 1904. During the latter year he entered the service of the Curtain Supply Company as western representative and since 1907 has served as eastern sales manager with headquarters at New York.

R. F. Hayes

E. S. Fitzsimmons has been appointed manager of sales of the Flannery Bolt Company, Pittsburgh, Pa. He was born on April 12, 1876, at Columbus, Ohio. He served his apprenticeship with the Chicago, Rock Island & Pacific at Horton, Kan., leaving that company in 1899 to become foreman boilermaker with the Delaware, Lackawanna & Western at Scranton, Pa. In 1904 he served as general boiler inspector of the New York, New Haven & Hartford and from 1905 to 1907 as general foreman boilermaker of the Erie. He was then promoted to master mechanic at Galion, Ohio, and in 1908 was transferred as master mechanic to Hornell, N. Y., which position he held until 1912, when he was promoted to mechanical superintendent Erie, Lines West. In 1914 he was transferred to New York as mechanical superintendent of the Erie Lines East, resigning in 1918 to become works manager for the McCord Manufacturing Company, Detroit, Mich. Mr. Fitzsimmons entered the service of the Flannery Bolt Company at Pittsburgh as salesman in December, 1920, and now becomes manager of sales of the same company.

C. E. Skinner, manager of the research department of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has been appointed assistant director of engineering. His duties will cover research, standards and other work along these lines. Mr. Skinner was born near Redfield, Ohio, on May 30, 1865, and was graduated in 1890 from Ohio State University. The same year he joined the Westinghouse organization in the controller department and supervised the construction of the first controller turned out by that company. Soon afterward he was placed in charge of the testing of insulation, and in 1892 he was transferred to the research laboratory. In 1895 he was placed in charge of insulation design in the engineering department, taking charge, in 1902, of the insulation division of that department, together with the chemical and physical laboratories. Four years later he organized the research division, of which he has been in charge until his present promotion. In 1915 he was a special representative of the American Institute of Electrical Engineers, of which he is a fellow, at the international conference on electrical standards held in London, and he is now a member of the committee representing the Institute of the International Electrotechnical Commission. He was chairman of the American delegates to the Brussels meetings in 1920.

Geo. W. Bender, whose appointment as vice-president of the Argyle Railway Supply Company, Chicago, was noted in the *Railway Mechanical Engineer* of March, was born at Pittsburgh, Pa., on August 20, 1884. Seventeen years later he entered the engineering department of the Pressed Steel Car Company, at Pittsburgh. In 1906 he entered the service of the American Locomotive Company, where he had charge of the extra work order department. He became associated with Mudge & Co., in 1910, as chief draftsman, and subsequently was placed in charge of the mechanical department. Later he was promoted to assistant to the vice-president and in April, 1918, was appointed eastern manager in the New England and Atlantic Coast states. In September, 1919, he was appointed manager of sales and service, with headquarters at Chicago, the position he occupied at the time he entered the service of the Argyle Railway Supply Company.

G. W. Bender

John P. Landreth has been elected president and treasurer of the Universal Packing and Service Company, Chicago. Mr. Landreth was born at Beloit, Kan., on August 11, 1883, and attended the public schools and a business college at Joplin, Mo., and later the Missouri Military Academy at Mexico, Mo. He entered business with the Joplin Water Works Company, Joplin, Mo., as a collector and inspector of accounts. Later he served as a car clerk on the Denver & Rio Grande at Salida, Colo., and, in 1902, became associated with the English Iron Works at Kansas City, later entering the railway specialty sales department of this company at St. Louis. In 1904 he became associated with the Garlock Packing Company as traveling salesman, and on January 1, 1905, was transferred to St. Louis as city salesman. One year later he was placed in charge of the Kansas City office of the company and in May, 1908, was made Chicago manager, which position he held until July, 1916. On the latter date he was appointed western sales manager of the Anchor Packing Company of Philadelphia, Pa., with headquarters at Chicago, which position he still retains in addition to his duties as president and treasurer of the Universal Packing and Service Company.

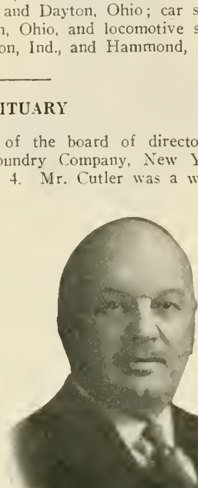
J. P. Landreth

George H. Green has been elected vice-president and secretary of the Universal Packing and Service Company. Mr. Green was born on December 19, 1886, at Chicago. He entered business in the testing department of the Chicago, Rock Island & Pacific in 1906 and during the succeeding eight years served as inspector and chief inspector of materials. In 1914, he was appointed railroad representative of the Garlock Packing Company, and two years later he entered the service of the National Waste Company as sales representative. During the war Mr. Green served as a lieutenant in the field artillery branch of the service and upon his return to this country entered the service of the National Waste Company. In 1919, he was elected vice-president of the company, which position he still retains in addition to his new duties with the Universal Packing and Service Company.

The Meadville Machinery Company, Incorporated, Meadville, Pa., has been organized. William Schlafge, mechanical manager of the Erie at New York has been elected president of the new company; Charles James, who was mechanical superintendent on the Ohio Region of the Erie at Youngstown, is vice-president and W. A. Cotton, of the office of the mechanical manager, is secretary and treasurer. The general offices will be at 50 Church street, New York City. The company was organized to operate the locomotive and car shops of the Erie at the following points: Stroudsburg, Pa., Dunmore, Pa., Avon, N. Y., Meadville, Pa., Galion, Ohio, and Dayton, Ohio; car shops only at Elmira, N. Y., and Marion, Ohio, and locomotive shops only at Cleveland, Ohio; Huntington, Ind., and Hammond, Ind.

OBITUARY

Otis H. Cutler, chairman of the board of directors of the American Brake Shoe & Foundry Company, New York, died at Miami, Florida, on March 4. Mr. Cutler was a well known figure in the railway supply field for many years. He was born in New York city and educated at the Rockland Military Academy, Nyack, N. Y., and the Washington Law University. He served as private secretary to Senator William P. Frye, of Maine, from 1884 to 1895 and for the following three years was a member of the New York State Assembly from Rockland county. He started his business career as secretary of the North River Bridge Company and later became manager of the Ramapo Iron Works. He was instrumental in forming the American Brake Shoe & Foundry Company, serving as its vice-president and general manager in 1902, and from 1903 to 1916 as president, when he resigned and became chairman of the board of directors, the position he held at the time of his death.



Otis H. Cutler

During the recent war Mr. Cutler volunteered his services to the American Red Cross and organized and was the first manager of its Insular and Foreign Division. For his work in this direction he was made a major. After the armistice he spent considerable time in Europe assisting in the organizing of the League of Red Cross Societies, headquarters of which are at Geneva, Switzerland.

Mr. Cutler was identified with large and important enterprises in the industrial and financial world, being associated with many of the J. P. Morgan undertakings and he was director in numerous corporations, including: The Railway Steel Spring Company; American Arch Company; Bronze Metal Company; American Manganese Steel Company; Manganese Steel Rail Company; Southern Wheel Company; American Malleables Company; Dominion Brake Shoe Company, Ltd., and New York Telephone Company. He was also a member of many clubs and societies.

TRADE PUBLICATIONS

Cranes.—A four-page, illustrated circular describing in a general way its complete line of cranes, also foundry equipment, short turn trolley systems, and hoists, has been issued by the Whiting Corporation, Harvey, Ill.

Circular Sawing Machines.—Bulletin No. 5 featuring several types of sawing machines and giving a number of practical pointers about circular saws and their care, has recently been issued by the Oliver Machinery Company, Grand Rapids, Mich.

Metallographic Equipments.—The Bausch & Lomb Optical Company, Rochester, N. Y., has recently issued a bulletin describing and illustrating its inverted style of microscope and three complete metallographic outfits in which it is embodied.

Automatic Driving Box Wedges.—The Franklin Railway Supply Company, New York, has issued a phantom view of the Franklin automatic adjustable driving box wedge showing the construction of the wedge and related parts and giving instructions for proper methods of lubrication.

Portable Electric Drills.—The Black & Decker Manufacturing Company, Baltimore, Md., has recently issued a miniature catalogue and price list of its portable electric drills, electric screw driver and socket wrench, electric grinders, safety cleaning machine and electric valve grinder.

Locomotive Repairs.—How milling has become a means of reducing costs on many machining operations in railroad shops is the subject covered in the 32-page illustrated catalogue recently issued by the Cincinnati Milling Machine Company, Cincinnati, Ohio Specifications, a description of the operation of Cincinnati millers, and a list of locomotive parts which should be milled are also included in this catalogue.

The Shepard Electric Liftabout.—The Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., has recently issued a small illustrated folder descriptive of a new and smaller type of electric hoist, manufactured by that company. The text and illustrations show a wide number of purposes for which this hoist can be utilized to advantage such as the loading and unloading of freight, the shifting or storing away of material in storehouses, etc.

Cutting Torch.—A leaflet fully describing the various features of design and construction of the Airco "D" cutting torch has been issued by the Air Reduction Sales Company, New York. Sectional views of the torch are shown and tables given showing the thickness of metals that can be cut, the pressures of oxygen and acetylene necessary, and the gas consumption in cubic feet per hour when using tips adapted to the cutting of steel, cast iron or rivets.

Oil Burners.—A 32-page illustrated booklet has been published by the Denver Fire Clay Co., Denver, Colo., in which oil burners are described and illustrated. According to the foreword of the booklet, the purpose of the catalogue is to aid in the selection of fuel and oil burning equipment by describing what has been found through experiments, much study and competition to be the best methods of burning liquid fuel. Complete description and specifications are given.

Centrifugal Pumps.—Much valuable data regarding centrifugal pumps is contained in Bulletin W605 published by the Worthington Pump & Machinery Corporation, New York. The bulletin is, in reality, a handbook for operating engineers and covers thoroughly the question of installation, operation and maintenance of centrifugal pumps. One of the features of the book is a curve showing the maximum water temperature allowable for varying suction lifts which, it is stated, has never been printed before. Curves are also included to show the head capacity and efficiency capacity characteristics of centrifugal pumps. The concluding pages contain a large amount of valuable tabular matter to facilitate the solution of pumping problems.

Railway Mechanical Engineer

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Fuel Economy and Locomotive Maintenance

There are two distinct fields for the saving of fuel under the jurisdiction of the mechanical department. One is through improved operation of the locomotive, by proper firing practice and careful adjustment of cut-off. The other is by maintaining the locomotive in such condition that it will give the maximum efficiency in the generation and utilization of steam. On many railroads the road foremen of engines are held responsible for fuel economy. This usually has the effect of focusing attention on saving fuel on the road, comparatively little attention being given to maintenance from the fuel standpoint. It is probably not overstating the case to say that the condition of the locomotive is a more important factor in determining fuel performance than the way it is operated. Even the best enginemen cannot get good results from a wasteful locomotive, but if the power is in good condition, showing that the management is interested in saving fuel, it has an immediate effect on the engine crew and their co-operation is more readily obtained. For this reason it is important that when locomotives are repaired, they should be put in condition to use fuel economically and that roundhouse forces should keep the boilers clean, the flues blown and the tubes tight, that valve and cylinder packing should be kept free from blows, steam pipes tight, valves square and front ends free from leaks. These are all opportunities for saving fuel at the source which will yield big returns.

Another Comment On Price Buying

In spite of the evident costliness of basing railroad shop equipment and machine tool purchases on price alone this "penny wise and pound foolish" policy is still being followed in many cases. Competitive bids are requested by the purchasing agents and orders placed with the lowest bidders irrespective of the quality or producing ability of the tools purchased. It is not known how general this practice has become, but the evidence shows that it is all too common. The principal cause for it is failure on the part of mechanical department officers to convince those higher up that a poor tool usually wastes annually, and sometimes monthly, many times its first cost. Take such standardized small tools as twist drills and reamers, for example. The manufacturers are compelled by force of circumstances to be well acquainted with their competitors' drills. They know just which of the companies are producing good drills and which are cutting the corners here and there and producing drills to meet the price only. They know the average hole-producing ability of these various makes of drills and reamers. It comes as more or less of a shock therefore, when these companies find that the railroads time and again place orders not with one of the standard drill manufacturers but with some little fellow who is cutting the corners and then cutting the price. One drill manufacturer has assumed a very fair attitude in the matter, at the same time stating the case plainly. He writes as follows: "You can scarcely blame the railroads, handicapped as they have been by the lack of actual cash, if they should have adopted this policy (price buying) for a few months or a year, but now it has been going on for a little over a year, and there seems to be no let up in it. Not only in our line but in many lines the railroads are actually losing money by this short-sighted policy." Railroad shop men realize as never before that it is the cost of unit *producing* and not the cost of the unit *purchase* which counts in the acquisition of railway shop machinery and equipment. These facts should be impressed most strongly on the railroad executives and department heads responsible for the actual placing of orders. It is poor business judgment to save five per cent on the cost of a twist drill and send it to the shop where it may break at the first trial and produce nothing. The same truth applies with equal force to other standard and special tools, equipment and material used in railroad shops in which quality is the essential characteristic.

Facilitating Work on the Repair Track

Freight cars are subject to many defects which make them unfit to operate. Some are of little consequence; others require considerable time and labor to repair. Because of the expense involved in sending cars to the principal shop points for repairs, the local cripple track is usually called upon to undertake any repairs to cars in its territory almost regardless of whether the work is heavy or light. Freight cars are usually designed to be repaired with crude facilities and it is surprising what a variety of work can be done at repair points where there is practically no equipment besides jacks, hammers and chisels. The ordinary repair track affords a good example of what can be performed with crude equipment, but it also represents waste of man-power that should be avoided where possible. Most of the work on a repair track is done by main strength and the fact that it can be handled without better tools is often used for an excuse for not installing repair facilities that are needed and would prove a paying investment. It is costly to make repairs without proper equipment and conditions are becoming worse as the weight and capacity of cars increase. It is enlightening to watch a gang of men raising a heavily loaded car. Probably twenty minutes is required to jack it up. The cost for such a simple operation is often over one dollar and this is repeated many times every day. This is only one example of work that should be arranged so that it can be done with the aid of machines. Another example is wheel work. The familiar sight of men with wheel sticks laboriously lifting a pair of mounted wheels over obstructions, taking them to or from the car should be done away with at every important shop. Drop pits or hoists should be provided and the work all performed at one point instead of all over the repair yard. It is, of course, out of the question to provide numerous costly machines, cranes, etc., where only a few cars are handled, but some repair tracks that turn out as many as a hundred cars a day have practically no equipment for expediting the work. The labor cost of repairs made on large repair tracks is usually much too high. Careful planning of the major operations and the judicious expenditure of a small amount for facilities will do much to correct this condition.

Why Perpetuate the Consolidation?

For a number of years the Mikado locomotive has been the prevailing type for general freight service but recently there appears to be a tendency on a number of roads to revert to the Consolidation. The reasons given are the reduction in weight and first cost, lower maintenance due to the elimination of the trailing truck and the increased proportion of the total weight carried on the drivers. These are good reasons as far as they go, but the disadvantages of the Consolidation for heavy freight power far outweigh the advantages. The fundamental defect of the Consolidation is the impracticability of getting an efficient firebox and boiler. With normal overhead clearance, it is almost impossible to get the proper distance between the grate and the brick arch. Without the arch the short flame travel causes incomplete combustion. Furthermore, the short tubes contribute an additional source of decreased boiler efficiency. As a result the capacity of the locomotive is limited and it must be forced beyond the economical rate to give relatively high tractive effort even at moderate speed. The outcome is that the costs of both fuel and wages are increased. Tests have shown that the fuel used per ton-mile by a Consolidation locomotive of the most modern design is 20 per cent greater than that used by a Mikado. Unfortunately, no reliable comparison of the cost of maintenance of the two types is available but it is quite certain that the difference in favor of the Consolidation would be only a fraction of the increased cost of fuel. If all cost items are considered, it is doubtful whether any railroad will find justification for ordering Consolidations for heavy freight service.

Improving Shops With Small Expenditure

The majority of railroad shops in this country were not planned and built as complete modern plants, but are rather the result of gradual expansion. In building extensions an attempt is usually made to work the existing facilities into the new plan, which almost invariably spoils the arrangement of machines. This explains why railroad shop men usually have to contend with severe handicaps in production. Many a foreman wishes he could start at the beginning and redesign the entire layout. This can seldom be done so the question arises what measures may be taken to improve shops with a moderate expenditure.

In considering shop improvements, it is well to bear in mind that a few major operations make up a considerable proportion of the work. In the machine shop, for instance, the important operations are those on driving wheels, driving boxes, shoes and wedges, main and side rods, and pistons. A study of the best method of doing the work on these parts, including routing through the shop, tooling of machines and special fixtures, will often show great possibilities for improvement. Any saving effected will bring the maximum results because the operations are repeated so many times. As an example, some shops in finishing shoes and wedges use three set-ups and three cuts for operations that other shops do in a single cut. The time for finishing each casting varies from 20 min. to 2 hr. An estimate of the number of shoes and wedges finished in a shop each month and a comparison of the actual time with the best performance will often show a large field for economy in this job alone and a few similar savings on other work will do much toward reducing excessive repair costs.

Another phase of shop operation which should not be overlooked in the search for possible economies is the handling of material. Many shops struggle along distributing repair parts and supplies by a poorly organized labor gang with wholly inadequate equipment, when oftentimes this very feature is increasing the costs in every department, not merely because the service itself is expensive, but because it also contributes to lost motion and delay. Material handling has been highly developed in recent years and equipment is available for meeting practically every requirement. The lift truck, the platform truck and the crane truck are particularly adapted for railroad shops and probably offer the best means available for overcoming the disadvantages of bad location of departments or machines.

Drill Grinders Needed

One of the most important small tools required in each railroad shop and enginehouse of any size is a machine that will grind and point drills correctly. An investigation of many of the toolrooms in railroad shops today will show that a considerable proportion of the drills are ground inaccurately; in some cases it is even attempted to grind them by hand without the use of any sort of guiding fixture. Drills are probably the most widely used of any cutting tool and great quantities of them are bought each year. "Familiarity breeds contempt" and it may be due to their common use that drills are so often maltreated. A poorly ground drill results in the following losses: (1) unnecessary power loss through friction; (2) increased wear and tear on the drill presses due to greater strains; (3) longer time required for drilling; (4) shorter life of drill.

If the above losses are resolved into dollars and cents it can be easily appreciated what tremendous savings will be effected by the introduction of proper drill grinding methods. These methods consist of the following: (1) select a drill grinder that will point the web of the drill as well as grind the lip; (2) see that the machine grinds from the point to the outer edge of the drill so that the clearance will be sufficient to insure free cutting and yet not enough to weaken the cutting edge. The more metal there is backing the cutting edge, the less chance there will be of heat breaking down the cutting edge and consequently shortening the life of the drill; (3) clamp the drill rigidly in the correct position to insure exact similarity of the cutting edges and both lips being ground under precisely the same conditions; (4) the grinder must have a pointing attachment. Many users do not appreciate the marked benefits derived from pointing a drill. Pointing greatly diminishes the power required to feed the drill and there is consequently less tendency to split the point, a frequent cause of drill failure. It has been observed that by pointing a drill properly the end pressure can be reduced about 60 per cent and the horsepower required to drive the drill by over 25 per cent.

It will be evident from the above, that the drill grinder is really an essential tool which often receives less attention than its importance warrants. It would probably pay to run a short test in the majority of shops and enginehouses using drills ground with slightly different adjustments of the drill grinders. This would indicate which adjustment was the most desirable and in many cases would probably show that the older machines ought to be replaced by modern grinders capable of sharpening drills for maximum production.

An Intimate Chat With the Editor

As a subscriber to the *Railway Mechanical Engineer* we want you to feel that you are a member of our family. We want your co-operation and we want to help you in a practical way. If we do not serve you to the best advantage, please do not hesitate to let me know. Remember that your subscription represents an investment from which you ought to receive adequate returns.

Some of you have suggested that you would like to see more personal items about promotions in the mechanical departments of the various railroads, thus enabling you to keep in touch with the advancement and movements of your friends. Nothing would please us better than to be able to do this. The information, however, originates in so many places over such an extensive territory that it seems to be almost impossible to secure data about all of the appointments. We have tried hard to secure information covering a greater percentage of these appointments, some of the methods used entailing considerable expense. The results, however, have been disappointing.

You can help us immeasurably if you will co-operate by sending to us promptly, notices of changes on your road or in your district. We have two columns of personal items in this issue. Will you help us to make it three columns in the June number? It will take only a very little of your time and one cent for a postcard, but you will help to make your paper more effective.

A few of you are asking for a return to the old prize competitions. Are there others that would like to have us do so? If so, what subjects would you like to have discussed through these competitions?

Don't look upon your subscriptions as a petty business transaction, but more as your membership dues in a big club made up of the best minds in the mechanical departments of our railroads. Be frank with us. Take us into your confidence and together we will boost the mechanical department and make it a greater and greater power and influence in the railroad world.

How about it?

Sincerely,

Roy V. Wright

NEW BOOKS

Locomotive Engineers' Pocket Book and Diary. 250 *pages, 3 in. by 5¼ in., illustrated. Bound in cloth. Published by the Locomotive Publishing Company, Ltd., London, E. C. 4, England.*

General engineering handbooks as a rule contain very little data regarding locomotive design and construction. For this reason the Locomotive Engineers' Pocket Book will have a special appeal to designers and draftsmen. The book covers a wide field and is particularly valuable for the information it gives on British locomotive practice. Some of the data is not applicable to American conditions, but a considerable proportion of the work deals with the methods and with the fundamental principles that are of universal application.

The section on locomotive design opens with a discussion of the general conditions governing the selection of locomotives and covers road conditions and train resistance. This is followed by data regarding boiler capacity and steam consumption in which the results of numerous boiler tests are given. Engine performance is discussed and wheel arrangement notations explained. The distribution of weight on locomotive wheels is treated at length. Some of the fundamentals of design as counterbalancing, wheel base in relation to track curvature, and design of springs are treated in a thorough manner, although some other parts of the locomotive receive scant attention. A tabulation of dimensions and weights of British locomotives is included which is of considerable interest. General comments are given on boiler and accessories, methods of firing, shop layouts and shop and roundhouse work. The book suffers somewhat from incompleteness and inadequate indexing for a handbook, but it contains much valuable information that entitles it to a place in the railway engineer's library.

The Firing of Locomotives. *By J. F. Cosgrove. 368 pages, illustrated. 6 in. by 9 in., one chart. Book Service Department, Simmons-Boardman Publishing Company, New York.*

The railroads of this country use in locomotive service practically every kind, grade and size of coal produced. The characteristics of these fuels vary widely; some coke in burning, some clinker, some are very high in gaseous content, others have excessive ash. The variations in the characteristics of the coals make it necessary to use different methods in firing them if the best results are to be obtained in each case. Because of the wide variety of conditions, it is extremely difficult to prepare a book that will deal satisfactorily with firing practice in various sections of the country. Mr. Cosgrove has had the benefit of long and varied experience and his book is undoubtedly the most authentic and comprehensive work of its kind that has been published.

The book treats the subject of firing in a logical manner. The composition of the various types of coal and their principal characteristics are first discussed. This is followed by a section on the principles of burning coal in locomotives. The general theory of combustion and the chemical processes involved in the burning of coal are explained in simple language. Thus the first section of the book gives the reader an understanding of the fundamental principles that underlie correct firing practice.

The remainder of the book is devoted to a detailed consideration of the various conditions met in actual service and the methods to be used under each condition to obtain the best results. The locomotive boiler and appliances are described with particular reference to their influence on firing methods. Several chapters are devoted to a detailed discussion of the proper methods of handling the fire—such subjects as the thickness of the fuel bed, the shaking of grates, and the prevention of clinkers are discussed fully. The proper practice when firing the various types of coal is treated and instructions are given for firing under adverse conditions. The last subject discussed is the operation of stoker locomotives. Detailed instructions are given for the operation of the stoker engine to obtain uniformly good results under various conditions of operation.

The coal chart accompanying the book lists the coals mined in every state, giving the principal characteristics, such as heating value, fusing temperature of ash, and the proportion of the various constituents.

The proper methods of firing are of the utmost importance in securing fuel economy irrespective of the equipment or the grade of coal used. Mr. Cosgrove's book is a valuable contribution to this important subject. It has a place in the library of everyone who is interested in saving coal, from the purchasing agent and superintendent of motive power to the engineer and fireman.

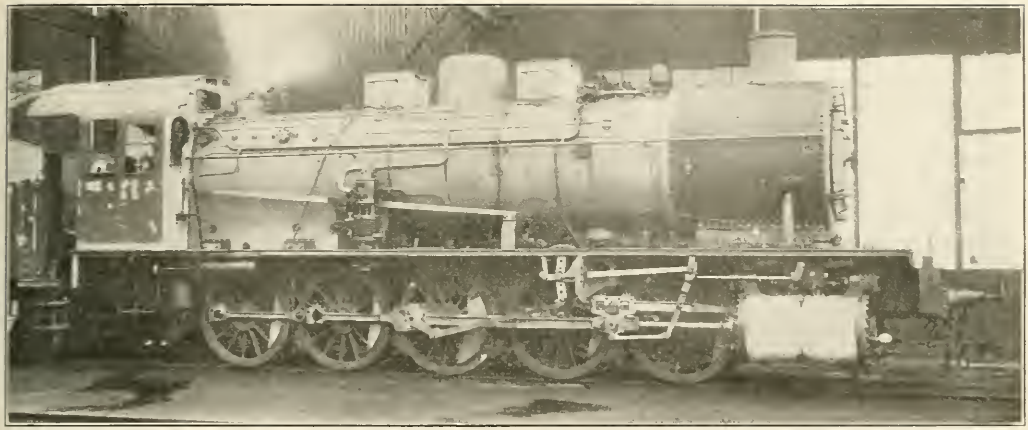
Hendey, 1870-1920. 112 *pages, 6 in. by 9 in., illustrated, bound in cloth. Published by the Hendey Machine Company, Torrington, Conn.*

Under the above title is set forth in attractive form the inspiring story of Henry J. Hendey and the machine tool business which he founded and developed in Torrington, Conn. The story is described as "A Brief Record of a Charted Course" and standing out prominently in 50 years development of the Hendey Machine Company is the rugged, courageous character of its founder whose ingenuity and understanding of the mechanics of machines was second only to his high business standards and ideals.

Henry J. Hendey was born in 1844 in London, England, being brought to this country at the age of four by his parents who settled in Waterbury, Conn. In 1865, at the age of 21, he moved to Torrington where he lived until his death in December, 1906. Entering into partnership with a brother, Arthur, a proprietary machine shop business was started. Among the first products were a three horse-power rotary engine and twenty wood turning lathes. Working space was first secured in a local shop and later a small one story shop was built, but in 1872 the work seemed to justify larger quarters and a "new and commodious" plant was built on the site of the present works. The Hendey brothers were quick to note the demand for new products and manufactured special machines of many different types.

Owing to ill health, Arthur Hendey had to move west and a stock company was formed in 1874, providing sufficient working capital needed for enlargement of the business. Engine lathes, friction drive planers and shapers were developed. The year 1892 was highly important as marking the introduction of the first quick change gear box which was commercially successful. In 1900 the company's products were pratically standardized into a line of lathes, shapers and milling machines. The development of the crank shaper with its greater speed, accuracy and capacity was consummated in 1915.

An interesting account is given of the development of a foreign market for Hendey products, a task which was greatly facilitated by the award of a gold medal to the quick change lathes exhibited at the Paris Exposition in 1900. The latter part of the book is devoted to illustrations of both early and modern types of machines; also pictures of the men who have guided the Hendey Machine Company in the capacity of president from 1874 to the present time, including such well-known names as A. F. Migeon, C. F. Brooker, C. F. Church, H. J. Hendey, F. F. Fuessenich, and the present president, C. H. Alvord. The book is printed and illustrated with unusual care and the author has succeeded in presenting a highly interesting story of achievement in the machine tool field.



Unaflow Freight Locomotive Built by A. Borsig of Berlin, for the German State Railways.

Recent Developments in the Unaflow Locomotive

Exhaust Ejector Effect Overcomes Handicap of High Compression and Reduces Size of Cylinders

THE reciprocating steam engine has been freely criticized as an inefficient machine. During recent years turbines and internal combustion engines have displaced steam engines for many purposes, principally where economy of fuel is an important factor. In spite of the trend toward other types of prime movers, the reciprocating engine, with certain improvements, has retained its place in locomotive service due to the advantages of simplicity, reliability and large power output in relation to its size and weight. The steam engine has not been neglected by scientists and engineers and constant progress is still being made which will probably result in that type of engine holding its place for many years to come.

Characteristics of the Unaflow Engine

One of the recent developments in reciprocating steam engines which promises to add to the efficiency of the locomotive is the Stumpf unaflow cylinder arrangement. Briefly, the unaflow engine consists of a piston of a length somewhat less than the stroke of the engine working in a cylinder of nearly twice the usual length. At the center of the cylinder is a row of exhaust ports which are uncovered by the piston at each end of the stroke. The admission of steam takes place as usual through valves and ports at the end of the cylinder. Thus the steam flows through each end of the cylinder in one direction only, which results in a considerable reduction in the losses due to heat transfer between the steam and cylinder walls and a considerable economy in the use of steam.

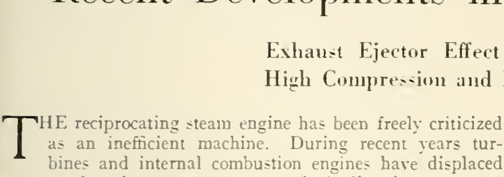


Fig. 1—Effect of Exhaust Ejector Action on Indicator Card

Professor Stumpf, inventor of the Stumpf unaflow engine, has recently given attention to the design of locomotives and about 200 locomotives of this type are now operating in Europe. The Stumpf Unaflow Engine Company, Syracuse, N. Y., is now arranging for installations in this country.

The unaflow cylinder as ordinarily designed is best adapted to condensing engines. Compression occurs early in the stroke and the large amount of negative work is a disadvantage in getting the high mean effective pressure desired in locomotive service. This difficulty can be overcome by supplementary exhaust valves with some sacrifice of economy. Very short cut-off is desirable in a unaflow engine and this involves a large cylinder if the engine is to deliver an average piston thrust equivalent to that of the counterflow engine with its longer cut-off. The unusual length of the cylinder also complicates its application to the locomotive.

From the features already mentioned it is apparent that the design of the unaflow locomotive presents numerous difficulties but experience with locomotives of this type now in service indicates that the handicaps have been overcome and the unaflow now offers an opportunity for eliminating some of the losses which are common to the operation of other types of reciprocating engines.

The Exhaust Ejector Principle

One of the most important improvements in the latest design of unaflow locomotives lies in the application of the exhaust ejector principle. The method by which this is utilized to overcome the difficulties met in the design of the unaflow locomotive is illustrated in Fig. 1. A loss of area in the indicator diagram begins within the limits of the piston stroke due to the fact that the exhaust commences with a certain exhaust lead before the dead center is reached as shown at *fv* in Fig. 1, this loss increasing as the exhaust lead and terminal expansion pressure *pe* increase. For small exhaust lead and low terminal pressure, this loss is negligible and it is almost always insignificant when compared with the loss represented by the toe of the diagram, shown shaded at *D*. In the unaflow locomotive the energy represented by the area *D* has been utilized to reduce the pressure *pu* at which compression begins, with a consequent lowering of pressure throughout compression.

A smaller clearance volume may therefore be used thus diminishing the volume loss. The area regained on compression, shown shaded at *F*, is proportional to the shaded area *D*, or in other words, the higher the terminal expansion pressure, or the longer the cut-off, the lower will be the terminal compression pressure. This makes the use of a longer exhaust lead *fv* permissible since the loss area within the limits of the piston stroke now form a part of the toe of the diagram and cooperates in lowering the back pressure at the time compression begins. There is, therefore, no objection to making the exhaust lead large since by increasing

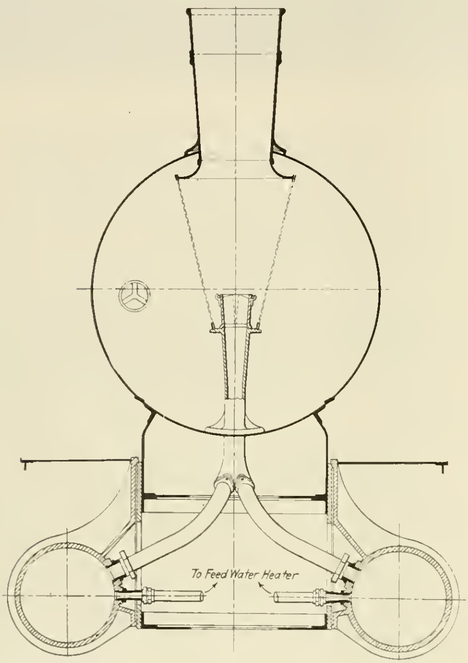


Fig. 2—Arrangement of Exhaust Passages and Nozzle

the duration of the exhaust the compression is shortened and the exhaust puffs are softened. If this is done the number of the exhaust ports at the center of the cylinder will be so far reduced that the exhaust belt ordinarily used in unaflow cylinders may be dispensed with and only one port remains which connects directly to the exhaust pipe. This also enables the piston and cylinder to be made considerably shorter.

The utilization of the energy represented in the toe of the diagram is based upon its conversion into kinetic energy by means of conical nozzles such as are commonly used in steam turbines. The general arrangement of the nozzles and passages is shown in Fig. 2. An engine having two cranks at right angles with an exhaust lead of 25 per cent will produce sufficient overlap of the exhaust period so that the exhaust of one cylinder begins before the other has ceased. If now the exhaust pipes are joined at acute angles, a jet ejector action is obtained. In order to obtain as high efficiency of ejector action as is practicable, friction losses must be kept at a minimum. This necessitates careful proportioning of the exhaust passages, the exhaust nozzle and the stack.

A theoretical analysis of the ejector action indicates that 28 per cent of the energy ordinarily lost may be converted into useful work. The steam consumption also is improved, the saving varying from 12 per cent at 43 per cent cut-off to 0 at 14 per cent cut-off. The exhaust ejector effect also permits a considerable reduction of clearance volume, the decrease in a typical case being from 17 per cent to 11 per cent.

The reduction in back pressure obtained in actual service by the exhaust ejector action is clearly shown by the indicator cards in Fig. 3 and the diagram in Fig. 4 which shows the variation in the pressure in the exhaust pipe between the cylinder and junction during a complete revolution of the crank. It will be noted that the cylinder card shows the exhaust coinciding with the atmospheric line for a considerable distance and the card taken from the exhaust pipe shows that a vacuum as high as 7 lb. per sq. in. was formed at certain positions.

The extent to which the increase of the exhaust lead shortens the cylinder and piston is clearly shown in Fig. 5.

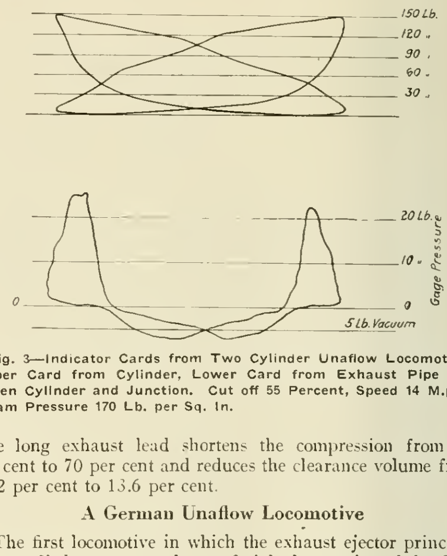


Fig. 3—Indicator Cards from Two Cylinder Unaflow Locomotive; Upper Card from Cylinder, Lower Card from Exhaust Pipe Between Cylinder and Junction. Cut off 55 Percent, Speed 14 M.p.h., Steam Pressure 170 Lb. per Sq. In.

The long exhaust lead shortens the compression from 90 per cent to 70 per cent and reduces the clearance volume from 16.2 per cent to 13.6 per cent.

A German Unaflow Locomotive

The first locomotive in which the exhaust ejector principle was applied was a superheater freight locomotive of the German State Railways, built in 1920 by A. Borsig of Berlin, and illustrated at the beginning of this article. The main dimensions of the locomotive are as follows:

Cylinder bore	630 mm.	(24.8 in.)
Stroke	660 mm.	(26.0 In.)
Driving wheel diameter	1,400 mm.	(55.1 in.)
Maximum speed	60 km. per hour	(37.2 m.p,h.)
Steam pressure	12 at. gage	(177 lb. per sq. in.)
Grate area	2.62 sq. m.	(28.2 sq. ft.)
Boiler heating surface	149.65 sq. m.	(1,610 sq. ft.)
Superheater heating surface	53.00 sq. m.	(571 sq. ft.)
Total heating surface	202.65 sq. m.	(2,181 sq. ft.)
Feedwater heater surface	15.0 sq. m.	(162 sq. ft.)
Weight empty	65.5 tons	(144,200 lb.)
Service weight	72.0 tons	(158,700 lb.)

The cylinder of this locomotive is illustrated in Fig. 6. It is notable for its compactness, lightness and simplicity. This is in part due to the use of horizontal single-beat poppet valves which were employed for the first time on this locomotive. Piston valves have been used on some unaflow locomotives while others have double-beat poppet valves. The single-beat type of valve, although simple and perfectly steam tight, has so far not been favorably received because it requires a high lift and a large force to raise it. With the high compression of the unaflow engine, however, the pressure on the valve is balanced to a large extent and the high lift is obtained by arranging the cam roller between the valve and the fulcrum of the valve lever as shown in Fig. 7. The lift of the cam, which is 14 mm. (0.55 in.) radially, is thus increased to 24 mm. (0.95 in.) at the valve. For cut-offs up to 50 per cent, the effective inlet areas of the single-beat valve are equivalent to the areas of a standard piston valve of 220 mm. (8.67 in.) diameter. The fact that beyond this cut-off the valve area remains constant must be considered a further advantage. The small cam lift permits of a cam profile of very gentle curvature, thus insuring smooth lifting and seating of the valve. The whole cam mechanism is very substantially constructed and swinging

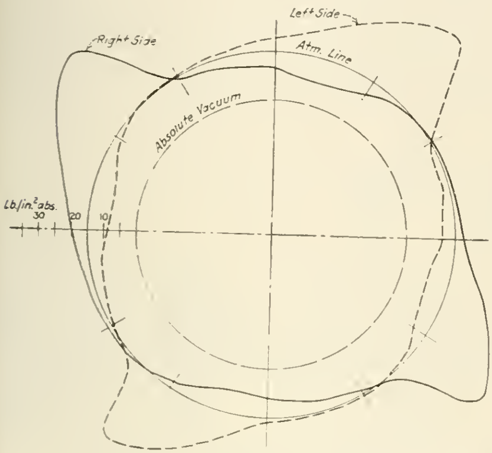


Fig. 4—Diagram Showing Pressure in Exhaust Pipe Throughout a Complete Revolution

levers were used instead of sliding parts wherever possible. It should therefore stand up well in service.

Details of Poppet Valves

The single beat valve is made of chrome-nickel steel and works on a removable steel seat expanded into the cylinder casting. If this seat should become damaged by scale or other foreign matter it can be easily resurfaced or renewed.

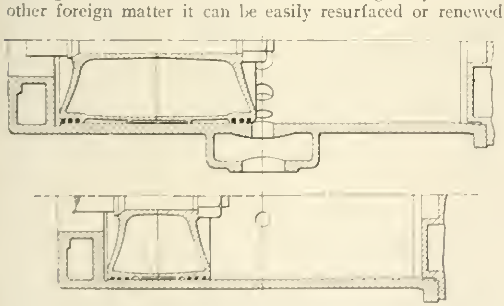


Fig. 5—Comparative Lengths of Cylinders for Exhaust Lead of 10 Percent and 30 Percent

The valve stem has a diameter of 25 mm. (0.99 in.) and is supplied with oil under pressure. The common center of gravity of the valve head and spring retainer is located at about the center of the guide so that good working conditions are assured. The valve stem, furthermore, is not exposed to the live steam, but to the varying pressure and temperature of the cylinder steam. It is entirely independent of the cam mechanism except for the tappet contact, and is free to follow any slight distortion of the cylinder casting.

When coasting, the valves may be lifted off their seats by compressed air admitted between small pistons formed on the valve tappets so that the rollers clear the cam. Special means for connecting the cylinder ends are therefore not required, and the relief valves ordinarily used to prevent high compression may be omitted, since the inlet valves act as such. They also relieve the high compression which may occur when the throttle is nearly closed. The automatic compression release device also may become superfluous since the late cut-offs at starting produce a strong exhaust ejector effect and the compression is therefore considerably shortened.

Attention may be drawn to the accessibility of the valves; for their renewal it is only necessary to take off the valve chest cover and disconnect the valve spring, the spring cap lock being a split spherical washer. Comparing this with the procedure of taking out an ordinary piston valve, the great simplification due to the single beat valve will be appreciated.

The driving parts and the Walschaert gear are the same as those used on counterflow locomotives. On account of its greater length the cylinder was moved forward 180 mm. (17.1 in.). The unaflow cylinder is not heavier than the corresponding counterflow cylinder, since the piston valve chest with its large exhaust chamber as well as the tail rod and its guide are omitted. This allows the piston rod of 95 mm. (3.74 in.) diameter to be bored out to a diameter of 60 mm. (2.36 in.), thus also saving weight. The forged steel piston heads, which are only slightly dished, hold between them a cast-iron supporting drum cast from a special

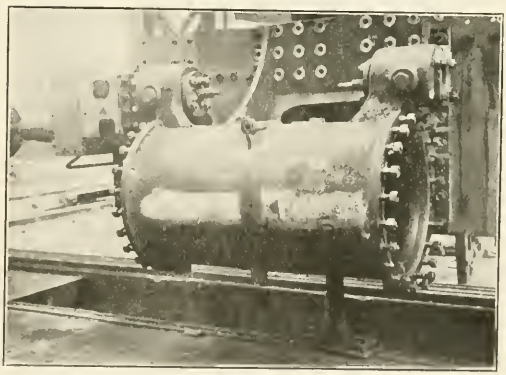


Fig. 6—The Unaflow Cylinder with Poppet Valves Is Light and Simple

soft mixture, while the cylinder is made of a hard quality of cast iron. The supporting drum is turned smaller than the cylinder bore by 2.2 mm. (0.087 in.) on a length of 140 mm. (5.5 in.) at its middle, which allowance increases to 5 mm. (0.197 in.) towards the ends. Each piston head carries three rings. The greater part of the total clearance volume of 12 per cent is taken up by a linear clearance of 40 mm. (1.57 in.) between the piston and cylinder head, and this also results in very small harmful surfaces. The pressure oil feeds are arranged at the middle of the cylinder, where the temperature is lowest and little possibility of carbonizing exists. One feed is placed on top and one on each side of 45 deg. below the horizontal center line.

Steam Consumption of Unaflow Locomotive

It is hoped that tests of these locomotives will soon be available and it is expected that they will show unusually high economy in the use of steam. The result of tests of earlier type unaflow locomotives are available and justify the following conclusions: The unaflow locomotive shows better economy than the compound for small loads, while at higher loads its fuel consumption is higher than that of the latter. This can be easily explained by the effect of the long constant compression and the large clearance volume. The unaflow locomotive working with saturated steam shows in general a higher economy than the compound except for long cut-offs. Larger cylinders would be of advantage in this case. The superheater unaflow locomotive is at least on a par with the superheater compound, although even here the former has a slightly higher fuel consumption for heavy loads. Larger cylinders are, of course, more feasible with the unaflow system than with the compound engine.

Future Locomotive Development

In concluding the discussion of the locomotive in his recent book on the unaflow engine, Professor Stumpf makes the following observations on the probable future trend of locomotive design: "With the customary design of firebox, steam pressures up to 16 at. (235 lb.) gage are possible, although the number and size of the stays becomes excessive. For still higher pressures a different design of firebox would be necessary, such as for instance a box of the Brotan type, which permits of steam pressures of 20 at. (294 lb.) gage. By raising the steam pressure from 12 at. to 20 at. gage (176 lb. to 294 lb.), the amount of heat which can be converted into work increases from 116 to 146 cal. per 1 kg. steam. This represents a gain of about 26 per cent.

"This remarkable result can only be attained by employing the unaflow principle, since the pressure at which the steam becomes saturated increases from 2.2 at. (32.4 lb.) to 4.75 at. (69.8 lb.) abs. and during a considerable part of the expansion moisture is therefore formed in the cylinder. This does not have much effect upon the economy of the unaflow engine, but is very detrimental to that of the counterflow cylinder where the moisture causes large surface losses.

"The practice with counterflow locomotives is therefore to use higher superheat with higher initial pressure. The increase in temperature, however, is the cause of many difficulties with piston valves and piston rod packings. Furthermore, the superheater elements must be shortened so that the flue gases do not exert a cooling effect upon the superheated steam. This in turn leads to a great number of superheater elements and inefficient utilization of space. The unaflow engine can of course be adapted to meet this condition in a better manner, since its design makes it more suitable for high temperatures than the customary counterflow cylinder with piston valves. On the other hand there is no necessity for using these high temperatures in the high pressure unaflow locomotive, since the unaflow action corrects the bad influence of moisture in the steam.

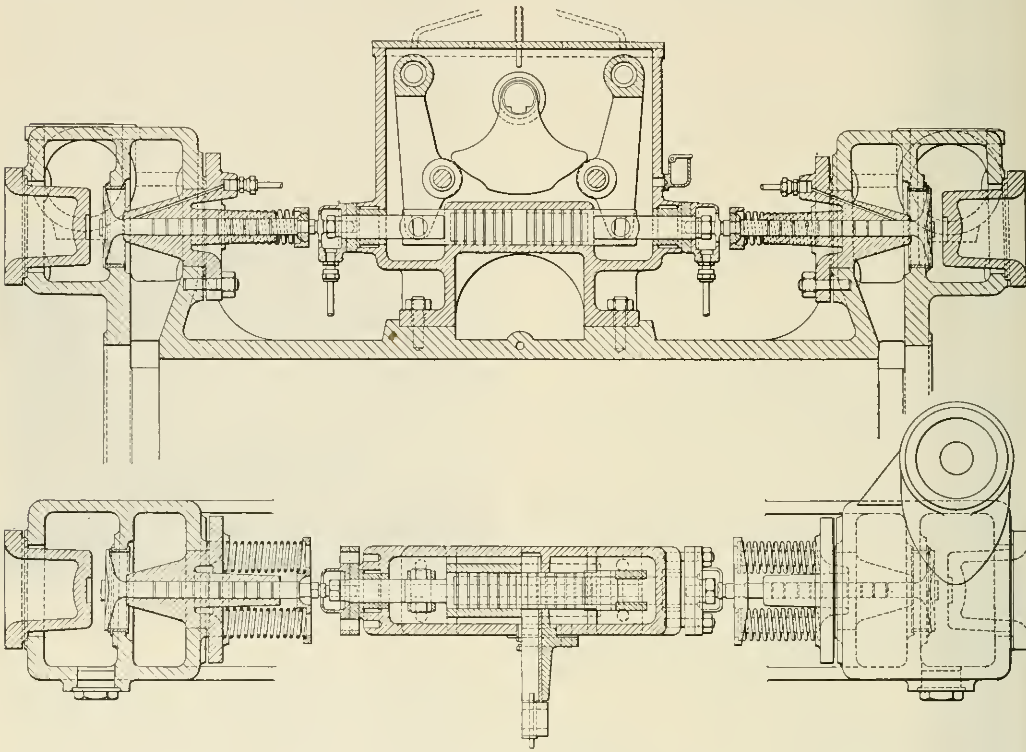


Fig. 7—Details of Poppet Valves and Lifting Mechanism

"The calculated gain of 26 per cent of the high pressure unaflow locomotive with exhaust ejector action will probably be exceeded in practice, since it does not include the benefit due to the single beat poppet valves, the reduction of the clearance volume to seven per cent, nor even the gain due to the unaflow principle itself.

"The future line of progress of the locomotive is therefore clear. It leads naturally from the two-cylinder to the three-cylinder engine with unaflow cylinders having small clearance volumes, to the use of single-beat poppet valves and the utilization of the ejector action of the exhaust, in combination with high pressures and modern superheat."

Modern Tendencies in Locomotive Design*

Need of Increased Economy in Use and Production of Steam; Turbine and Internal Combustion Locomotives Possible

By James Partington
Estimating Engineer, American Locomotive Company, New York

THE types, weights and general details of construction of locomotives have undergone striking changes in the last 20 years. A study of these changes will show in a great measure the modern trend of locomotive design.

Modifications of type may be briefly summarized as follows: Eight-wheel passenger locomotives have been superseded by Pacific and Mountain types; Consolidation freight locomotives have been superseded by Mikado and Santa Fe types, and to some extent by Mallets; four and six-wheel switchers have been, to a large extent, superseded by eight-wheel switching locomotives.

The weight per axle has been increased from time to time as track and bridges would permit so that 60,000 lb. per axle is a common axle load today and 70,000 lb. is sometimes reached.

The boiler of moderate size with a narrow firebox between the frames or between the drivers has been superseded by a modern steam plant with wide firebox above the wheels, fitted with superheater, brick arch, flexible staybolts, feedwater heater, thermic syphons, circulating devices, combustion chambers, exhaust steam injectors, etc.

Stephenson valve gear and slide valve cylinders have been superseded by piston valve cylinders with outside steam pipes and outside valve gears of a number of different types.

Some Prime Requisites

All locomotives should conform to certain prime requisites that may be stated as follows: (1) A drawbar pull that will handle the largest tonnage that road conditions permit; (2) The production and delivery of drawbar horsepower at minimum cost; (3) Careful designing to embody road standards, to meet Interstate Commerce Commission requirements and to keep maintenance charges down to a minimum.

To meet the first requirement all the physical conditions of the road must be carefully studied, the horse power curves of different types of locomotives at the speeds they will have to operate analyzed and the type selected that best fulfills the needs of the service.

Importance of Economy.

In designing locomotives to meet the second requirement, all the devices which make for economy of fuel must be considered. The application of a brick arch in the firebox and a fire-tube superheater are items of general design which have shown noteworthy reductions in coal and water and are being applied in all modern locomotives. The use of a feedwater heater or an exhaust steam injector is a comparatively recent development in American practice although each of these devices has shown marked saving in fuel in European operation. The use of these is now becoming more common on our railroads. On many designs of locomotives the use of a combustion chamber, providing a longer flame-way and an opportunity for secondary combustion before the flame and gases enter the tubes, shows an economy which is available with but slight additional first cost.

A more careful consideration of diameter of tubes as a factor of the length over tube sheets may also be cited. For the best results with bituminous coal the length of the boiler tubes should be approximately within the following limits:—

Out. diam. of tube	Distance over tube sheets
2 in.	18 ft. 0 in. to 19 ft. 6 in.
2¼ in.	22 ft. 6 in. to 24 ft. 6 in.
2½ in.	28 ft. 0 in. to 30 ft. 0 in.

These proportions are based on the evaporative values of tubes of varying lengths and can serve only as a guide in deciding tube diameters, especially for the intermediate lengths not covered by the table where a choice of either of two diameters can be made without sacrificing efficiency. For example, 2 in. or 2¼ in. tubes may be used for a length over tube sheets of 21 ft. unless there are special conditions of draft or fuel which require separate consideration.

The tendency which was frequently indicated after the introduction of superheaters, to curtail the steam space of the boiler, is being avoided to as large an extent as possible in the locomotive of today. Sufficient steam space and a throttle designed and located to deliver dry steam to the superheater are recognized items having an important bearing on the performance of the locomotive.

The type of throttle usually applied now is designed to permit entrance to the boiler through the dome without removing the throttle, thus avoiding the use of an auxiliary or inspection dome.

The boiler and cylinder proportions of modern locomotives are such that extravagant forcing of the fire is unnecessary, the heating surface and the grate area being sufficient to provide the maximum amount of steam required with a coal consumption per square foot of grate per hour not exceeding 120 lb. for bituminous coal, and not exceeding 55 lb. to 70 lb. for anthracite.

Present day locomotives are usually designed to be as large and powerful as the roadbed, bridges and clearances will permit. This makes it necessary to apply automatic stokers to supply the large amount of coal consumed, the limit per hour for hand firing by one fireman being about 6,000 lb.

In connection with the economical production of steam there are a number of other devices coming into use, important among which the following may be mentioned:

The application of two or three thermic syphons; the number depending on the width of the grate. These provide a considerable amount of additional heating surface in the most effective location, *i. e.*, in the firebox, and contribute toward a better circulation of water over the firebox crown.

Another method of improving circulation which has been applied on a number of recent locomotives, embodies the application of a horizontal plate laterally in the boiler shell, located so that about one-half of the tube heating surface is above this plate, the balance below it, causing a lower circulation of water toward the back tube sheet and sides of the firebox and an upper circulation forward.

A generous use of flexible staybolts is noticeable in all modern boilers on account of the noteworthy saving in frequency of inspection and cost of renewals.

On account of the weight necessary to provide for boilers of ample size and the auxiliary attachments necessary for the most economic production of steam, the weight of the machinery parts must be carefully proportioned to keep them down to a safe minimum. This has caused a demand for the

*Abstract of a paper presented April 7, 1922, at the Newport News meeting of the American Society of Mechanical Engineers, Virginia Section.

employment of special alloy steel for many parts subject to severe stress and fatigue.

To secure materials which can be readily repaired or replaced by the ordinary railroad shop the present trend is toward the employment of alloy steels which will give the required additional strength and tenacity without the necessity of heat treatment of these special forgings.

The employment of a booster to gain additional tractive power by utilizing the adhesive weight on truck wheels and the application of cylinders on the tender in a number of cases may be noted as one of the recent developments intended to provide increased tractive power for emergencies, such as short steep grades, starting trains on a grade, etc.

Maintenance Cost Must Be Kept Down

In designing locomotives to meet the third requirement—keeping down the maintenance charges—the engineers of the railroads and of the locomotive builders are giving special attention to the following points:

Careful determination of the stresses in all parts of the locomotive and tender and securing proportions and materials which will withstand these stresses and avoid costly failures in service.

Adoption of designs which will reduce the number of parts as much as possible thus keeping bolted connections to a minimum.

Avoidance of construction which cannot readily be removed for repair or renewal or repaired in place at reasonable cost.

Due consideration of the question of lubrication and making the engine parts accessible for lubrication and inspection. Nearly all bearings on modern designs are arranged for grease lubrication.

Possible Future Developments

Whether the design of locomotives of the future will continue along conventional lines will depend largely on experiments along new lines and the success or failure of such experiments.

The writer believes we will see more successful adaptation of three-cylinder locomotives in which the advantages secured will be greater and the complications of construction will be simplified. Increased efficiency will also be sought by the employment of higher boiler pressures and higher degrees of superheat. To secure higher boiler pressures without entailing prohibitive increased charges for boiler maintenance, a new type of boiler may be necessary. To secure higher degrees of superheat, the changes involved can readily be worked out and adapted as required.

It may be that the merits of internal combustion will be tested out on our railroads, although the complications involved do not appeal strongly to the maintenance departments. Several locomotives of this type are being developed in other countries.

Progress is being made abroad in condensing turbine driven locomotives and the results thus far obtained have been encouraging.

Further improvements in the draft appliances and reduction in the back pressure of exhaust are being diligently sought. The improvement of locomotives from the standpoint of design and operation is a fascinating subject on which much time and study has been expended in the past, is being expended at the present time and will undoubtedly attract as much if not greater effort in the future. The promise of the future is bright. May the accomplishments of the next decade equal, yes, may they exceed what has been attained in the past one.

Discussion

L. D. Freeman, (*assistant superintendent Motive Power, Seaboard Air Line*): An interesting feature in the design of modern locomotives is found in a comparison of the Mountain type locomotive of Seaboard Air Line with locomotive No. 50000 built by the American Locomotive Company in 1910. In 1913 the largest passenger locomotive on the Seaboard Air Line was a Pacific type of 36,000 lb. tractive effort, the maximum permissible wheel load at the time being 47,000 lb. per pair of driving wheels, necessitating double-heading on regular trains.

Based on the proportions of locomotives No. 50000, ten Mountain type locomotives were built in 1914 by the American Locomotive Company having 47,800 lb. tractive power and weighing 209,000 lb. on four pair of drivers, or 52,250 lb. average per pair, which is still the maximum permissible wheel load on that road. After experience with these locomotives five more were built in 1917 and ten more in 1922.

The performance of these locomotives over a period of seven years indicates that the original design was correct and no changes were found necessary in the two repeat orders. It is felt that in view of this performance the statement that the basic principles developed in the design of locomotive No. 50000 were correct is fully justified.

The locomotives in question are successfully operating over a very congested section of single track regularly handling 11 steel cars weighing 75 tons each or 825 tons behind tender at 28 m.p.h. over ruling grades of 1.1 per cent with a maximum speed restriction of 50 m.p.h. over a division of 154.7 miles, making an average speed of 34.9 m.p.h. On the next division under the same conditions the train is handled 202.3 miles, making an average speed of 36.7 m.p.h. When conditions require, these locomotives handle up to 13 cars weighing 75 tons each, or 975 tons behind the tender over the 1.1 per cent ruling grade at 22 to 25 m.p.h. and maintain the regular schedules.

The average fuel consumption in winter months is 120 lb. of coal per locomotive mile with an average of 12 cars per train which takes into account the varying condition of the entire group of locomotives of this class. The first ten locomotives have performed since 1914 a total average mileage of 370,000 per engine, with an average mileage between the general repairs of 95,000 miles and in a few exceptional cases of 180,000 miles, indicating proper design of details.

In recent years many improvements tending to economy in steam production have been made in the locomotive boiler by the addition of superheaters, brick arches, feedwater heaters, mechanical stokers, power grate shakers and improvements in grate arrangements, ash pans and front ends.

Unfortunately the same degree of improvement in the use of steam in locomotive cylinders has not been attained. After nearly a hundred years of locomotive building we have still retained the slide valve, or in cylindrical shape the piston valve, to admit steam to and to exhaust steam from the cylinders, the latter with increased cylinder clearances. The most objectionable feature in connection with the use of a single slide valve or piston valve is the fact that when the valve travel is decreased to reduce the steam cut-off the exhaust closes earlier, causing high back pressure and necessitating comparatively large cylinder clearance space to prevent compression in excess of boiler pressure, which results in considerable loss due to the comparatively low ratio of expansion at short cut-off and early release periods.

Experiments are now being made of applying to a locomotive a valve arrangement consisting of four valves for each cylinder, two for intake and two for exhaust, operated by a modified Walschaert valve motion, the object being to apply the best principles of the four-valve non-releasing Corliss valve mechanism as used in high speed stationary engines to a locomotive, with a view of reducing the cylinder clearance, delaying the exhaust closure to reduce the back pressure and increase the ratio of expansion by providing a constant point of exhaust opening independent of the point of cut-off of the steam inlet valves. While this arrangement is still in the experimental stage it appears to point the way for a substantial increase in steam economy for locomotives.

Advantages of Treating Locomotive Feed Water*

Questionnaire by Master Boiler Makers' Association Outlines Practices Followed on Railroads

IN an address before the New York Railroad Club on April 20, 1917, and the Western Society of Engineers at Chicago, on April 29, 1920, it was estimated that an average of 625,000,000,000 gallons of water are used on American railroads each year and of this amount, 450,000,000,000 gallons are used by locomotives for making steam. Following these figures a little further and taking two pounds per thousand gallons, which is a conservative average of the amount of scale usually found in water supplies, we have the total amount of 900,000,000 pounds, or 450,000 tons of scale annually going into our locomotive boilers, the greater part of which, unless removed by chemical treatment, will adhere to the tubes and sheets.

Quality of Boiler Water

Very few good boiler waters are found naturally and the railroad is indeed fortunate where these possibly can be secured. The proper development of such supply warrants considerable expense as it assures constant good performance in boilers with the elimination of the cost and uncertainty of any treatment.

Water is secured from wells and surface supplies such as streams and lakes. The quality of the well waters varies considerably, even, at times, in wells of close proximity. The well waters as a rule are clear, but similar to the mythical purity of the sparkling spring water, this clearness in most cases conceals unexpected troubles in the shape of dissolved injurious, incrusting salts. Fortunately, the amount and extent of their properties can be accurately determined by short laboratory tests and it is no longer necessary in the development of new supplies to have the engineer wire back to the dispatcher from the next station that water is good and then find it necessary to renew the flues in a few months. Although the dissolved solids are low, streams at most times carry enough sediment and dirt so that there is visible evidence of portending trouble and care is taken accordingly. It is the clear waters that should warrant investigation.

The common constituents carried by water are generally known as "lime," "gyp" and "alkali." The "lime" refers to the carbonates or soft forming scale; "gyp" is applied to the sulphates or hard scale, and "alkali" to the miscellaneous dissolved salts, mainly sulphate and chloride of sodium which do not precipitate at ordinary boiler water concentration. A detailed description would involve a lengthy report in itself and is not within the province of this report.

Treatment to Prevent Scale

A perfect boiler water is one which will allow the tubes to run the full government amount with but a white wash coating of scale, and will cause no delays to locomotives attributable to water conditions, with but minimum attention at terminals. Where impossible to obtain naturally this condition can be approximated by proper treatment as has been conclusively demonstrated. There is no question concerning the advisability of removing the scale with its corresponding trouble, chemically, thereby conserving labor and material for more important needs as well as securing the numerous attendant benefits in the improved locomotive performance.

Interior treatment by means of boiler compounds were probably the first method of water treatment. These undoubtedly accomplished efficient results in many cases. There is no "cure-all" for boiler troubles and it is usually inadvisable to put into boilers promiscuously, compounds of a secret composition except under the direction of a chemist. All compounds have the universal disadvantage of precipitating the scaling solids in the boiler and making a sludge tank out of the locomotive.

Soda ash, the commercial carbonate of sodium, is probably the most common chemical used as a scale preventive. Its action is on the "gyp" or hard scale and similar to the action of boiler compounds throws down the scale as sludge which can be blown out of the boiler. Several large western railroads have obtained remarkable results by the treatment of water in wayside tanks with this material alone and following up the results with chemical tests to see that proper amounts are used regularly. The increased flue mileage has been very marked. It has also been found a big help where used in predetermined amounts direct into boilers or engine tanks at terminals. The disadvantage is the tendency to induce foaming from the suspended matter thrown down in the boiler. It has also caused some disfavor where it has been used without chemical direction in greater or lesser amounts than necessary with the corresponding foaming troubles or lack of scale removal. However, experience has shown that very efficient results can be secured under competent direction.

Plants Designed for Water Treating

Complete treating plants give the most efficient and satisfactory means of handling bad water propositions. In these the scale and injurious impurities are removed and settled or filtered out and a good clear, soft water given to the locomotives. The only disadvantage in this method of treatment is the high initial expenditure, but this is warranted in most cases by the large return on the investment in decreased fuel consumption, increased life of flues, staybolts and fireboxes, reduction in necessary repairs and increased availability of locomotives with the attendant improved performance.

Treatment of water for its foaming qualities is usually in the engine tank with an anti-foaming compound, which is essentially a weak acid emulsion of castor oil so prepared that it will mix uniformly with the cold water in the tank. It is prepared on some railroads by their chemical department, but in most instances, it is purchased as a proprietary compound. It is within the province of this association to call attention to the danger in the use of crude or mineral oils for this purpose on account of the large amount necessary to check foaming and the liability of formation of oil scum on the hot sheets, which is much more injurious than scale of many times the thickness and may result in bagged sheets.

In connection with water treatment as well as railroad water supply in general, it may be well to call attention to the advisability of having the responsibility for the quality and condition of a railroad water supply centered in one department which should work in close cooperation with the mechanical, engineering, maintenance and operating departments and so coordinate the work that the utmost advantage is taken of all conditions, and with constant and effective supervision remarkable results are assured.

Economies Possible With Treated Water

With the advent of the heavy type of power and the large investment involved, the importance of continuous availabil-

*Report to be presented at the 1922 meeting of the Master Boiler Makers' Association, to be held at the Hotel Sherman, Chicago, May 23-26. The committee which prepared this report consisted of T. P. Madden, general boiler inspector, Missouri Pacific Railroad, St. Louis, Mo., chairman, George Austin and E. W. Young.

ity of the locomotives has been accentuated. The brick arch, superheater units, and front end rigging have made work on flues more difficult and requiring longer time. The advisability of so treating the water as to eliminate leaky conditions and avoid tying up this machinery, is generally recognized. Even the best of boiler work cannot eliminate engine failure on the road due to leaks, whereas experience has shown that by water treatment this is but one of the numerous advantages. Much has been said concerning the increase in foaming from the use of treated water and this argument is frequently advanced against such improvements. By proper treatment of the water in a correctly designed softening plant there is but little if any increase in foaming tendency while with compound of soda ash treatment, this tendency can be minimized by judicious use of blow-off cocks without detriment to the performance of the locomotive. Attention is often called to the evident fuel loss from hot water wasted in blowing off, without consideration being given to the much greater saving that is being made by the removal of the insulating scale from the heating surfaces, which far outweighs the slight blow-off loss, in addition to making the large boiler maintenance savings.

Questionnaire on Water Treatment

A questionnaire was submitted by the committee to the general boiler inspectors of the leading railroads and 10 answers were received covering experience and results on most of the territory in this country with the exception of the southeastern section. It appears that the northeastern section is not greatly troubled with water quality, but in the central and western sections waters of extremely bad quality for boiler purposes are frequently encountered and treatment has been applied with good results.

The following is a list of the questions submitted with a summary of the answers immediately following the respective questions:

Q.—Do you use treated feed water in your territory; if so to what extent?

Answers show that waters are treated from occasional application of compounds to as high as 50 percent of regular treatment. There are 125 complete on the Santa Fe, 78 on the Great Northern, 73 on the Missouri Pacific, while some roads have occasional plants and others have complete equipped engine districts.

Q.—Do you treat feed water to prevent formation of scale, corrosion, or foaming?

This developed that in most cases water was treated to remove the scale and in some instances corrosion. Four of the 10 reported all three.

Q.—Is treatment applied to wayside tanks or by direct injection into boilers?

Where water is handled by the complete treatment, this is done in wayside tanks. In some cases of well developed soda ash treatments the chemical is added to wayside tanks. The Chicago, Burlington and Quincy has about 50 percent of its water treated by this method; the Wabash, 118 plants, and development is under way on the Frisco and Alton. Some compounds are applied direct to engine tanks immediately after washouts and others to the engine tanks. In some cases soda ash treatment is handled in a similar manner.

Q.—Do you find that water treatment increases or decreases the mileage between washouts?

Eight of the 10 replies indicated an increase while two advised no change. Where muddy water is treated or soft scaling waters there should be an increase in mileage. Where very heavy "gyp" waters are softened with soda ash or compounds the alkali salts are increased to such extent that more frequent washouts are required unless particular care is taken in blowing off.

Q.—What, if any, has been the increased life of flues, staybolts, and fireboxes since treated water has been adopted by the railroads?

This increase varies from 15 to 300 percent, depending on the character of the raw water. It appears that by proper treatment of the water no difficulty is encountered in obtaining the full government allowance in the life of flues, and in cases where but 8 to 12 months life was formerly secured the increase to three and four years makes a very considerable showing.

Q.—Do you notice any increase or decrease in the pitting of flues or boiler plates since the adoption of treated water?

The answer to this question showed some variation and it would appear that considerable pitting is being encountered. However, on the railroads where complete plants have been installed throughout entire engine districts, we are advised that the decrease in pitting has been very marked.

Q.—Do you notice any increase or decrease in the deposits of scale on the heating surface and do you get the impression that the general performance of the locomotive is better or worse on account of the use of treated water?

The replies were all in accord in advising of a marked decrease in scale deposits and better performance of the locomotives. In complete plants the scale should be practically removed before the water is delivered to the boilers if plants are properly operated, so that in such cases a marked decrease is assured. With soda ash treatment a large part of the scale is precipitated as mud and is blown out so that it will not show up on the tubes and sheets. Advice in one case of compound treatment was that scale was much thinner but harder and more difficult to remove. The only case of no improvement in locomotive performance was where treatment caused increase in foaming tendency of the water.

Q.—What are the benefits as well as injuries from using soda ash direct through the tank of locomotives?

The use of soda ash is a cheap method of reducing the scale troubles and where properly used in correct amounts will greatly decrease scale deposits. However, it has the disadvantage of leaving sludge in the tank and accentuating the foaming tendency of the water with the corresponding complaints from engine crews.

Q.—Have you any experience with mechanical devices for purifying boiler feed waters, either before or after they are taken into the tenders?

No experience given.

Q.—To what extent, if any, does the use of treated water decrease the time of locomotives at terminals?

The use of properly treated water materially reduces the time of engines at terminals in direct proportion to the decrease in leaky conditions with the elimination of the calking and other boiler repairs. This, of course, varies with the quality of the raw waters and makes a large saving in some instances while others are not so marked. Where an increase is obtained in mileage between washouts, this is an additional factor.

Q.—What is the approximate cost of treating water per thousand gallons by methods employed on your line?

Replies showed a variation of from two to 14 cents, but costs were not based upon the same conditions. A chemical analysis of the water will show the amount of chemicals necessary for treatment and the cost can then be readily calculated for individual points from current market prices.

Q.—Will the saving, if any, in cost of boiler repairs due to the use of treated water more than offset the cost of treatment?

The replies where full treatment or soda ash was used were in accord that the saving would much more than offset the cost of treatment, estimates being as high as 200 percent. In two cases where compounds were in use there appeared to be some question.

Q.—Are your locomotives equipped with blow-off cocks; if so, how many and where located?

Number of blow-off cocks varied from one to three. The favorite location appeared to be on each side near the front mud ring corner. However, several were located in the throat sheet and two in the R. B. corner connected with perforated pipe along mud ring.

Q.—What are your instructions to engineers and others in regard to use of blow-off cocks?

The instructions as a rule called for short and frequent blow-off while on the road with longer periods at terminals. Long blow-offs should be avoided. Blow-off cocks should not be used while injectors are working and preferably while the throttle is closed.

Q.—Are blow-off cocks used while on the road and at terminals?

Replies to this question indicated that both are desirable and generally in effect.

Q.—What provisions have been made on your road and at the terminals in the way of blow-off boxes or otherwise to facilitate the use of blow-off cocks?

Many terminals have been equipped with blow-off boxes while convenient locations only are selected for blowing off on the road.

Q.—Are the operating devices of the blow-off cocks so arranged that they can be operated from the cab?

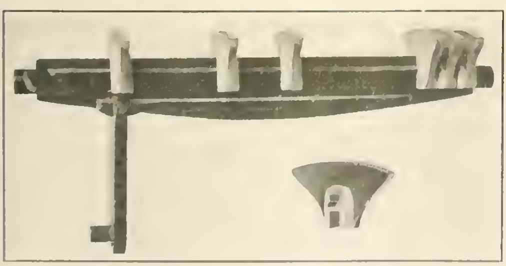
It was generally agreed that this feature was very desirable and had been put into effect in many cases. The tendency appears to be to make such connections.

Q.—Does the use of treated water increase or decrease injector and boiler valve trouble?

There was some variation in the replies to this question, some advising increase and others decrease. In cases where water is properly treated throughout an entire engine district there appears to be a decrease in injector trouble. Where water is improperly treated or raw and treated water is mixed, as well as in the case of straight soda ash treatment, there seems to be an increase of this trouble.

Service of Hulson Grates on the Wabash

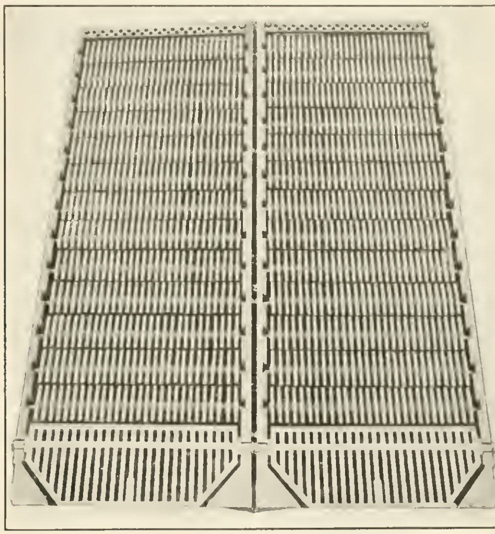
THE types of grates generally used in locomotive fireboxes have probably been subject to less modification than any other part of the locomotive which has to do with combustion and heat absorption. The simplest form of finger bars or table castings still prevail although it is generally recognized that they have well defined limitations as to economy of maintenance, percentage of air opening and restricted removal of ash from the firebox to the ash pan.



Hulson Grate Finger Bar and Fingers

Several years ago the Hulson Grate Company, Keokuk, Ia., brought out a locomotive grate* in the construction of which was embodied a number of novel features designed to remove or materially extend these limitations. This grate was an adaptation of a design which at that time had already met with considerable success in stationary service. This grate differs in construction from the ordinary finger grate in that each grate bar is built up of loose fingers of light section fitted onto a finger bar which sets well below the surface of the grate, so that the openings between the fingers may extend entirely across the surface of each assembled grate instead of being interrupted at the center. This feature makes it possible to secure an air opening equal to 55 per cent of total grate area with 5/8 in. openings between fingers. This is considerably in excess of the maximum draft area obtainable with conventional locomotive grate designs, and tends toward fuel economy.

An equally important feature of the removable finger construction is the possibility of decreased maintenance which it offers. If a finger burns off in service it is replaced by a new one weighing two pounds whereas with ordinary grates it would be necessary to renew a grate bar weighing from 85 lb. to 150 lb.



A Full Set of Hulson Grates for a Wide Fire Box

Consideration of these features, together with a favorable report from another road that had its locomotives equipped with the Hulson grate, led the Wabash to equip a ten-wheel passenger locomotive, having rather limited grate area for the size of the boiler, in January, 1918. The service of the grates on this engine was quite satisfactory, and after about three years the maintenance cost was found to have been less than half the maintenance cost of the standard grates.

It was then decided to equip ten Prairie type freight locomotives. These engines have 54.25 sq. ft. grate area, use Illinois and Missouri coal, and operate out of Moberly, Mo., principally between Moberly and St. Louis. The first of these engines was equipped in December, 1920; the others followed within a few months. Records have been kept of repair costs on these ten locomotives and fuel records are available for all engines in the class.

*See the *Railway Age Gazette, Mechanical Edition*, for August, 1[illegible], page 432.

The fuel records from May, 1921, to December, 1921, inclusive, shows the following results:

Type of Grate	Av. tons per train	100 ton miles	Tons Coal	Lb. coal per 100 ton miles	Decreased fuel consumption per 100 ton miles per cent
Standard	1,300	4,149,415	26,572	12.81	....
Hulson	1,340	2,665,032	16,189	12.15	5.15

Fuel records of engines in local service were eliminated on account of the erratic performance in local freight on the ton-mile basis.

The maintenance costs are not here compared with other grate costs but are presented for use where costs are already known or can be derived from existing records. These grates have only been in service a year, and after several years there may, of course, be a period of somewhat higher maintenance when finger bars need renewal. The repair costs were as follows:

Total repair cost (labor and material) to Jan., 1921...	$116.27
Total grate area..................................	542.5 sq. ft.
Cost of repairs per sq.. ft. grate area per month.....	$.0216
Cost repairs per engine per year....................	$14.06

The Hulson grate fingers roll through the fire bed instead of tearing it, and they are in favor with the firemen because of the ease with which they can be shaken. The fire is kept in better condition on the road, and on long freight divisions the cleaning of fires halfway over the road has been eliminated on these engines. It has also been possible to increase the diameter of their nozzle tips by 1/4 in.

The standard grate on this class of locomotives is of good design, with about 43 per cent air opening, and the additional air opening of the Hulson grate would probably not result in as much fuel saving as on grates with but 30 to 35 per cent air opening. The experience with these engines, however, has led to the conclusion that the reduced maintenance cost alone will make the Hulson grate worth while. At present ten more of the Prairie type locomotives are being equipped and it is the intention to extend the application to those classes of locomotives most susceptible to reduced grate repair cost. The locomotive grates now in service include rocker grate bars only, and while there has been no difficulty in cleaning the fire the plans are to include the Hulson shaking dump grate† in future installations.

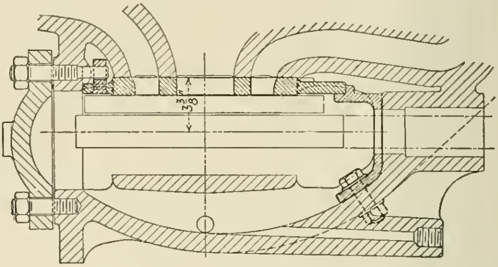
This type of grate has a wide use in stationary power plants and during 1921 the Wabash equipped six 250-hp. boilers in the power plants at Moberly, Mo., and Decatur, Ill. The grates have the good will of the stationary firemen, and there has been a noticeable decrease in fuel consumption and in black smoke from the stacks. It is the intention to extend their application to all large stationary boilers.

Hardened Steel Valve Seat Liners

CONSIDERABLE trouble has been experienced from unusually rapid wear of the valve seats on certain express locomotives of the London, Brighton & South Coast Railway, England. The method adopted by Col. L. B. Billington, locomotive engineer, to correct the difficulty is illustrated in the drawing.

The locomotives referred to are of the 4-4-0 type with 19 in. by 26 in. cylinders, and balanced slide valves underneath the cylinders, an unusually novel arrangement from an American point of view. The boilers furnish saturated steam at 180 lb. pressure. After the locomotives had been in service a comparatively short time the valve seat faces of the cylinders were so worn, due to the soft iron of which they were made, that it became necessary to apply false seats or scrap the cylinders despite the fact that the barrels of the cylinders were in excellent condition.

The use of valve seat liners is not unusual but the method of application here adopted is distinctly a novel one. The frequent lack of success in applying false seats in the past has undoubtedly been due largely to the fact that they have been secured by bolting in such a way that no room was allowed for expansion and contraction between the casting and the plate, with the result that invariably such faces blew after a short period of time. With this fact in mind, attention is called to the drawing from which it will be noted



Floating Hardened Steel Valve Seat Liner

that the false seat is not held in position by bolts or screws but is literally suspended and is practically floating.

It was the intention at first to leave the seats almost free but, after consideration, it appeared that there would be grave likelihood of blowing on account of grit or sediment getting between the faces and, in order to avoid this, the idea was first sketched out of taking the weight of the plate on short, stiff springs so that the plate would always be held in contact with the casting but in no other way secured or prevented from expanding or contracting at will. Unfortunately, due to the restricted space on this type of engine, this scheme was not practical without undesirable modifications and complications. The idea of using springs was therefore given up and the method shown in the drawing was adopted. The three upper studs for the front valve chamber cover are extended to enter holes in three-quarter inch eye-bolts riveted to the front end of the false valve seat. The back end of the seat is carried on a bracket fitted into the valve chest. Both the valve seat and the bracket are made of mild steel, case hardened. The valve seat is 1 1/8 in. thick, this being the amount planed off the valve face of the cylinders.

After being fitted up in 1920 the locomotive was placed in service and up to date there has never been a complaint concerning blowing. The wear of the false seats has been practically negligible and in addition the wear of the valves themselves has been not more than half as great as that of similar valves on engines not fitted with hardened steel valve seats.

In a Letter in the Electrical World, N. B. Hinson, engineer of distribution of the Southern California Edison Company, Los Angeles, Cal., describes how compressed air proved of service in fishing wire through a long conduit. He states that in an installation of street lights in southern California where the runs between outlets were generally 300 ft. and often as much as 450 ft. it was impracticable to use the usual means of fishing the wire through the conduit. Compressed air, however, proved available, and a small air compressor driven by a gasoline engine was used to supply it. This engine was set on a hand truck and employed in connection with a storage tank similar to those commonly found in rural garages. A pneumatic fishing machine was used with a special cord consisting of extra heavy fish line. In addition to the ease of operation, this method had the advantage that all dirt and foreign matter were blown out of the conduit.

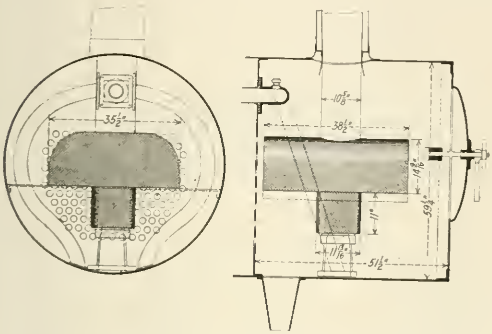
†For a description of this grate, see *Railway Mechanical Engineer*, for November, 1920, page 733.

Spark Arresters for Smokeboxes of Wood-Burning Locomotives

By Dr. Horatio Da Costa
Superintendent of Motive Power, Mogyana Railway, Brazil

Due to the limited supply of domestic coal and the high price of imported coal, the use of wood as a fuel for locomotives is still common on many railroads in Brazil and it will undoubtedly continue to be used extensively for some time to come. The design of a spark arrester which will prevent the escape of sparks and at the same time not interfere with the draft is, therefore, a question of considerable importance.

But little information being available, a study of the subject of arresters to meet the conditions in Brazil was



A Satisfactory Design of Spark Arrester for Wood Burning Locomotive with Low Exhaust Nozzle

made a few years ago by Dr. Jayme de Castro Barbosa, then superintendent of motive power in the Rede Sul Mineira, and the results of the observations were embodied in a book entitled, "Spark Arresters for Steam Locomotives Burning Wood," which was published in 1918. Since this date a careful investigation has been made on the Mogyana Railway of the results obtained from 28 types of spark arresters on as many designs of locomotives. These arresters were built on the general principles advocated by Dr. Barbosa. The form was modified, however, so as to give a curved surface on the top side instead of a flat surface as was used on the Rede Sul Mineira.

Perforated metal sheets were found to give the best results. Of the several types tried, sheets 0.0015 meter (0.059 in.) thick with round perforations 0.0035 meter (0.137 in.) diameter and with openings equal to 44.4 per cent of the surfaces were most satisfactory. In general, the total area of the holes through the spark arrester was in excess of four times the area through the boiler tubes. As a result of the experience with these arresters a ratio of not less than four to one was subsequently adopted as a minimum for all future applications.

The drawing shows the spark arrester as applied to a lot of 16, 10-wheel type locomotives built by Byer, Peacock & Co., England. These engines had 15¾ in. by 20 in. cylinders, 45 in. wheels and carried 150 lb. steam pressure. They weighed 81,600 lb. of which 60,850 lb. was on the drivers, the rated tractive force being 14,700 lb. As the exhaust pipe was of the low type there is a perforated extension reaching down from the main section of the arrester. The total surface of the arrester is 3.0837 sq. m. (33.2 sq. ft.) and the free area 1.3692 sq. m. (14.73 sq. ft.). As the sum of the gas openings through the boiler tubes is 0.2237 sq. m. (2.41 sq. ft.) the coefficient of free area of the arrester is therefore 6.1.

The spark cinders which accumulate in the smokebox should preferably be discharged at stations, but under conditions which exist on certain roads and where stations are long distances apart, it is necessary to discharge the cinders on the road. Formerly the Mogyana Railway ejected the cinders through a cast iron tube extending straight down from the smokebox, the engineman using a jet of steam to blow them out. After the line was rock ballasted and the ties exposed to greater risk of fire, arrangements were made to discharge the extinguished sparks at the side of the locomotive beyond the ends of the ties. The design adopted was a cast iron ejector pipe 23½ in. long with an opening 7 in. by 8½ in. to the smokebox and a hinged cover at the outer end which was 4½ in. diameter. In order to insure the extinguishing of sparks, a pipe connection was made on the back boiler head about six inches below the normal water level, and led to a discharge nozzle in the ejector pipe, the end of this water pipe being reduced to ½ in. The results obtained by this ejector were so satisfactory after two years' trial that the same design has since been adopted by a number of railways in Brazil which are using wood as a locomotive fuel.

Consolidation Freight Locomotive for Huntingdon and Broad Top Mountain

Two of these locomotives have lately been delivered by the Baldwin Locomotive Works. They are designed for coal traffic in western Pennsylvania on a road having 18-deg. curves, 1.86 per cent grades and 85-lb. rails. The locomotives weigh 190,700 lb., of which 170,000 lb. are on the drivers, have a tractive effort of 40,600 lb., cylinders 22 in. by 28 in., 51 in. drivers, boiler pressure 190 lb., evaporative heating surface 2,237 sq. ft., superheating surface 503 sq. ft. and grate area 46.7 sq. ft.

WHAT OUR READERS THINK

Lack of Efficiency Not Due to Foremen

PRESCOTT, Ariz.

TO THE EDITOR:

Under the caption, "A Workman Expresses Himself," your issue of April, 1922, contains a letter from "Mechanic," in which he seeks to charge the greater responsibility for the existing lack of efficiency in maintenance of equipment to the incompetence of minor foremen rather than to the mechanics who perform the work.

"Mechanic" evidently had in mind some provoking cases of engine failures due to rushing engines into service with repairs partially completed when he wrote his letter and hastily concluded that such was common practice. Foremen sometimes take a chance of that kind under pressure of conditions that the mechanic in the roundhouse is not familiar with and may even take such a chance with no better excuse than to make good his promise to the master mechanic to get an engine out on a certain date as "Mechanic" states, but if engine failures repeatedly occurred under the latter condition, he would be a very poor foreman indeed who persisted in the practice, and he would certainly have to be some genius or be responsible to a very indifferent master mechanic to be able to pull the wool over his eyes very many times on such a performance. It is well known to all practical railroad men that decreased efficiency and increased cost in the maintenance of equipment is much further reaching than any number of cases of poor judgment by minor foremen could account for, and are too serious in character to be much improved by the mere adoption of suggestions from the mechanics on the work as your correspondent seems to want.

The fundamental reasons for the low efficiency of the past three years is to be found in the changed attitude of mechanical employees in general toward the companies for which they work and to the large number of incompetents who have been classified as mechanics in that department. The avowed anxiety of "Mechanic" to criticize officials is one evidence of the changed attitude, but is by no means the worst. Others are the prevailing indifference of workmen as to the amount and quality of the work they do; the lack of interest in output; the endless carping about the rights of certain crafts to certain work; the classifying of many of the simplest operations which any unskilled laborer could do as mechanics' work; the decline of the spirit of loyalty to their employing company and the everlasting effort to show that they have conflicting, instead of common interests.

These are some of the reasons for the sad decline of efficiency and increased cost of the motive power department as compared with pre-war times and the foremen who have to contend with these conditions, get results and keep peace with professional hair splitters on agreement rules have a hard row to hoe and are entitled to more credit than "Mechanic," is disposed to give them when he proposes to criticise them off the job.

I think too that superintendents of motive power and master mechanics who do not hold their foremen responsible for the prevailing lack of efficiency instead of having the wool pulled over their eyes are showing a much fairer appreciation of the difficulties of the foreman's position than your correspondent is in a position to form.

SUPERVISOR.

Two Unique Locomotive Designs

CHICAGO.

TO THE EDITOR:

I have read with great interest your article "Turbine Characteristics and Design of Turbo Locomotives" in the February number of the *Railway Mechanical Engineer* and am wondering if it is good policy for American engineers to consider European tendencies along this line before the possibilities of the reciprocating engine have really been exhausted.

I have had in mind for some time two modifications of locomotive design.

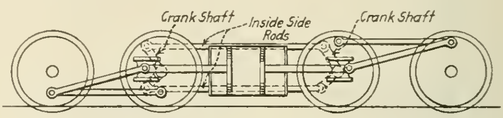


Fig. 1

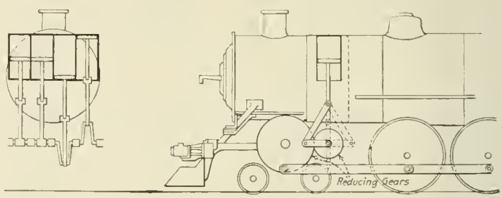


Fig. 2

The first design in my opinion would be most applicable to freight locomotives and would give the power of a four-cylinder engine with only two cylinders (four pistons, however). The stresses caused by the reciprocating parts would be taken care of by the frame and cylinders, but the forces would tend to neutralize each other and not cause nosing. The only departure from present designs would be inside side rods to keep the two pistons in one cylinder in their proper relative position. A silent chain drive might answer but a crankshaft and side rod seem more reliable, especially when the unavoidable movement of the axles or shafts is considered. Fig. 1 is a rough sketch of what I have in mind and shows the relative positions of cylinder, pistons, wheels and rods.

The second design seems most suitable for passenger engines and is simply a modification of the logging engine with cylinders at the side and bevel gear drive on the axles. However, I propose to mount four cylinders (two high pressure and two low pressure perhaps) in the smoke box, so as to avoid cylinder condensation and also get a superheating effect. As reducing gears have reached a high degree of mechanical perfection, it is feasible to design this four-cylinder (perhaps three would appeal to some designers) engine as a self-contained, automatic-lubricated, high-speed engine, geared in a suitable ratio to a drive shaft from whence the motion would be transmitted by side rods to as many axles as desired. Fig. 2 is a rough outline of this idea.

ROBERT HOFSTETTER.

Contract Work and Apprenticeship

Thomas, W. Va.

To the Editor:

In one of the issues of your magazine the question was asked: What can be done to stimulate interest and induce more apprentices or helpers to become A-1 mechanics?

I may answer this by asking a question. Does or will the contracting of all car shops, roundhouses and maintenance of equipment, with a view to reducing the wages, help to get more helpers, apprentices or helper apprentices to take up the trade, with the idea of completing the course for an A-1 mechanic? The final answer to the question is, it cannot and never will help the situation a bit, and will tend only to demoralize the men and put a damper on not only the mechanical department of the railroads, but on other departments. Is this not true?

Samuel F. Plyler.

Why Freight Cars Jump the Track

Springfield, Mo.

To the Editor:

Several years ago I had occasion to investigate the cause of a number of railroad wrecks. In most cases these wrecks were of freight trains though occasionally a passenger train was derailed. Moreover, when a passenger train was involved, it frequently happened that the Pullman cars stayed on the tracks. The greater frequency of freight train derailments and the rarity of a Pullman car leaving the rails caused me to wonder if the cause did not lie in some material differences in the design of the trucks. In pursuing the investigation, I quickly discovered that whereas the gage of the tracks is 4 ft. 8½ in., the distance between the centers of the wheels or the wheel base of the trucks under freight cars was often 5 ft., occasionally only 4 ft. 10 in. and rarely over 5 ft. 6 in. even on heavy modern equipment; this distance was 10 ft. 6 in., or 11 ft. on Pullman cars. The shortness of freight car trucks is, I believe, a sufficient explanation of the cause of many derailments and wrecks.

Another point to be considered is the friction of the center plates. When a truck approaches an uneven place in the track, the friction on the center plate hinders the truck from turning and when it does turn it goes with such a jerk that the flange of the wheel strikes the rail with a heavy blow. This at times causes a piece of the flange to break out and at other times the flange climbs the rail and wreck occurs.

I can see no relief from the numerous freight wrecks with the attendant losses, until the length of the truck or the wheel base is increased to at least one and a half times the gage of the track or to 7 ft. In addition trucks should be equipped with roller or ball bearing center plates.

C. H. Whitmore.

Boiler Explosions Not Caused by Water in Spheroidal State

Ghent, Belgium

To the Editor:

The January issue of the *Railway Mechanical Engineer* mentions a novel explanation of a locomotive boiler explosion, which is not very novel and of a hypothetical character disproved by facts.

Some 35 years ago, two French engineers, Detwarte (1886) and Witz (1892), made a set of experiments in view of determining the possibility of the spheroidal state of the water in practical boiler operation. The conclusions of their experiments were: (1) The spheroidal state of water is a phenomenon obtainable only with a very limited amount of water; a single drop of a pound weight was the maximum ever obtained in a laboratory. (2) Whenever the quantity of water present in a boiler is of some importance, a few cubic feet, the water fed on the red hot crown sheet of a locomotive firebox does and cannot give rise to the phenomenon, the spheroidal drops if any—and none were detected by the most minute investigation—would lose the spheroidal state instantly when coming in contact with the mass of water. The explanation of Mr. Calthrop is at least 40 years old and Witz' experiments 30 years ago have exploded the spheroidal water hypothesis instead of the boilers.

This suggestion, same as the "superheated water" are very problematic. It should be remembered that after an explosion of a severe character, it is often impossible to ascertain the real causes, hence recourse to hypothesis more or less fanciful of which the least that can be said is that they destroy the faith of the user in his boilers, and stoker or engineer are continually under the Damocles' sword of an unforeseen spheroidal state against which contingency they are unarmed and powerless.

Agreed that the explosion of a high pressure boiler can be compared to that of a blasting charge. According to Hirsch, the mechanical effect is proportional to the energy liberated by the hot water passing from the working to the atmospheric pressure. Adiabatically expanded a ton (2,240 lb.) of water at 210 lb. per sq. in. and a temperature of 390 deg. F. liberates an energy of 25,000 ton-feet.; released in one second this energy represents nearly 100,000 hp. and is of the same order of magnitude as the energy liberated by the firing of a 60 lb. charge of blasting gelatine. The severity of the explosion and its dynamic effects can be gaged by the above comparison, and the usual locomotive boiler contains a good deal more than a single ton of water. The cause of those mysterious explosions is very likely a hidden defect in the boiler itself, a defect which the usual official proof does not detect and may even provoke, but to investigate completely the latter point is beyond the scope of the present article; let it be mentioned that it is an unfortunate practice to ascribe to unverified hypothesis boiler explosions due to cause unknown by lack of careful inspection and maintenance.

A. Montangie.

Rough-Riding Passenger Cars

Small Town, N. Y.

To the Editor:

Nowadays the aim seems to be the building of a ponderous car to withstand collision but with no thought as to comfort. As I sit in one of these battering rams and try to divert my thoughts from the vibration, caused by the poor riding qualities of the trucks with their short plate springs and no auxiliary coil springs, I wonder how much of my fare is absorbed by a car weighing 75 tons instead of 50 tons of the coach of 20 years ago. The thought comes that in automotive engineering, steel has been substituted for wood, without any increase in weight or decrease in strength; that the tendency has been to build motor cars lighter; that the lesser weight has been accompanied by better riding qualities through better suspension; that, although collisions with other vehicles and with trains at crossings occur, often with serious fatalities, the automobile is not built armored for these occasions.

On the other hand, when I travel in an English passenger coach 70 ft. long and weighing less than 40 tons, I appreciate how comfortably it rides, how all the shocks and noises are deadened. The reason is that the designer deliberately tried to do it. The wheels, for instance, have a wooden filler between the hub and rim; the long wheelbase of the truck, the long springs making contact with the truck frame through rubber blocks all contribute to the desired end. We frequently criticize the British for not profiting by our methods of handling freight. Why don't we profit by their way of handling passengers?

W. G. Landon.

THE QUESTION BOX

Grease Lubrication of Tender Truck Journals

Question.—Can a locomotive tender truck journal be run successfully with hard grease lubrication instead of oil and wool waste? A. GIANNELL.

Answer.—Many attempts have been made to use hard grease for the lubrication of journals on tender trucks, trailers, and freight and passenger cars but they have never been entirely successful. Trailer trucks and car journals have been lubricated quite well with grease where the pressure was low, but with bearing pressures of 150 lb. per square inch or over, grease will not lubricate the journals properly.

It is true that hard grease is used successfully on locomotive axles which carry very high pressures and it might seem that it should be suitable for heavily loaded car journals. The reason that it is not successful on cars is that the bearing pressure is distributed differently. In a locomotive driving axle the axle is always pulling the box and there is an opening between the rising side of the axle and the bearing which allows the grease to enter. On a car the box is pulling the journal and the pressure is greater on the rising side of the journal and tends to wipe off the grease, preventing efficient lubrication.

Copper Fireboxes and Fuel Economy

Question.—The railroads of this country have been giving careful consideration to fuel conservation and it seems strange that more attention has not been devoted to possible savings through the use of copper for fireboxes. The heat conductivity of copper is 534 per cent more than steel and it is to be wondered at that some of the American railroads have not taken advantage of such an apparently efficient fuel conserving method of converting water into steam. Inasmuch as European roads are using copper fireboxes, is there any reason why they should not be adopted in this country in view of the large saving of fuel that should result?—L. G. F.

Answer.—It is true that copper fireboxes would have decided advantages over steel if the ratio of heat actually transmitted was the same as the ratio of conductivity of the metals. However, in a boiler the rate of heat transferred to the water depends on the surface resistance on the outside of the plate, the resistance of the plate itself, the resistance of scale on the inside of the plate, and the surface resistance or film resistance on the inside of the scale. Since the limiting factor is usually the amount of heat that can be passed from the gas to the plate or that can be conducted through the scale on the inside of the plate, the actual amount of conduction through plates of steel and copper varies very little.

These conclusions are borne out by tests of the relative fuel consumption of locomotives with steel and copper firebox sheets. The Pennsylvania Railroad conducted comparative tests at Altoona a number of years ago which led that road to abandon the use of copper sheets in fireboxes. The Paris, Lyons & Mediterranean Railroad in France also found that as regards heat transmission there is no difference between similar locomotives whether the fireboxes are of steel or copper. The only reason copper has been retained in service in Europe is because steel fireboxes gave more trouble from cracking due to the use of cold water for washing and filling the boilers. Hot water washout systems are now being installed and European railroads are adopting steel for firebox plates.

AIR BRAKE CORNER

Why Does Cross Compound Air Compressor Stop?

Question.—What is the matter with a cross compound pump which will stop when the engine is worked hard? When the engine is worked easy over the levels the pump runs all right, but when going up heavy grades and the train is pulling hard the pump stops dead still. This engine did not steam and the nozzles were bushed down to make a harder pull on the fire.—C. D.

Answer.—You do not say whether this compressor is of the high pressure or low pressure type; that is, whether built for 200 lb, or 160 lb. boiler pressure. Neither do you say anything about the pipe connections. Some of these details will have to be assumed in order to make a reply. We will assume that the compressor is built for 200 lb. steam pressure, also that the exhaust pipe of the compressor is tapped into the exhaust port of the cylinder saddle. With these assumptions and the engine working hard on the hill, and the steam pressure perhaps dropping down a few pounds, the back pressure of the engine exhaust steam in the cylinder saddle backs up through the compressor exhaust pipe and increases the pressure on the exhaust side of the steam pistons of the compressor. This, plus the resistance of the air pressure in the air cylinders, more than equals the pressure on the live steam sides of the compressor pistons. Under these conditions the compressor would stop, particularly as you say the engine did not previously make steam freely and the exhaust nozzles were reduced down to produce a stronger draught on the fire and make more steam.

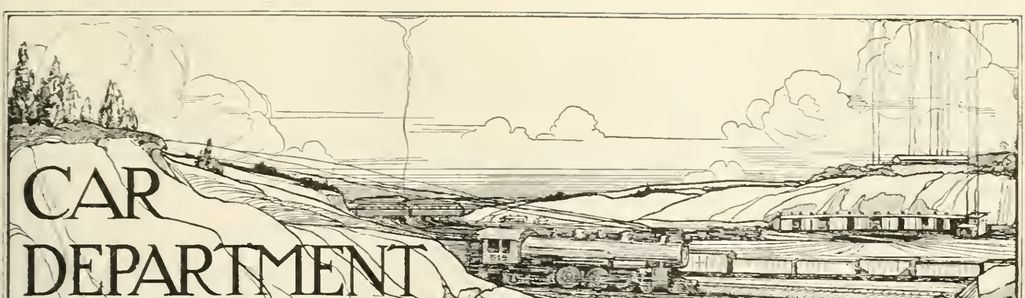
Early Applications of Pneumatic Brakes

Questions.—1. When were air and vacuum brakes first applied to railroad equipment?

2. To what extent were air and vacuum brakes applied before their use was required by law?—S. B. C.

Answers.—1. The first pneumatic brake was a vacuum brake patented by James Nasmyth and Charles May in 1844. In 1848 Samuel B. Lister patented an air brake similar to the straight air brake, except that it was designed to be operated by the guard or brakeman and not by the engineer. The Westinghouse straight air brake was brought out in 1869 and first applied to a Steubenville accommodation on the Panhandle railroad, now a part of the Pennsylvania System. The Westinghouse air brake was first applied to a Steubenville accommodation on the Panhandle railroad, now a part of the Pennsylvania System. The plain automatic brake was invented in 1872 and the Smith vacuum brake in the same year.

2. In 1896, 98 per cent of the passenger cars and 29 per cent of the freight cars in this country were fitted with brakes.



Some Pullman Dining Cars Used in England

Railways Operate Their Sleeping and Parlor Cars: Pullman Cars Mainly of Dining or Buffet Type

THE term "Pullman" conveys a distinctly different meaning in England from what it does in the United States. An American thinks of a Pullman as primarily a sleeping car, sometimes as a parlor or chair car and occasionally as a dining car. An Englishman does not associate the term with sleeping or parlor cars as the railways themselves own and operate such cars where there are long runs, as on the northern roads from London to Manchester, Liverpool or Glasgow, the latter of which is about 400 miles away. There are, however, a number of Pullman dining or buffet cars in service on a number of roads. The London, Brighton & South Coast, the South Eastern & Chatham and the Great Eastern have recently received new equipment which is to be used mainly on short runs of from 50 to 60 miles between London and the coast resorts.

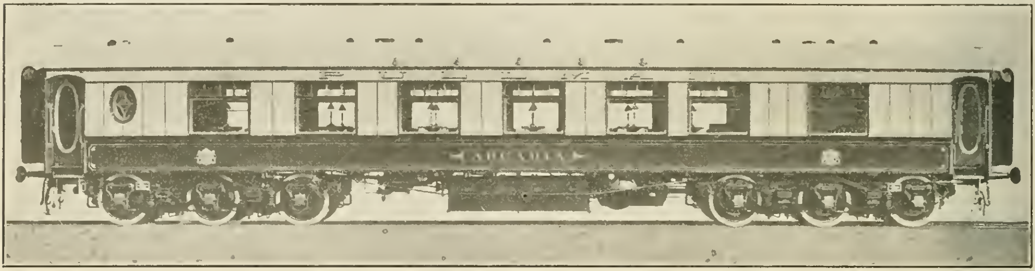
These cars are fitted with movable chairs and tables. Seats are subject to reservation and distinctly limited. The rates, however, are exceedingly reasonable, the charge for a seat being about 50 or 60 cents for a trip. One may occupy them simply as a chair car without ordering food although tea, something to drink or a regular meal are supplied if desired. In conformity to the demands of English customs, both first-class and third-class cars are provided. The illustrations showing exterior and interior views as well as floor plans convey a good idea of the general character of British Pullman cars. All those illustrated were built by the Clayton Wagons, Ltd., Abbey Works, Lincoln, England.

The cars used on the Great Eastern are 63 ft. 10 in. long over vestibules. The extreme width is 8 ft. 10 in. and the height 12 ft. 6 in. They are carried on six-wheel trucks

First Class Pullman Dining Car on South Eastern & Chatham with 12 ft. wheelbase, spaced on 41 ft. centers. The wheels are 3 ft. 6⅞ in. diameter and the journals 4 in. by 9 in. The first-class cars have accommodations for 21 passengers, the main saloon next to the pantry seating nine and the other large saloon eight, while the private compartment is arranged for four passengers. Removable tables with glass tops are provided throughout and where more than two passengers are served an extension is arranged to these tables. In the large saloon a handsome cabinet surmounted by a clock is fitted against the cross partition adjacent to the pantry. Each passenger has a luxurious arm chair especially designed to afford a maximum of comfort. Both an exterior and an interior view of one of these cars are shown in the photographs.

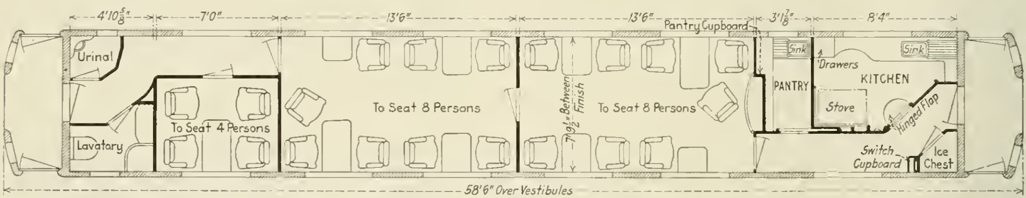
The third-class cars are of the same size and exterior appearance but are designated by numbers instead of by names. The interior is divided into two large compartments, one seating 24 and the other 23 passengers. The seats near the aisle are arranged to tip up so as to afford easy access to the fixed seats against the body sides. The majority of the seats are arranged in a group of four around a table. Third-class Pullmans are a recent innovation in England but are proving extremely popular.

The cars used on the London, Brighton & South Coast and on the South Eastern & Chatham are similar in design. They are 58 ft. 6 in. long over vestibules, 8 ft. wide over all and 12 ft. 6½ in. high. The trucks are built entirely of steel and of the four-wheel type, with 9 ft. wheelbase and spaced 41 ft. between centers. Semi-elliptical bearing springs with auxiliary rubber springs are used above the axle boxes and coil springs on the bolster. The general arrangement of the trucks will be noted in the illustration. The equipment consists of both first and third-class cars. The weight of the first-class cars is 73,400 lb. and of the third-class 72,575. The first-class cars are arranged with two compartments, each seating eight persons, and a small private compartment for four persons. The third-class cars are divided into two compartments, one seating 23 persons and the other 24. The arrangement of kitchen and seats for both classes of cars is shown in the illustrations; also an interior view of one of the third-class cars.

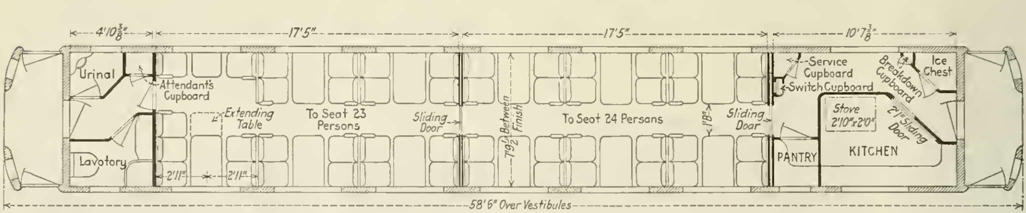


First Class Dining Car on Great Eastern

Bodies and underframes formerly were constructed as one combined unit, but on later cars are built as separate units. The underframes are of steel. The bodies are framed of pitch pine, teak and ash and are strongly braced to prevent racking. In order to reduce noise to a minimum and to improve the riding qualities, a number of specially designed body cushions have been introduced between the body and the underframe. Specially selected mahogany is used in the exterior framing, panelling and sheathing .



Floor Plan of First Class Pullman Dining Car on South Eastern & Chatham Railway

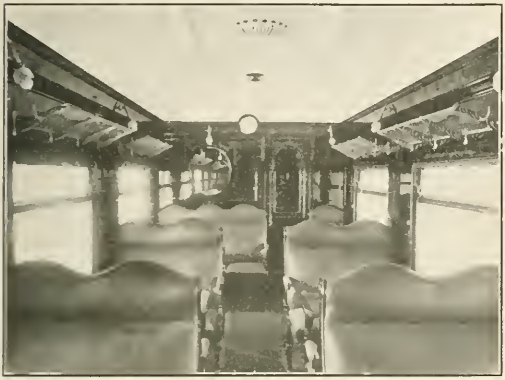


Floor Plan of Third Class Pullman Dining Car on London, Brighton & South Coast Railway

Couplers and buffers are of the general type commonly used on English roads. It is interesting to note, however, that provision has been made for the substitution of automatic couplers and the necessary modification of vestibules if such should be found necessary at any future time.

Special attention has been given to securing efficient ventilation, torpedo air extractors and electric fans being liberally provided. In this connection attention is called to the fact that the upper windows are arranged to slide sidewise. The Stone system of electric lighting is used. The adoption of a dead white ceiling, coved at the sides and ends and treated with enriched moldings together with the disposition of the lights, results in very effective lighting and a pleasing appearance. Table lamps are also provided in the first-class cars. Water is carried in roof tanks, wrapped in felt.

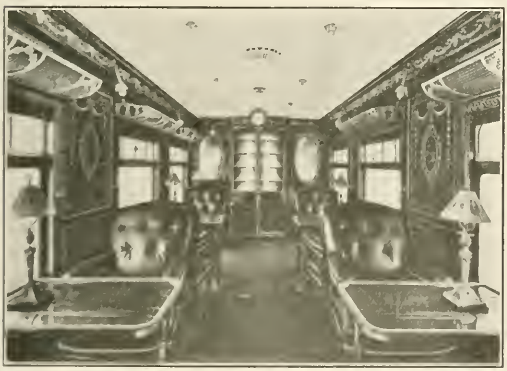
The equipment of kitchen, pantry, ice chest and cupboards is complete and well arranged. Cooking is done by gas. Each car carries three cylinders which hold enough gas to



Double Seats are Used in Third Class Dining Cars on the London, Brighton & South Coast

answer for several hours supply. The floors in the kitchen and pantry are covered with "Decolite," while those in the vestibule and toilet compartments are covered with interlocking black and white rubber tiling.

The brake equipment varies on different roads. On some



The Interior Finish In the First Class Dining Cars on the Great Eastern Is Unusually Artistic

lines the vacuum brake is used and on others the air brake is standard. Owing to this difference it is necessary to equip cars with both types of brakes if they are to be used on runs over two roads which use different kinds of brake apparatus

One of the most noticeable features of the recent English Pullman cars is the unusually pleasing and artistic decorative schemes employed in the interior finish and furnishings. Special care has been taken to give an individual character to different cars. As an example, the following finishes were used in five first-class cars on the Great Eastern:

The first car is the Arcadia in which a specially beautiful effect is obtained by quartered panelling in plum-pudding mahogany tastefully inlaid, the chairs being upholstered in green buffalo hide and the carpets also being in green. The Corsair is panelled in richly figured, mottled and fiddle backed mahogany, and also has green chairs and carpets. The Catania is finished in diamond stripe mahogany and has red carpets with the chairs upholstered in red buffalo hide. The Cambria is panelled in curl mahogany with green chairs in buffalo hide and the Ansonia is finished in pear wood and has blue carpets, the chairs being upholstered in blue buffalo hide. Similar schemes are used in cars for other roads. Even the second-class cars have an individuality of finish.

Motor Cars on the New Haven

In a discussion at a recent meeting of the New York Railroad Club, W. L. Bean (N. Y., N. H. & H.), referred to the use of small self-propelled units in place of steam trains where runs are short and traffic light and unremunerative. He pointed out that there are two fields for these cars, short line runs and branch lines of larger roads. The requirements of these two classes of service are different and care should be taken to make sure the equipment is suitable. It is also necessary for railroad officers to understand definitely the limitations of power available in a gasoline engine, which differs from a steam engine and must not be overloaded. For this reason, grade, speed and weight per horsepower must be carefully considered. At this time it is best to keep on the safe side and not overdo the application of internal combustion engines as this might cause a serious setback in the development.

Mr. Bean discussed the operation of the cars which are now in use on the New Haven. The equipment has only been in service since January 3 and it is impossible to state definitely what the results will be in maintenance, depreciation or reliability, but it is felt that it will be satisfactory in these respects. One of the cars is now making two round trips a day on a 15-mile branch, making a schedule speed of 25 miles an hour with three stops. The car has made 1,437 train miles, carrying from 3 to 38 passengers, the average being 21.2 passengers per trip. The average delay has been 1.3 min. per trip. A second car is making 137 miles a day, the schedule varying from 19 to 23 miles an hour, with five to eight stops. It is carrying from 10 to 66 passengers, the average being 27.2 passengers per trip. The average delay has been 1/5 min. per trip. The third car is making 146 miles a day, the schedule varying from 20 to 26 miles an hour, with three to twelve stops. The car covers six separate trips in a day on lines with grades varying from level to 100 feet per mile. It has carried from 10 to 73 passengers. The average delay has been 1.2 min. per trip.

As a result of the experience up to this time, Mr. Bean is confident that very large economies are available by the use of motor cars. The development will no doubt be rapid and should be directed along sound engineering lines to avoid the building of unsatisfactory equipment. He pointed out that standby losses and the cost of coal and ash handling and attendance at terminals must be considered in comparing steam operation with motor trucks as the gasoline-driven equipment will save large amounts in these items of expense.

Railway Workers of Lemberg, Poland, recently received from the American Relief Administration 50 outfits of clothing for the children of the poorest workers. Out of gratitude the railway men who were in better financial condition collected the sum of 1,350 marks and presented it to the Administration to use as they saw fit. It was used to cover the cost of sewing clothing for orphans in different institutions in Warsaw.

Delayed by a Hot Box

Present Lubrication Methods Faulty

Positive Mechanical Oil Feed Would Reduce Friction and Wear and Minimize Equipment Delays

By J. J. Hennessy

ANY reduction of resistance to train movement by better lubrication would have a direct bearing on coal consumption per unit moved, with an indirect bearing on train operation in general and maintenance expense. Delays because of hot boxes, and the labor and material costs involved in bearing and journal renewals, would be correspondingly reduced.

Advantages of Better Lubrication

Some tests to determine resistance to car movement have been made by the Pennsylvania Railroad and reported in Bulletin No. 26. Among the resistances considered are rolling resistance of wheel on rail (influenced by type and condition of track), flange pressure on rail, wind resistance due to speed, curve resistance and grade resistance, none of which resistances can be reduced by better lubrication of journals. It is safe to assume that track and equipment conditions, as well as the condition of packing in boxes were ideal, or in other words that the journals were lubricated in a manner superior to that obtained in ordinary railway practice. Tests with ball bearing journals on railway equipment, the improvement effected being confined entirely to eliminating resistance due to journal friction, have shown such a decrease in effort required to pull cars as to prove that about one-third of the resistance to car movement on good, ballasted level track is due to journal frictional resistance. It would seem from the figures reported in the test that six pounds per ton is required to move what might be considered an average loaded car on level track, or that six pounds per ton would be a fair figure to consider as necessary to pull an average car, considering the number of empties moved and the average loadings of box cars.

Amount of Journal Friction

The test figures show resistance to movement of light loads and empties to be much greater per ton than with heavily loaded equipment, which further proves that resistance other than journal resistance is of small consequence. Taking two pounds per ton as the resistance due to journal friction as a basis, the coefficient of friction is easily twice as high as under the most unfavorable (wick fed) method in the laboratory. If a method more nearly approximating what should be expected of bath lubrication as shown by laboratory tests is used the journal resistance will be reduced still further. More cars can be hauled and as small a number as three cars added to each freight train of normal size means a considerable increase in revenue per train to say nothing of the decrease in maintenance cost on all cars.

Expense attributable directly to hot boxes on all classes of equipment is enormous and an investigation of the expenditure due to, or resulting from, hot boxes on any of the larger systems would show great possibilities of saving by reducing this trouble alone.

A comparison of the lubrication of railway equipment bearings with the bearings of other heavy machinery is almost impossible, due to the crude method of lubricating railway journals and the conditions under which these journals operate. In spite of this fact, when the number of journals that are in service, their loads, operating conditions and the uncertainty of lubrication are considered, the comparatively small amount of trouble experienced is amazing. The success attained with the present methods is made possible by the constant attention of highly trained specialists and the unremitting perseverance of a large number of railway employees. The cost, however, is proportionately large and journals demand a much greater proportion of attention in relation to other matters pertaining to train operation than they should. It would pay to make a serious effort to bring railway journal lubrication up to a status requiring no more attention and expense than the lubrication of ordinary machinery bearings.

Oil of the Right Consistency Needed

Oil of a certain consistency is required by the present method of supplying lubricant to journals by waste feed, to insure its feeding in sufficient quantity under all atmospheric conditions. This requirement limits the lubricants to oils not always most satisfactory from a strictly lubricating standpoint. The constant disturbing of the waste by a large number of operatives, which is absolutely necessary in severe service, also increases the liability of failure and the application of oil directly to a journal does not seem to reduce this liability. With the best attention possible and the use of all the oil permissible with the present method of application, it is absolutely impossible to avoid a great deal of hot box trouble on the heavier equipment in severe service.

The inadequacy and the unreliable nature of the present method is most noticeable on equipment moving the greater portion of the time under heavy loads. Lubrication failures or hot box troubles develop on this equipment with the greatest frequency, although the inadequacy of the lubrication afforded is proportionately as great on journals carrying less loads a greater portion of the time. The tendency of these journals is to heat when placed under full load, and journal resistance is increased.

An improvement in the method of applying lubricant to such a point that oil of any desired body could be furnished to journals under all conditions, entirely independent of the capillary action of the waste in the box, would reduce the running temperature of journals under heavy load. Little tendency to heat would be noticeable, or if there was heating, it could be detected by a casual inspection and remedied before the box became hot enough to damage the bearing.

A great deal of expense is incurred by giving unnecessary attention to bearings in severe service as a result of the inability of the inspectors to determine exactly which journals are lubricated properly or which are in need of attention. The expense necessary to lubricate railway journals successfully has become accepted as unavoidable, and about the only remedy applied where trouble is experienced seems to be to increase the number of operatives giving journals inspection and attention, without any definite plan of procedure to remedy the trouble. Some positive mechanical means of supplying the lubricant to the journal should be provided and arrangements made for ready inspection. In this way the exact condition of journals can be determined and the efforts of the inspectors will not be nullified because of the impossibility of carefully inspecting all journals.

Business Handicaps of the Railway Car Shop

Lack of the Incentive of Competition—Limitations on Specialization—Absence of Cost Control

By J. W. Roberts
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IN a series of articles which recently appeared in these columns the present writer reviewed the results of a special study of the relative cost of making heavy repairs to freight cars in a railroad shop and in a contract shop. In the case reviewed the cost of the work done in the outside shop was found to be less than that done in the railroad shop, but the question may quite properly be raised as to whether this result is typical, or may not be due to special conditions not generally prevailing.

We know much more of the cost of contract shop work than of railroad shop work. In the former case the volume and the quality of work performed for the money paid out is definitely established by contract and is measurable. In the case of the railroad shop, however, we have, generally speaking, no reliable information either as to the total actual cost, the volume or the quality of the work turned out. Since railroad accountancy does not recognize the cardinal principle of cost accounting—that expense should follow the benefit conferred or the causative responsibility—the ascertainment of dependable railroad shop costs is a difficult undertaking. The question, therefore, cannot be answered by the simple process of demonstration, and we shall be obliged to satisfy ourselves by an analysis of the general situation.

Railroad Manufacturing Ventures

It is often contended that a common carrier strays outside its bailiwick when it engages in manufacturing enterprises. Manifestly a railroad should engage in manufacturing effort, if it be foreign to its nature, only for very good reasons. One good reason would be, for instance, the advantage of definite and enduring economies, if they are thus to be gained. Another would be necessity imposed by isolation from manufacturing centers, or the difficulty attending any other than an internal source of supply. The genuineness of the necessity can be readily tested, but where economy is the motive it is more difficult to determine whether appearances may be relied on and, if so, for how long a time. How many railroad manufacturing establishments are strictly necessary adjuncts or are definitely known to be paying their way? Most such enterprises live, it is believed, by grace of the management's tolerance.

Railroad management requires special training and a high degree of technical skill because of the peculiar demands of the business. Even so does the manufacturing industry require peculiar skill and ability because it has its own laws and rules of procedure which are as inexorable as those pertaining to the field of transportation. The known advantages possessed by a railroad-fostered manufacturing enterprise, such as transportation at actual cost, an unsolicited patronage, a divided burden as to general expense, and certain other special privileges are, after all, merely incidental benefits. On the other hand it is subjected to handicaps of a fundamental character when compared with private industry. It lacks the spur of vigorous competition, which is the ever-present incentive for the private producer to work efficiently lest his business perish, and we recognize no greater necessity than that of self-preservation.

Now let us briefly examine into the commercial car plant's situation, as compared with the average railroad shop, after which the reader may, it is hoped, be assisted in arriving at his own conclusions.

Relation of Wage Payment Basis to Labor Efficiency

Manufacturers have long since recognized that while the labor wage is an important element of cost, the man-hour output is of even greater importance. Every workman's service costs more than his wage. The additional cost is proportional to the time he expends in the shop. If the wage is based on piece work performance, the individual's pay depends on his output, but the fact remains that the shop time he consumes further regulates the cost of his production.

For example, a shop operating on a piece-work basis may determine that 100 operations constitute a normal day's work, and may fix a rate of eight cents a piece. An inefficient operator may produce only 80 pieces a day and receive therefor $6.40; an efficient operator may produce 120 pieces a day for which he receives $9.60. Adding to these amounts the cost of power, supervision, maintenance of buildings and equipment, depreciation, insurance, taxes and other items of indirect expense, which may total $5.00 a day for each man employed, it is found that the total cost of 80 pieces produced by the inefficient workman is $11.40, or 14¼ cents each, while the 120 pieces produced by the expert workman costs $14.60 or 12⅙ cents each. The spread represents a difference of 17 per cent. It may be readily perceived that the increased productive costs due to the employment of inefficient workmen may convert the operating results of a shop from profit to loss.

In many instances the piece-work idea is carried a step farther in contract shops, and gangs, including their leaders, are paid for piece-work. This not only stimulates the productivity of the individual but promotes co-ordination of effort and produces the maximum results from the group.

The piece-work basis may constitute only a temporary advantage enjoyed by the outside shop, but its unbroken sequence therein has placed the railroad shops under a handicap which they cannot quickly overcome. The contract shops have a corps of skilled workmen who are specialists, a tested method of rewarding special ability and a quick means of determining and disposing of the inefficient. Railroad management is now deterred from taking advantage of these methods of effecting increased output by the restrictions of public control. Furthermore, because of the labyrinth of relationships which must be sustained the problem of securing maximum efficiency from individual workers is a detail which perhaps never can be given the studious attention it merits.

Effect of Volume of Output on Cost

Volume of output in a railroad shop frequently fails to meet the requirements of economical shop operation. The immediate needs of the transportation business must be promptly served. Even if repair cars are concentrated in large numbers, their progress through the shop may necessarily be interrupted by emergency jobs. On the other hand, repair cars may be purposely shopped in small lots because of the traffic conditions, labor scarcity, shortage of funds, or for other reasons. If the shop operating costs are not under strict control it is easy to overlook the effect which lapse of time has on the cost of output and to allow subnormal output unduly to increase the proportion of indirect expense.

In this respect the outside shop is unhindered except possibly by its inability to procure business. It is stimulated by a different incentive and follows a different procedure. Its sales force is constantly informed of the status of work in the shop and is charged with the responsibility of procuring business which will always keep work ahead. The heaviest possible load is kept on the shop because the manufacturer well knows the relation between maximum production and low costs. His fixed charges, which do not fluctuate with production, may be 50 per cent of the cost with low output and only 10 per cent with an output approximating capacity.

The outside shop draws its business from many sources; the railroad shop usually has but a single patron. The car builder may escape some burden of expense in slack periods by closing down his plant, but the railroad shop must maintain its non-productive organization because its shops are frequently used for repair as well as construction purposes.

Effectiveness of Supervision

The private manufacturer stresses the importance of effective supervision because he is cognizant of the numerous opportunities for creating expense which will devour his profits if individual effort is not properly directed and all operations fully co-ordinated. He therefore holds his supervisors to strict accountability; he requires that they administer strict discipline. In the railroad shops more laxity is observed with respect to these matters. There is more lost motion because individual accountability and discipline is less exacting. The atmosphere which pervades a properly managed private factory is frequently lacking. These conditions would lessen the benefits received by the railroads under the identical wage payment plans used in outside shops.

Cost Affected by Shop Routine

There are marked differences in the practices of railroad and contract shops. The contract shop is normally organized and equipped to provide for the movement of cars under repair or construction from station to station until the work is completed. At each station the car is subjected to a definite set of operations, and the workmen are skilled in the performance of these operations. Tools and machinery necessary to expedite their performance are conveniently at hand. The materials required are ready in sufficient quantities to prevent delay, and so placed as to facilitate application. By this and similar methods the contract shop enjoys the effect of a high degree of specialization on the volume, quality and cost of output.

Contract shop undertakings are carefully planned and scheduled before the work is begun. The machinery is rearranged, if necessary, to permit a smooth and uninterrupted flow of work through the shop. Tools are made accessible, the material is stored at the proper place to avoid unnecessary handlings and delays and every operation from beginning to end is carefully co-ordinated to avoid lost motion and retarded movement.

Because of demands made on it by the operating requirements of the road, the railroad shop cannot attain a corresponding degree of perfection in its functioning. The variety of its performances and the relatively lesser volume of each, generally preclude the handling of work in the manner above outlined. Improperly laid out plants, inadequate equipment and the lack of skillful workmen are common handicaps.

Shop Arrangement and Equipment

A contract shop specializing in heavy repairs is usually carefully laid out and arranged for the special task for which it is intended. The machinery will be specially designed to fit the work and to reduce productive costs. The shop will be constructed with a view to expansion with the least possible additional outlay of capital. The whole arrangement and equipment will be attuned to a program of undertakings with certain definite limitations.

The average railroad shop is designed for less highly specialized service and expansion is usually effected by a "patching on" process which does not permit of the orderly conduct of operations throughout the shop. Special machinery which would facilitate production and decrease the cost is often absent because it would be used only periodically. It is evident that a railroad shop designed and equipped to carry a peak load of heavy repairs with the greatest efficiency would represent a heavy investment which would be unproductive for a considerable part of the time.

Ordering and Handling Material

The contract shop, except under unusual market conditions, orders construction materials sufficient to meet known requirements only. Shipments are arranged so as to avoid delay to work, as well as to minimize handling and storage expenses. The builders seem to be able to control deliveries to better advantage than the railroads when the latter supply certain materials, and but little difficulty is experienced in adjusting receipts so as to keep pace with production. Many of the car plants are situated near established market and production centers, which expediates delivery and generally provides loads for the completed cars when homeward bound.

The railroads' situation is somewhat different. The constant need for many kinds of repair material prompts the accumulation of stocks at central stores, from which distribution is made to outlying points of consumption. Many railroad stocks have a very slow turnover. Much expense attaches to the repeated handlings to and from storage, and sometimes delay to shop work ensues. This disadvantage cannot be easily overcome. An extension of the inventories might save back hauls and shop delays, but the increased investment and risks caused by market fluctuations might offset or exceed the gains.

Differences in Character of the Work

The work let to an outside shop is usually defined by a rigid set of specifications, and regulated by constant inspection of the most critical sort. Outside repair work is generally done with a wholesale thoroughness, which creates a uniform physical condition in all of the cars affected. This thoroughness reduces the frequency of general shoppings, stabilizes the repair program and when cars are in demand it reduces the time out of service.

The work customarily done in the railroad shop is less thorough and passes a less critical inspection. A larger element of discretion is permitted as to the extent and character of repairs, as to the quality of materials used and as to the time the cars may be held out of service.

Supplementary Manufacturing in Outside Shops

One of the most disturbing conditions in the car building industry arises from the periodical fluctuation in the volume of available business. Railway purchases are controlled by the condition of the finances as well as the need for equipment. To provide against operating losses which would otherwise occur during periods of light production, many contract shops catering chiefly to car repair or construction work, are equipped to manufacture other things involving the same general processes. These related manufacturing operations serve to employ portions of the plant which would otherwise be idle at times, and reduce the expense of maintaining the business that under other circumstances would need to be borne by the output of new and rebuilt cars.

The railroad shop generally has no such relief. Its losses must be charged against the railroad's revenues, but they are not conspicuously displayed and frequently escape notice.

Close Control Exercised by the Management

In the average contract shop the managerial influence is not so far removed as in the case of a railroad shop. It is direct and positive and obtains a quicker response. The delegation of responsibility is definite and unevasive. The system of accounting affords a clear insight into each phase of the business. It serves the manager as effectively as the instruments before him serve the driver of an automobile. The manager is not distracted by duties more or less foreign to his principal interest, which is to keep his production up and his costs down.

The managing head of the railroad shop is often less fortunately circumstanced, through no fault of his own. His opportunities are less extensive, and his freedom of action is more restricted. These handicaps are inherent in his position.

Are Independent Car Plants Necessary?

Whether existing railroad shops that are used for manufacturing purposes are justified or not, the contract car shop must remain a necessity unless all railroads provide complete facilities for constructing and rebuilding their own equipment. It has already been suggested in these columns that the outside shops now provide a safety-valve for the railway shop labor situation.

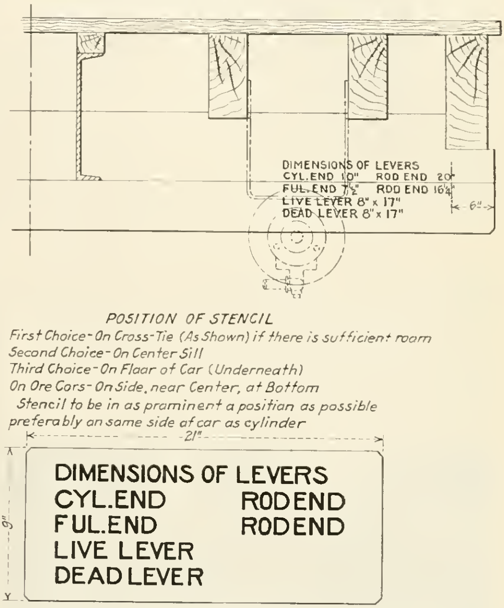
If, then, good reason be found for the existence of the independent plants it behooves the railroads not to withhold their patronage without good reason, because the builders' charges must be regulated by their expenses. When their shops are only partially filled or shut down they are a source of expense that in the long run must be paid by the customers. Instead of investing large sums in additional facilities of doubtful economical value, would it not be well for the carriers to divert at least the overflow of heavy work to the outside plants? This could readily be done under a predetermined program for repairs or construction, which would permit of shop space being contracted for in advance.

Any general discussion of this subject cannot be wholly convincing because of the wide differences of conditions in railroad shops. But let the reader remember that as a condition precedent to passing judgment, he should have not only a knowledge of the cost of the outside work, but a thorough understanding of the true cost of doing business in the railroad shop, because judgment requires comparison and discrimination. Without such knowledge he may only guess, and the matter is much too important to be so decided.

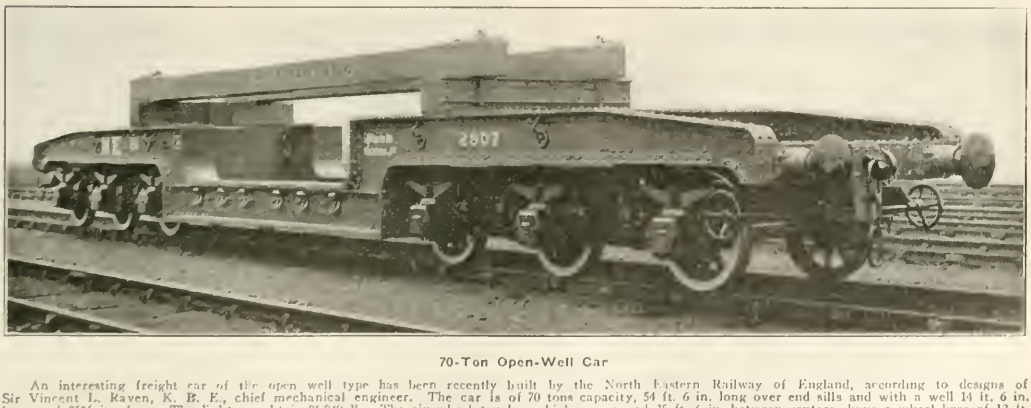
Stenciling Brake Lever Dimensions on Freight Cars

It is the exception rather than the rule to find brake levers of correct dimensions under freight cars that have seen any considerable period of service. In renewing or reapplying brake levers under cars on the repair track, particularly in the case of foreign cars, the repair man has little to guide him in the selection of levers of proper dimensions. Wrong levers are therefore frequently applied and the car returns to service with an incorrect braking ratio.

The present practice on the Chicago, Milwaukee and St. Paul is to check the dimensions of all brake levers on system cars as they appear on the repair tracks at the West Milwaukee shops. Variations in the braking power have been found to range from 15 per cent to 100 per cent of the light weight of the car and in one case the braking ratio was found to be 120 per cent. After providing cars with levers of the correct dimensions these dimensions are now being stenciled on the underframe, using letters and numbers one inch high. The stenciling is applied as near the brake cylinder as possible, the preferred locations being shown on the drawing.



C. M. & St. P. Practice for Recording Brake Lever Dimensions on Freight Car Underframes



70-Ton Open-Well Car

An interesting freight car of the open well type has been recently built by the North Eastern Railway of England, according to designs of Sir Vincent L. Raven, K. B. E., chief mechanical engineer. The car is of 70 tons capacity, 54 ft. 6 in. long over end sills and with a well 14 ft. 6 in. long and 25⅞ in. deep. The light weight is 86,940 lb. The six-wheel trucks, which are spaced 35 ft. 6 in. between centers, have a wheel base of 12 ft. The wheels are 37 in. diameter and journals 6 in. by 12 in. The car was designed primarily for the shipment of turbo-alternators erected complete.

Air Brake Repairs at Milwaukee Car Shops

Devices Which Save Labor and Improve Quality of Work: Triple Valves Cleaned in Soda Solution

A NUMBER of facilities and methods for repairing air brake apparatus have recently been developed at the West Milwaukee Car Shops of the Chicago, Milwaukee & St. Paul, which have materially reduced the amount of labor expended in the repair of triple valves and at the same time have improved the serviceability of the repaired valves. Some of these devices do not differ in principle from similar facilities in use in other shops and some of them are unique. All, however, are simple and effective.

Cleaning Triple Valves in Soda Solution

Triple valves are now being cleaned in a caustic soda solution. This is a complete departure from the almost universal practice of cleaning with kerosene. The equipment for cleaning by this method which is shown complete in one of the illustrations, consists of three tanks placed in a row, with a scrubbing shelf at one end and a horizontal steam drying coil at the other end.

The tank in the foreground of the illustration contains a

Fig. 1—Vats and Drying Coil for Cleaning Triple Valves with Caustic Soda

caustic soda solution made in the proportion of two pounds of soda to five gallons of water. This solution is maintained at a temperature of about 130 deg. F. by a steam coil laid in the bottom of the tank. Next to the soda tank is another steam heated tank containing clean water. The third tank is filled with cold running water to insure a continuous change of water.

After a triple valve has been completely taken apart, the parts are placed in a shallow wire basket and immersed in the soda solution for about 20 minutes. The valve body, cap and emergency section are hung on the ends of "S" hooks by the flange bolt holes and are immersed in the soda solution, the upper end of the hook being dropped over the edge of the tank. From the soda solution the parts are taken to the cold water tank where they are thoroughly rinsed. This removes all free soda solution and makes the parts safe to handle. They are then scrubbed off, using a small amount of soft soap in the process, and are again rinsed in the cold water to remove all loose dirt, after which they are given a final rinsing in the hot water. After the final rinsing the parts are placed on the steam drying coil, a part of which is shown at the left foreground of the illustration, where they are rapidly dried ready for repair and refitting.

When triple valves are cleaned with kerosene it is impossible to completely remove the kerosene from the sliding surfaces to which dry graphite lubricant is to be applied. The result is a tendency for the graphite to cake between the valves and their seats, sufficiently pronounced at times to cause improper operation of the valves. The new method leaves the parts perfectly dry with the surface of the metal

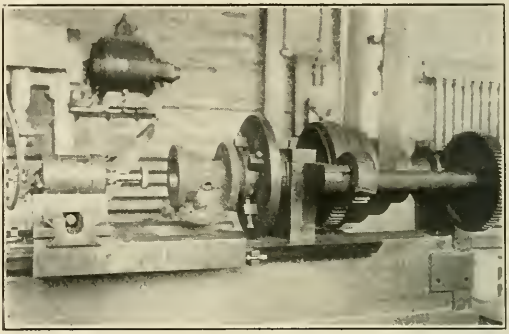


Fig. 2—Engine Lathe Fitted for the Internal Grinding of Triple Valve Bushings

in the best possible condition to take the dry graphite lubricant.

With the old method of cleaning considerable hammering and working of the piston rings in the grooves was necessary in order to loosen them and many rings were broken or bent in the process. The soda solution thoroughly cleans the grooves and leaves the rings free. This in itself effects a considerable saving both of time and material.

A Convenient Triple Valve Bushing Grinder

The principal wear on triple valve bushings takes place at the inner end between the service and release positions of

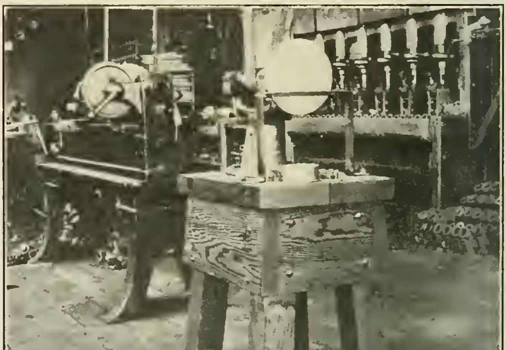


Fig. 3—Simple Disc Grinder for Facing Slide and Graduating Valves

the piston. When valves undergoing repairs are found to need new piston rings the rings are fitted in the outer end of the bushing and if it is appreciably worn the result is a loose fit of the piston ring in the service and release positions.

Such valves frequently fail to release after light applications and are the cause of many overheated wheels.

In order to refinish these bushings to true cylindrical form an old engine lathe was fitted with a special face plate to which is clamped a chuck on which the triple valve is mounted by its own threads. A small motor driven grinder mounted on the cross slide completes the device. The grinding is done by a small fibre wheel on the circumference of

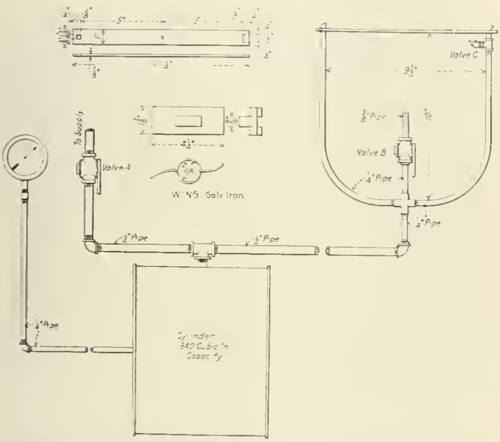


Fig. 4—Device for Grinding and Testing Retaining Valves in One Operation

which is glued a strip of carborundum cloth. Three grades of cloth—No. 0, No. 1/2 and No. 1—are used and as a rule three badly worn bushings can be finished with one cloth. The carborundum cloth has been found to work more successfully than carborundum wheels, which do not operate well without the use of water.

Facing Slide and Graduating Valves

The disc grinder shown in one of the illustrations has replaced the face plate for facing slide and graduating valves

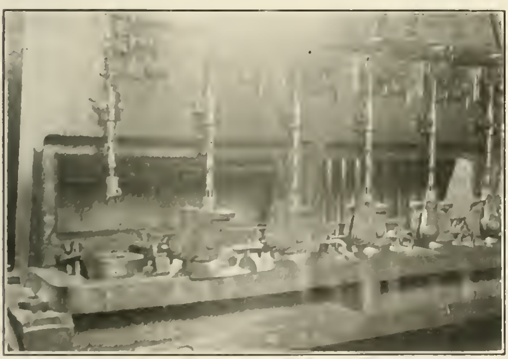


Fig. 5—Machine for Grinding in Triple Valve Rings

and piston rings. In order to secure accurate work when using the face plate and loose grinding material, frequent resurfacing of the face plate was necessary. Altogether from 15 minutes to 30 minutes was required to complete a valve on the face plate and even then much time was required in fitting the valve to its seat. The disc grinder faces a valve in four or five seconds and very little fitting is required.

The nature of the device itself is clearly shown in the illustration. It consists of a simple belt driven grinding wheel stand with an accurately faced steel disc mounted on one end of the shaft. The surface of the disc is covered with No. 00 carborundum cloth, glued on.

Grinding and Testing Retaining Valves

The drawing shows a device by means of which it is possible to grind and test retaining valves in one operation. The device is operated in the following manner:

After the retaining valve cap and weight have been removed, the body with the key in place is screwed on the end of the pipe above the valve *B*. The galvanized iron wing is then slipped over the top of the weight and the weight placed in the valve body and locked in place by dropping the 1-in. by 1/8-in. bar over the upper ends of the 1/4-in. pipe frame. A hole drilled in the center of this bar receives the projection at the top of the retaining valve weight, thus centering it for rotation.

The air supply valve *A* and the 1/4 in. pet cock *C* are then opened. The jet of air from the pet cock acting on the galvanized iron wing causes the weight valve to revolve rapidly on its seat. In about 30 seconds, when in the judgment of the operator the valve has been spinning long enough, the pet cock *C* and supply valve *A* are closed. The retaining valve handle is then turned to the retaining position and valve *B* opened. After the exhaust of air from the reservoir has ceased, observation of the gage soon shows

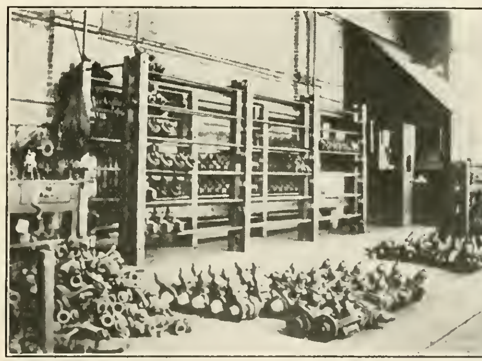


Fig. 6—Convenient Storage Racks for Finished Triple Valves

whether the valve is tight. Should further grinding be required it can be done without loss of time, and when the retaining valve is removed it is known to be fit for service.

Grinding in Piston Rings

One of the illustrations shows a machine which has been developed at the Milwaukee shops for grinding in triple valve piston rings. The machine consists of a table and frame of cast iron, the latter having a wide vertical face to which six driving heads are bolted. These heads all receive power from a single belt driven shaft, gear connected at each head to a crank shaft which may be independently started or stopped by means of a simple jaw clutch. Below each head is a vertical guide for the reciprocating spindle and to the lower end of the spindle is connected a simple two jaw chuck which fits over and grips the button on the end of the piston stem. The throw of the crank provides a piston stroke equal to its full travel in the bushing and the machine operates at 200 strokes a minute. The average time required to complete the grinding in of a new ring is about 10 minutes.

To grind in the rings by hand, 12 new rings constitutes a fair day's work for one man. With the aid of this machine, one man can remove the cylinder caps and fit rings to about 40 valves in eight hours. These 40 rings require 1½ hours operation of the machine. The cleaning and assembling of the 40 valves requires about seven additional hours. The 40 valves thus require about 16½ hours total time, or 22½ min. each, as compared with an average of 40 min. for hand work. The product of 1½ hours' operation of the machine, it will be seen, keeps one man busy for almost two days.

Racks for Storing Finished Triple Valves

Convenient racks for the storage of finished triple valves have been built of old truss rods, mounted in suitable wood frames. The truss rods are arranged in pairs which are spaced 6¼ in. from center to center with a vertical distance between pairs of 15 in. The wood frames are 4-in. by 4-in. pieces, through which holes have been bored to receive the rods. Each section of the rack is devoted to its particular type of triple valve, the designation of which is stenciled on the adjoining frame.

These racks save considerable floor space, keep the finished valves conveniently arranged for inventory and protect them from becoming dirty before they are placed in service.

Interesting Car Shop Practices Employed at Sayre

Lehigh Valley Effects Economy by Spray Method of Painting Equipment; Portable Roof Saw; Millroom Templates

THE main shops of the Lehigh Valley are located at Sayre, Pa., where practically all passenger cars and wooden freight cars on the system receive heavy repairs. At the present time the car shops are working with about 80 per cent of the normal force and it is a pleasure to note the marked spirit of loyalty of these men to the Lehigh Valley. In general, both supervising officers and shopmen seem to have united in an attempt to cut out lost motion, increase production and decrease costs.

Many labor-saving methods have been installed at the Sayre car shops, a notable one being the truck and trailer system of transporting all kinds of material both new and scrap. Other efficient methods and devices for which space is not available in this article, may be included in a subsequent issue. The practice of paint spraying is of especial interest.

Paint Spraying Practice

In accordance with its custom, the Lehigh Valley has adopted and extended the practice of paint spraying road

Fig. 1—Operation of Paint Spraying a Box Car

equipment only after extended tests to demonstrate the relative advantages and economy of the method. To summarize the conclusions, it has been shown that paint can be satisfactorily applied as a spray with important savings in labor cost which more than offset the slightly greater amount of paint used. Locomotives and tenders are now paint sprayed in the locomotive shops and passenger and freight cars in the car shops. After further tests it was found possible to spray varnish which greatly broadens the field and enables passenger, mail, baggage and other cars to be varnished by this method. The only equipment not sprayed is the insides of coaches and dining cars.

The paint spraying device or apparatus consists, as shown in Fig. 1, of a tank mounted on wheels for easy movement

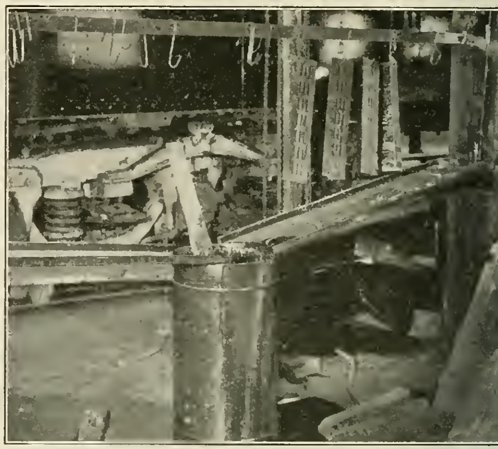


Fig. 2—Arrangement for Dipping Small Parts and Car Fixtures

about the shops and arranged to be supplied with paint through funnel and valve on the top. Air pressure from the main shop line is supplied through a hose connection to the upper part of the tank, a gage enabling the operator to know what the air pressure is at all times.

Two lines of hose, one conveying air and the other paint, lead to the nozzle where they combine, the amount of flow being controlled by a valve at the operator's hand. For painting the outsides of cars a long pipe nozzle is used, enabling the entire side of the car to be painted with the operator standing on the ground or floor. No staging is necessary. For inside work and places where the long nozzle would be inconvenient, a pistol-type nozzle is used giving the operator convenient and more flexible control both of the supply of paint and the direction in which it is sprayed.

The operation of paint spraying a box car, as illustrated in Fig. 1, can be performed in a much shorter time than it would take to apply the paint with a brush. One man can spray the car complete in 13 min. and owing to the fact that spraying does not require as much skill as brush painting a cheaper man can be employed with a total labor saving of $2.75 to $3.00 for each car. To brush paint the car would take one man three or four hours. While spraying this car will require 11 gallons of paint as against 9 gallons applied with a brush, one coat by the former method is equal to two by the latter. In addition the spray gets into corners and

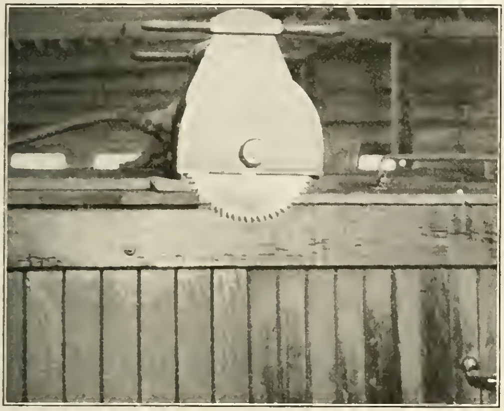


Fig. 3—Portable Pneumatic Sawing Machine

crevices which could not be reached with a brush. With experienced operators, practically no paint is wasted and the general condition of the floors at Sayre bears out this statement. When painting along the top of the sides, some paint spray may go over the edge of the roof boards, but this paint falls on the roof and therefore is not wasted. The

Fig. 4—Method of Making Sill Repairs Without Removing All the Sheathing

spray is a great convenience in painting trucks which were always more or less awkward to paint with a brush.

In painting cabooses, the outside presents a slightly smaller surface than a box car and can be paint sprayed in less time. The windows are protected by tin, except where the caboose is to be painted inside and out, in which case the sashes are removed. The only brush operation consists of painting the sash. The inside of a caboose can be sprayed by one man in about 54 min., the total saving in labor on the job being $7.66. There is also a saving in material of $1.17 owing to the fact that when paint is applied as a spray, only one coat is needed.

Sand blasting has been developed quite extensively for the removal of paint and varnish from passenger coaches, about 8 hours being required for the operation inside a car and 12 hours outside where vestibules, steps and trucks are included. The outside of a passenger coach can be spray varnished by one man in 2 hours. If this varnish is applied with a brush, it takes two men 2½ hours apiece. The resultant saving in labor cost is about $2.40.

The under parts of the car, including the iron work, steel floor, trucks, platforms, equipment boxes, etc., are sprayed in 2 hours by one man, whereas it would take 15 hours for this paint to be applied with a brush by one man.

Along the line of economy in applying paint may be noted the practice of dipping small parts and car fixtures, Fig. 2. This illustration shows four pipe guards which have just been dipped in the large can of red paint and are suspended from hooks, the paint dripping off and running back into the tank as shown. This method has many advantages, including in the first place, reduced cost of labor. There are 42 pipe guards in a car and these can be dipped in 18 min. as against 2½ hours required to apply the paint with a brush. The paint gets into all crevices; one coat is equal

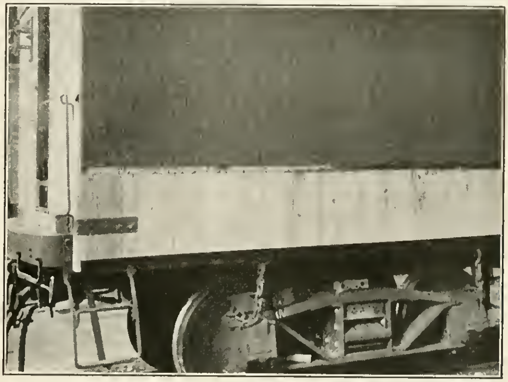


Fig. 5—View Showing New Section of Sheathing Applied

to two coats applied with a brush, and while more paint is used, an enamel finish is secured. Ventilators for passenger cars and all small material are dipped in this manner at Sayre.

Portable Roof Sawing Machine

A portable roof sawing machine which has proved its adaptability and value is shown in Fig. 3. This saw is a homemade device, used for sawing off the ends of roof boards, trimming the bottoms of side sheathing, and other similar work. The device consists of a framework supporting the saw bearings and guard and provided with four handles for ready control by the operator. The saw is driven by an air motor and can be adjusted to cut at 90 deg., or a slightly greater angle to the surface along which it is being pushed. The saw is guided by a long wooden strip lightly nailed to the roof in such a position that the cut comes at the proper place. One man can saw off one side of the roof illustrated in two or three minutes, including the time required to lay the strip. On account of the double roof it takes a man about eleven minutes to saw off one side of the roof of a refrigerator car. The side sheathing of a 60-ft. milk car can be trimmed in three minutes and the work is more rapidly and accurately done than would be possible with a hand saw.

In this connection it may be interesting to note the use of this portable saw in cutting off the sheathing of a milk car (Fig. 4) at a point 22 in. above the bottom of the sill. If the floor sill is rotted, it can then be removed and a new section of sheathing applied without tearing off all sheathing or removing the letter board. It is estimated that approximately one hundred dollars is saved for each car handled in this way.

In general, the operation consists in nailing the guiding

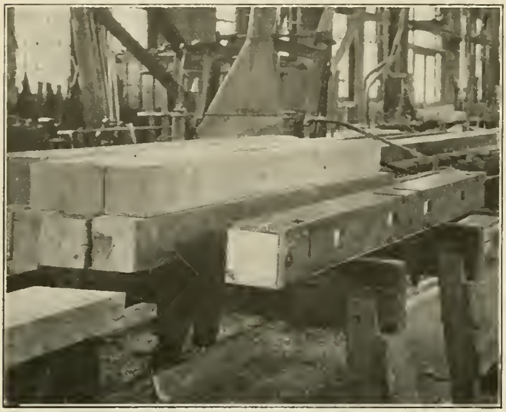


Fig. 6—Template for Laying Out Murphy End Ribbon

strip along the side of the car so that the portable saw cut will come 22 in. above the bottom of the sill. The saw is then adjusted, as shown in Fig. 4, at a slight angle, and the sheathing cut. After necessary repair or renewal of the sill has been made, a new section of sheathing is applied as shown in Fig. 5. A strip of galvanized iron is bent in the shape of a Z, starting under the old sheathing, coming

Fig. 7—Easily Accessible Storage Platform for Templates

out through the joint and being bent down over the new sheathing, an arrangement which effectually sheds the water. The lower ends of the new sheathing are trimmed off with the portable saw, leaving a neat job which, when painted over, can hardly be detected from a full new section of sheathing.

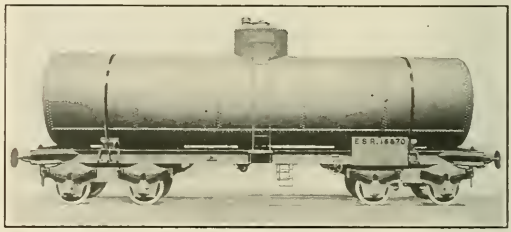
Millroom Templates Save Time

Experience at the Sayre car shops has demonstrated the value of templates for laying out work in the millroom. Taking, for example, the Murphy end sills or end ribbon template, illustrated in Fig. 6, the sill can be laid out with the greatest of ease and speed by the use of this template compared to laying it out with a square. Moreover, the laying out does not require as much skill and can therefore be performed by a cheaper operator. There is less possibility of error and no lost time looking for blue prints, etc.

With the great amount and variety of work passing through the millroom, it is obvious that a large number of templates must be employed and it is essential that they be readily available for use. The templates are kept on a platform as indicated in Fig. 7, the small templates being suspended vertically from hooks as shown at the right of the illustration, and the heavy, long templates being supported horizontally as shown at the left. The orderly arrangement of these templates and provision of means for locating and taking them quickly to the work has a lot to do with savings effected by their use.

Egyptian State Railway Tank Cars

The Egyptian State Railways have recently received from Clayton Wagons, Ltd., Lincoln, England, 50 petroleum fuel oil tank cars of 30 tons capacity. The light weight of these cars is 48,050 lb. and the weight loaded 116,370 lb. The inside diameter of the tanks is 7 ft. 3 in. and the length over heads 33 ft. 5 in. The heads and bottom sheets are of ½ in. steel, the other sheets being ⅜ in. thick. The tanks are designed to withstand a pressure of 60 lb. per sq. in. without leakage. The dome is fitted with two safety valves set to open at 25 lb. per sq. in. and is provided with a manhole cover which automatically releases any gas under pressure in the tank before the cover is entirely clear, thus safeguarding the operator. Either side bottom outlets are



30 Ton Tank Car, Egyptian State Railways

provided and five lengths of steam heating coils are fitted in the bottom of the tank to facilitate the flow of oil when discharging.

The cars are of standard gage and in many ways the design follows American practices, although couplings, hand brakes and truck details are distinctly English. They are 34 ft. long over end sills, 37 ft. over buffers and 23 ft. center to center of trucks, which are of the pressed steel type and have a wheel base of 5 ft. 6 in. Semi-elliptical springs are fitted above the journal boxes. Newlay steel wheels of 33½ in. diameter and axles with 5 in. by 9 in. journals are used. There are two sills of 12 in. by 6 in. by ⅝ in. I-beams, spaced on 4 ft. 3½ in. centers. The center or draft sills are of 9 in. by 3 in. by 5/16 in. channels, spaced 1 ft. 1⅝ in. apart. They are 11 ft. 8 in. long and reach from the end sill to a cross brace, both the end sill and the cross brace being of 12 in. by 3½ in. by 5/16 in. channels. The body bolsters consist of two 9 in. by 7 in. by ⅝ in. I-beams. When empty the distance from the top of the rail to the top of the sills is 4 ft. 1⅝ in. and from the top of the rail to the center of the tank 8 ft. ⅝ in.

Hand brakes are provided on one truck. They can be applied from the ground by means of a hand wheel on the side of the underframe, which can be noticed in the photograph.

Grinding Links and Link Blocks

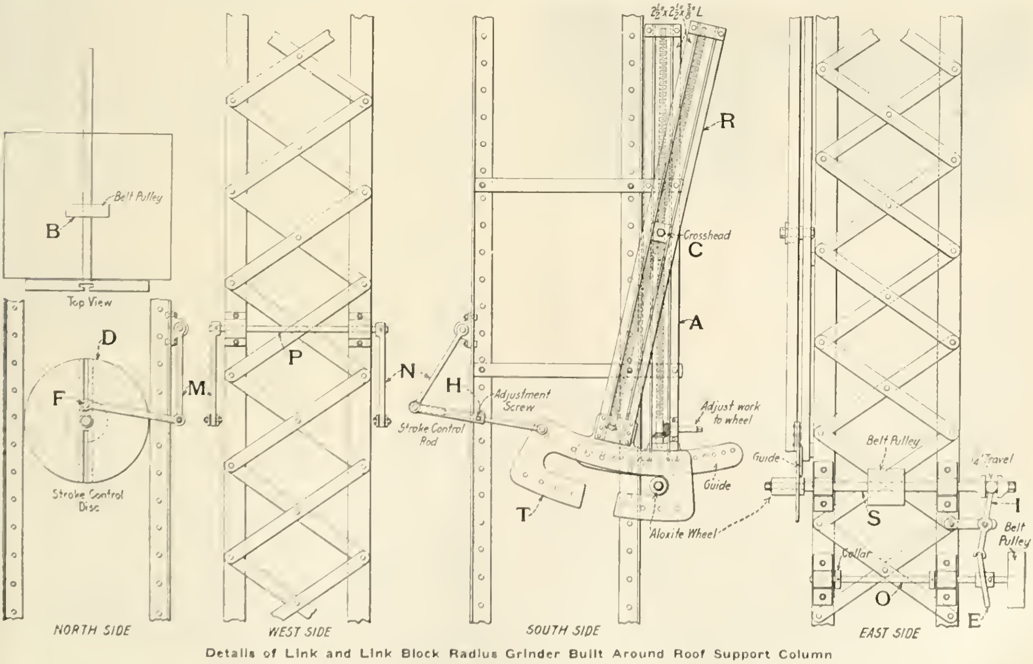
By J. M. Hamm
Tool Foreman. Lehigh Valley, Sayre, Pa.

A UNIQUE homemade link and link block radius-grinding machine has been built at the Sayre shops of the Lehigh Valley, using a roof support column as a frame for mounting the parts. Parts of the machine are located on the north, west, south and east sides of the column; also the inside, as shown in the illustration.

The radius bar *R* and table *T* for clamping the parts are riveted together, the material used consisting of 3/8-in by 2½-in, by 2½-in. angle iron, spacing blocks and a piece of scrap boiler plate. The adjustment bar *A* for adjusting the work to the aloxite wheel (after the radius bar has been set to the correct radius) is made from the same material as the radius bar. Both bars are controlled by a common crosshead *C* which is operated by two screws by tightening or loosening the crosshead nut on one bar or the other. The aloxite wheel shaft *S* is located at right angles with the table on the east side of the column. In order to give an oscillating movement to the aloxite wheel shaft, a second shaft *O* is located directly beneath *S*. By means of eccentric *E* and intermediate rocker arm *I* a 1¼-in. back and forth travel is transmitted to the wheel shaft *S* and aloxite wheel. This maintains uniform wear of the wheel. Both shafts *S* and *O* are driven by suitable belts from overhead shafting.

On the north side of the column is located the stroke control disc *D* with pin *F* adjustable in a radial slot and used for the purpose of causing the work to be ground to pass forward and backward over the aloxite wheel. On the west side of the column is a shaft *P* with levers *M* and *N* used to transmit the stroke from the stroke control disc to the radius bar table. It is obvious that the position of pin *F* in the radial slot in disc *D* will govern the throw of table *T*. The position of table *T* with respect to the aloxite wheel is further adjustable by means of screw *H*. The stroke control disc is mounted on a shaft that passes through the center of the column, the driving pulley *B* being inside the column.

The primary object of building this radius grinding ma-



Details of Link and Link Block Radius Grinder Built Around Roof Support Column chine was to secure a horizontal grinding wheel shaft with an oscillating movement because a vertical shaft is difficult to lubricate properly, resulting in fast wearing bearings which give constant trouble. The oscillating movement of the grinding wheel shaft produces uniform wheel wear. All lost motion and slack in the mechanism is automatically taken up due to the fact of its being suspended. A further important advantage is the relatively large grinding wheel which revolves at high speed, covers the full thickness of the link and grinds links and link blocks in a minimum time, depending upon the amount of metal to be removed and the quality of the grinding wheel.

Installing and Maintaining Charcoal Iron Locomotive Boiler Tubes

By G. H. Woodroffe* and C. E. Lester†

The following article is a continuation of the suggested standard boiler tube practice described in the April issue of the Railway Mechanical Engineer *and confined primarily to methods and tools used in applying body tubes, superheater flues and arch tubes. This second installment of the article deals with the use of welding in tube work, particular emphasis being placed on recommended maintenance practice in enginehouses. An effective flue shop equipment and layout is also described, the latter part of the article being devoted to a valuable discussion of successive safe ending and the necessity of keeping boiler tube service records.*—The Editors.

THE growing practice of electrically welding tubes and flues to back tube sheets saves a great deal of boiler trouble and maintenance work. However, welding alone will not hold carelessly set tubes and flues. Each operation should be carried out as carefully and thoroughly as though no welding were to be done.

The metal of the weld is somewhat brittle and may be porous on account of tiny blow holes that form as the metal solidifies from the molten state. The welding metal alone therefore cannot be depended upon to hold the tube in place or prevent leakage.

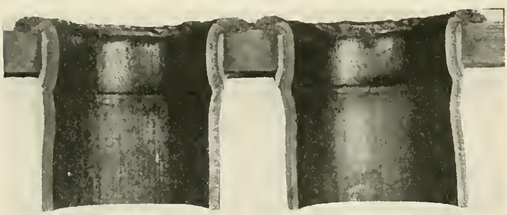


Fig. 1—Section of Tube Sheet with Charcoal Iron Boiler Tubes Welded in Place

By uniting the bead to the sheet, however, the weld furnishes the strength and stiffness necessary to hold the shoulder of the tube against the ferrule, just as it was left by the expanding tool and may also be dense enough to prevent a loosened tube from leaking in an emergency.

Electrically Welding Firebox Ends of Tubes

Setting Tubes and Flues for Welding.—Expand, roll and bead as described previously (first installment, March issue), using no lubricant on the setting tools. If it is felt necessary to use a lubricant, the following corn oil soap has been found to be satisfactory and is said not to affect the welding:

In a steel tank of about 60 gallons capacity, place:
- 20 gallons of water
- 15 pounds of lye (caustic soda)
- 10 gallons of pure corn oil

Boil from 6 to 8 hours, adding from 15 to 20 gallons of water to keep the mixture from boiling over. At the end of this time the solution should be clear, indicating complete saponification. If not, continue boiling until the mixture is clear. The resulting soap should be light amber in color and of about the consistency of vaseline.

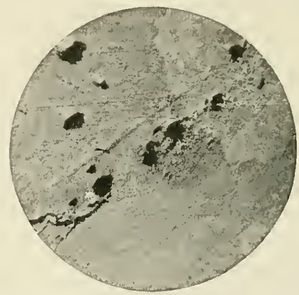


Fig. 2—Section of One of the Welds In Fig. 1, Showing Blow Holes in Welding

Preparation.—After tubes and flues have been tightened by expanding or rolling, but before they are beaded, the sheet should be thoroughly cleaned by sand blasting. The boiler should then be filled with warm water and tubes made perfectly tight before beading. If tubes are beaded (locomotives taken out of service to have tubes welded), they should be made perfectly tight before welding.

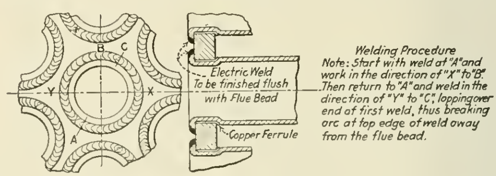


Fig. 3—Procedure for Electric Arc Welding Flues

The welding operation should be performed with warm water in the boiler and after the tubes or flues have been properly beaded.

Welding.—Begin with the top row and work downward, welding superheater flues first. Each tube and flue should be welded by starting near the bottom, welding first up one side, then up the other, completing the weld near the top center, Fig. 3.

Note:—This is the second instalment of an article on suggested tube practice which has been copyrighted by the Parkesburg Iron Company and which will be published later in book form.

*Mechanical Engineer, The Parkesburg Iron Company.

†Formerly General Superintendent, 19th Division, Transportation Corps, A. E. F., and Superintendent of Nievre Locomotive and Car Shops.

Removing Welding Deposit.—During the welding operation, a deposit will form on the sheet and beads adjacent to the bead being welded. Carefully remove this deposit with a wire brush before starting to weld.

Maintenance—Recommended Engine House Practice

General Suggestions.—Tubes should be made tight in the sheets with the least possible amount of working. Excessive working shortens the life of tubes and flues.

Roller expanders, particularly when driven by air motor, should not be used on firebox ends of tubes. They distort the metal, weaken the tube, raise the bead slightly from the sheet and not only shorten the life of the tube, but they enlarge the tube holes in the back tube sheet.

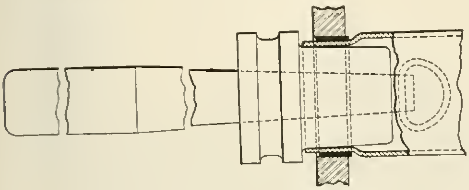


Fig. 4—Straight Sectional Expander

If necessary, new or safe-ended tubes may be rolled by hand, lightly, after beading.

Removing Tubes.—Tubes should be taken out at the front end, through their respective holes. If their condition is such that this is impossible, remove them through the large holes near the bottom of the front tube sheet.

The dangerous practice of enlarging holes in the back tube sheet for the removal of tubes should not be permitted.

Tubes Leaking Slightly.—With a standard beading tool, lightly set the beads down to the sheet. Trim off the burrs with a chisel. If necessary to expand a tube, use a straight sectional expander, with a light pneumatic or a four pound hand hammer. The tube should then be beaded lightly.

The use of the lipped sectional expander while a boiler is under pressure is a dangerous practice that should not be permitted.

Tubes Leaking Seriously.—When a locomotive arrives at the engine house with tubes that are leaking badly, draw the fire and drain the boiler. Reset the tubes with a standard lipped sectional expander, Fig. 5. Reset the beads with a standard beading tool. Remove any burrs that may be raised with a small chisel and hand hammer.

Washout Period.—At the washout period, reset the tubes with a standard lipped sectional expander. Set down beads with a standard beading tool, using a light pneumatic hammer. Trim off all burrs, using a small chisel.

Electrically Welded Tubes

Running Repairs.—Electrically welded tubes, leaking through "pin holes" in the weld, may be calked with a fuller and hand hammer. The pein of a hammer or a beading tool must not be used.

If the leak is under the weld, cut off the defective portion of the weld, reset the tube with a lipped sectional expander, bead down, clean and reweld. If welding facilities are not available, expand the tube with a straight sectional expander. Rewelding should be done at the first opportunity.

At the washout period and before steam is blown, carefully inspect all tubes and flues. Proceed with necessary work when the boiler has cooled.

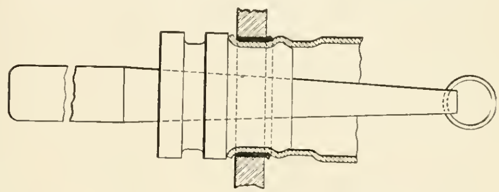


Fig. 5—Standard Lipped Sectional Expander

Flue Shop Practice

By flue shop is meant that part of the plant in which tubes, removed from boilers after a period of service, are cleaned, cut off, safe ended and stocked for future use and where new or reclaimed tubes are swaged and expanded for application.

Flue Shop Equipment and Lay Out

Flue shop equipment and lay out are seldom given the consideration which they merit. Too often, flue shop machinery is obsolete or inadequate and poorly arranged. A careful study of almost any shop layout will open up new

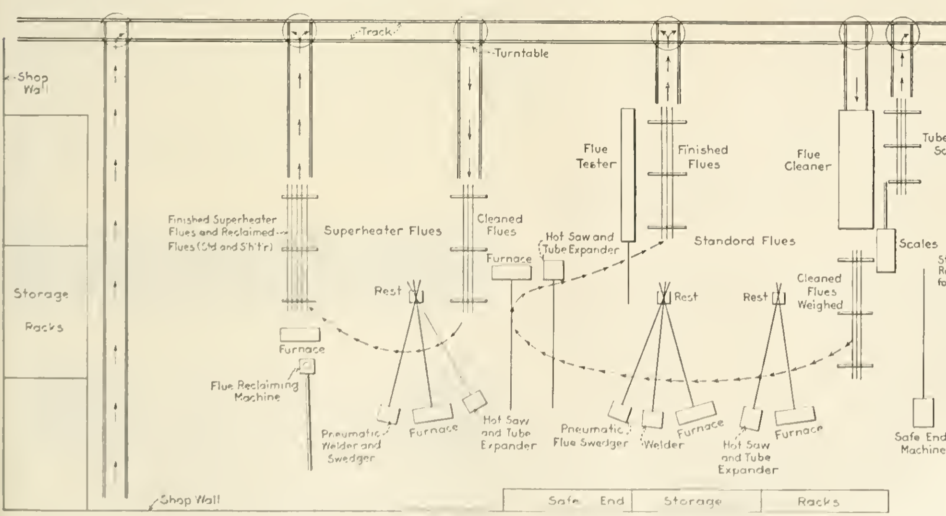


Fig. 6—Typical Flue Shop Designed to Handle 500 Tubes and Flues a Day

ways of saving time and money. Modern economical flue shop equipment, which can be purchased and installed at a moderate outlay, will save its initial cost in a short time and speed up the reconditioning.

The railroad flue shop shown in Fig. 6, handles five hundred boiler tubes and superheater flues a day at an exceedingly low cost. The work progresses in one direction only, forward. Specially designed cradle trucks are used. Machines have been so arranged as to make it unnecessary to turn tubes end for end. The use of an overhead crane though not essential will further reduce the handling cost. This layout, varied slightly to meet individual conditions, is followed in a number of shops throughout the country.

Cleaning Tubes.—There are three general types of tube cleaners: rotary single tube cleaner; dry rattler; wet rattler.

The small shop, handling comparatively few tubes a day, may find the rotary single tube cleaner sufficient for its needs. Where a considerable number of tubes have to be handled dry rattlers and wet rattlers are used.

Weighing Cleaned Tubes.—After cleaning, tubes should be weighed and those below definite limiting weights should be scrapped. This practice has two advantages; it saves good material that might otherwise be discarded and it goes far toward eliminating tube failures on the road by weeding out worn, under-gage tubes.

Table I.—Minimum Weights of Tubes

Diameter of Tube, inches	Gage of New Tube	Service	Weight: Pounds	Weight: Ounces
2	11	Locomotive	1	11
2¼	11	Locomotive	1	15
2½	11	Locomotive	2	3
3	12	Stationary	2	11
3½	11	Stationary	3	14
4	10	Stationary	4	12
5⅜	9	Locomotive / Superheater	6	11
5½	9	Superheater	7	00

Heating for Safe Ending, Swaging and Expanding.—For proper safe ending, swaging and expanding, tubes must be heated quickly, evenly and thoroughly. The heating furnace, whether coke-burning, gas or oil fired, should have sufficient brick work to absorb heat from the fuel and radiate it to the work.

Cutting Off Tubes.—Of the many types of tools used for cutting off tubes, the hot saw is perhaps the best. It cuts quickly, uses little power and leaves only a small burr which is easily removed while the metal is hot.

A hot saw and expander, mounted on the same housing, are shown in Fig 7. This machine eliminates one handling of the tube, which can be cut, and expanded at one heat and safe-ended after a quick wash heat.

Flue Welding Machine.—Good results may be obtained with welders of either the roller or hammer type. A little care and the right kind of mandrel will minimize or entirely eliminate the ridge that is often left inside the tube.

Electric Safe-ending.—Where cheap electrical power is available, the matter of safe end welding electrically should be studied carefully. The operation is quick and the welds excellent.

A heavy, low voltage current is passed through the safe end and the end of a boiler tube or a superheater flue, held in contact by pressure. The electrical energy is transformed into heat and the junction of the tube and the safe end soon becomes white hot, fusing or welding the two pieces together. The current is then shut off, the contact clamps released and the joint smoothed and rolled down to normal tube diameter in a roller welder.

Swaging and Expanding.—To facilitate insertion and removal of locomotive boiler tubes, tube holes in the front sheet are made slightly larger than the outside diameter of the tube. The front ends of the tubes, therefore, have to be expanded for a tight fit.

Tube holes in the back tube sheet are the same size or slightly smaller than the outside diameter of the tube. With a copper ferrule in the tube hole, it is necessary to swage the firebox end of the tube, reducing its diameter.

Swaging is always done hot. Tubes are usually heated for expanding.

With the use of the equipment and the arrangement suggested, safe end welding can be finished quickly enough to permit swaging (or expanding) at this heat. A slower

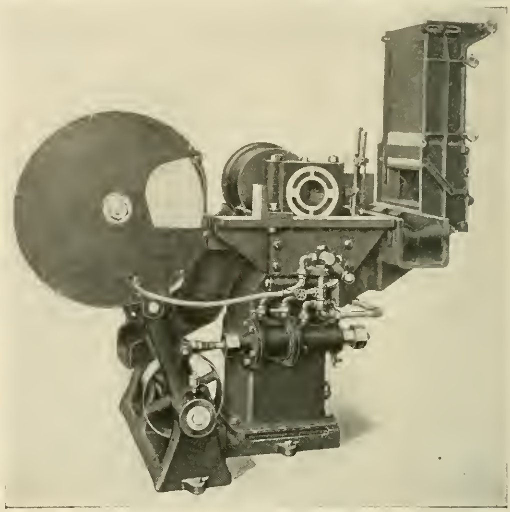


Fig. 7—Combination Hot Saw and Expander for Use in the Flue Shop

process, however, may necessitate a quick "wash heat" after welding and before swaging or expanding.

The charcoal iron tube has a critical range, 1,550 to 1,750 degrees, F., during which mechanical work like swaging and expanding should not be done. Temperature determination by color is misleading and unsatisfactory, but in this particular case, if the work is kept above an orange color (in the shadow), failures will be avoided.

In Fig. 8, one end of the short piece of charcoal iron tube was expanded while the tube was passing through the critical or "red short" range. The other end was given even more expansion at a temperature above this range. The perfect test on the one end would have been duplicated on the other had the tube been expanded at a temperature above or below the critical range.

Tube Testing.—The removal of tubes that leak under the hydrostatic test of the boiler causes delay and is expensive, therefore, we believe it to be good practice to test all safe

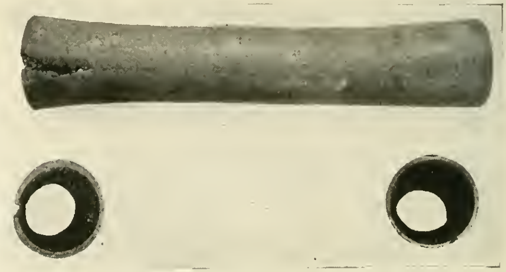


Fig. 8—Effect of Expanding Tube When Passing Through the "Red Short" Temperature Range. Right End of Tube Expanded Correctly at Proper Temperature

ended tubes before putting them into the boiler. The test pressure should be twenty-five percent in excess of the boiler working pressure and while under the test pressure the tubes should be struck near the safe end weld or welds with a two pound steel hand hammer or the equivalent.

One type of tube testing machine is shown in Fig. 9.

Tubes which on examination after cleaning are found to be pitted or worn one-third of the original thickness of the tube should be scrapped.

If the pitted or worn surface is not too great, it may be cut off and the good portion of the tube used in boilers having shorter tubes.

When tubes, otherwise good, have been reduced in weight below the limits given in Table 1, they should be discarded.

Tubes that are slightly pitted or otherwise weakened, but which are still serviceable, should be kept together and reapplied in sets of tubes which are in approximately the same condition.

Safe Ending

Good tubes should be safe ended as follows:

Safe ends should be scarfed on one end for half an inch, see Fig. 10, being tapered to 1/32 inch at end of scarfing.

Tubes to be safe ended should be expanded for the scarfed end of safe end so that they will fit snugly.

Place the safe end in end of the tube. Heat both to a welding heat. Draw out and quickly weld on the flue welding machine, taking care to see that the weld is smoothly made.

Fig. 9—One Type of Tube Testing Machine

Sucessive Safe Ending

It is recommended that body tubes contain not more than three welds at one time, with a total length of welded ends not to exceed 21 inches. If the total lengths of welds exceed 21 inches, all welds should be cut off and one piece of the tube welded on to bring the length up to the requirement. To this a new 5-inch safe end should be added at the firebox end at the first safe ending. Thereafter Table 2 should govern.

Superheater flues should not contain more than two welds.

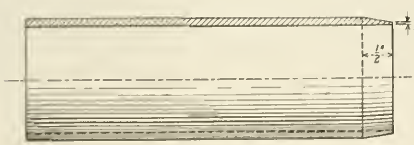


Fig. 10—Correct Method of Preparing Safe Ends for Use

The use of a safe end shorter than five inches is not recommended, Fig. 11.

First Application.—New flue.

Second Application.—Cut swaged end to 3½ inches and apply 5 inches safe end, cutting to length after welding.

Third Application.—Cut swaged end to 3½ inches and apply safe end just long enough to give required length.

Fourth Application.—Cut off previous weld and reswage end of original dimensions. Apply safe end of full diameter at smokebox end, just long enough to give required length. Expand to standard requirements.

Fifth Application.—Same as second.

Sixth Application.—Same as third.

Seventh Application.—Same as fourth, except that old safe end at smokebox end of the flue must be cut off and a longer safe end used.

Suggestions in Connection With the Ordering, Unloading and Storing of the Tubes

Ordering.—Requisitions or orders for boiler tubes, arch tubes, superheater flues and safe ends, for new work or replacements, should clearly state:

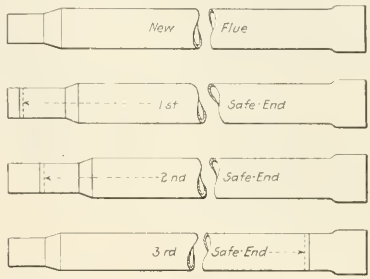


Fig. 11—Successive Applications of Safe Ends

Length .... in feet or inches.
Outside diameter .... in inches
Thickness .... in B. W. G. number, or in decimals of an inch.

The thickness of heavy wall arch tubes, water bars and marine stay tubes is often expressed in fractions of an inch: 3/16 inch, ¼ inch, etc.

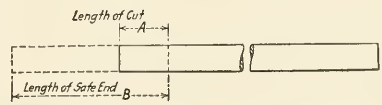


Fig. 12—Lengths of Safe Ends

Table 2.—Application of Safe Ends

Application	Length of Cut A Inches	Length of End B Inches	Remarks
First	...	..	new flue
Second	1½	5	one weld
Third	5½	8	one weld
Fourth	8½	11	one weld
Fifth	11½	14	one weld
Sixth	1½	5	two welds
Seventh	5½	8	two welds
Eighth	8½	11	two welds
Ninth	27½	30	two welds
Tenth	1½	5	three welds

Table 3.—Decimal Equivalents of Birmingham Wire Gage (B.W.G.) Numbers Used in Boiler Tube Practice

Thickness Birmingham Wire Gage Number	Inches
13	0.095
12	0.109
11	0.120
10	0.134
9	0.148
8	0.165
7	0.180
6	0.203
5	0.220

If tubes or flues are to be swaged or expanded, the fact should be stated on the order, and a blueprint or sketch furnished to the tube manufacturer. Heavy tubes for special purposes may have the ends upset and enlarged within certain limits. When such work is to be done by the manufacturer, a blueprint or sketch should accompany the order.

Length.—Tubes for locomotive type boilers should be ordered 1 inch longer and flues for locomotive superheater service 1½ inches longer than the actual distance between the outer sides of the tube sheets to allow for flaring and beading and irregularities in the tube sheets.

Measure carefully the distance between tube sheets. In new work, variations of ¼ inch to ½ inch may be found in the tube sheets of locomotives and horizontal return tubular boilers, due to distortion in manufacture. On boilers that have been in service, particularly locomotive boilers, bulging of the tube sheets may cause variations of an inch or more.

Safe Ends.—Buying safe ends cut to length is a costly practice, necessitating, as it does, a large stock of various sizes. It is more economical and satisfactory to purchase tubes in random lengths, cutting the safe ends as required.

RECORD OF FLUES															
	BODY FLUES							SERVICE		SAFE ENDS			SERVICE		
SHOP	APPLIED TO LOCO NO	REMOVED FROM LOCO NO	APP NO	NAME	MT'L	NUMBER	DATE APPLIED	MILES	MONTH	NAME	MT'L	DATE APPLIED	MILES	MONTH	REMARKS

Fig. 13—Service Record for Set of Locomotive Tubes

A good safe ending machine will handle 120 safe ends per hour at a very small labor cost.

Scarfing of Safe Ends.—Opinion differs as to the amount of scarf required to give the best results. Our suggestion is that safe ends be scarfed for a distance of ½ inch, the metal tapering to a thickness of 1/32 inch.

Unloading and Storing.—Tubes should be unloaded with care and placed under cover at once, the various sizes in separate racks. The ends of the tubes, if exposed to the weather, should be sprayed or coated with oil. Refuse lubricating oil answers the purpose, at very little cost.

Remedying Conditions Responsible for Tube Maintenance Work

A great deal of tube and flue repairs are due to:

Faulty application of tubes and flues.

Lack of standardization of tube setting tools, or tools of poor design.

Too many safe ends on tubes or flues at one time.

Poor workmanship in safe ending.

Continuance of tubes in service after they have become thin and worn out.

Tubes stopped up.

Abuse by careless or unskilled hot workers.

Cooling boiler too rapidly by injector and improper use of blower.

Cooling too rapidly by blowing down for washout.

Washing out hot boilers with cold water.

Lack of proper attention at washout period.

Delayed washout in bad water districts.

Firing up rapidly and raising steam too quickly.

Allowing fire to die next to tube sheet while locomotive is standing in engine house or yard.

Most of these conditions can be improved, if not corrected entirely, by the mechanical department. Defective or inferior material, bad fuel, impure feed water, poor boiler design and conditions beyond the control of the mechanical department may frequently be bettered as a result of constructive suggestions to the responsible departments.

Importance of Recording Boiler Tube Service

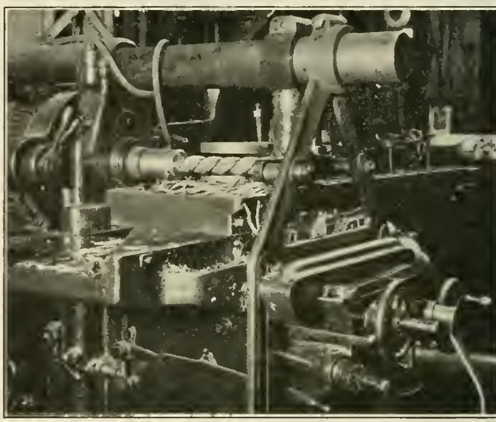
Recording the service life of tubes in locomotives running hundreds of miles every day and handled by two or more shops admittedly presents difficulties. But an accurate and systematic record of tube service is absolutely essential, if tube costs are to be reduced.

A suggested form for recording the service of a set of tubes is shown in Fig. 12.

Careful study of conditions disclosed by worthwhile records, together with modern flue shops, standardized tools and a generally adopted standard practice for setting and maintenance, would reduce the tube costs of American railroads by many thousands of dollars.

Spiral Milling Cutter Saves Time

THE operation of milling a side rod fork end, illustrated, was performed at the Sayre Shops of the Lehigh Valley in a fraction of the time required by former methods of drilling and slotting. In this particular case the work was done on a No. 5 knee-type Cincinnati miller, a special Goddard & Goddard spiral milling cutter, 2¼ in. in diameter by 12 in. long, being used. The side rod was of forged .50 carbon steel heat treated, the distance between the jaws



Spiral Cutter Milling Fork End of Side Rod

being 2½ in., the greatest width 8⅝ in., and the greatest depth 10 in. A cut was taken with the 2¼-in. cutter through the middle of the jaws using a feed of about ⅜ in. per min. and requiring 31 min. for the operation. A finishing cut was then taken along the top and finally a finishing cut on the bottom jaw, the total time required being 45 min. The cutter revolved at a speed of 80 r.p.m., the finishing cut being taken at a feed of about 2 in. per min. Owing to belt slippage and the large amount of hand feeding which was necessary, it was difficult to tell the feed accurately. This method results in a considerable saving over the former methods of drilling and slotting which would take not less than three or four hours.

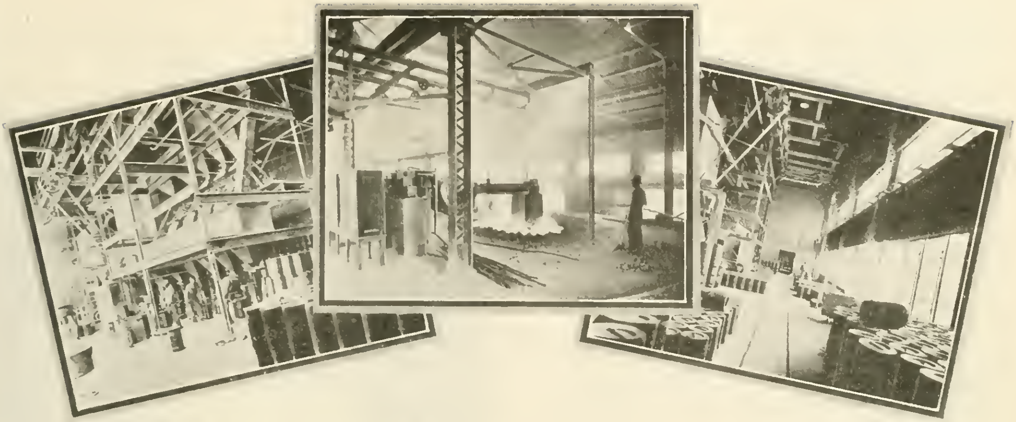


Fig. 1—Manufacturing Calcium Carbide by the Fusion of Lime and Coke

Principles of Oxyacetylene Fusion Welding

First Article of a Series Designed to Give Foremen and Welders a Clear Idea of Essential Principles

By Professor Alfred S. Kinsey*

THERE is so much interesting metallurgy and practical engineering involved in the use of the fusion welding of metals by the oxyacetylene torch that it is not surprising to find the engineer, the superintendent and other managers of men now giving careful consideration to the advancement of the art. This was sure to come, even though it may have seemed slow in doing so. The railroad superintendent of motive power, the master mechanic, the foremen would want to know the possibilities of the process, and much credit is due the shop foremen and the mechanics who have been the pioneers in the introduction of this type of fusion welding. They found the real value of the oxyacetylene torch even though so little had been written to guide them in the work.

Fig. 2—Battery of Electric Carbide Furnaces at Modern Plant of National Carbide Corporation

It is intended to have the following chapters cover the principles and practices of the process in simple detail, hoping that they will be of service to the shop manager who has not yet found it possible to give the necessary time to a careful study of the subject, and also that they will stimulate oxyacetylene welders to a better understanding of their work.

Before the advent of oxyacetylene welding the prevailing conditions were that: (a) Practically all welding was being done by the old forge method which depended on heating the metal to the soft plastic state and hammering the two ends together. (b) Only low carbon steel was being welded. (c) All jobs had to be taken to a forge fire for welding. (d) As most all forge welds were made in an open fire they were liable to be oxidized, made brittle by sulphur absorbed from the coal of the fire, and to be weak and coarse-grained from uncertain hammering and heat treatment.

It was time for a new way to make important strength welds, which came in the form of the "Autogenous" weld, depending on the melting and running together of the metal; that is, the transition was from the more-or-less uncertain plastic hammer weld confined to one metal, to the fusion cast weld made in a clean unoxidizing atmosphere under good control, and applicable to the successful welding of all the metals of shop practice.

Acetylene the Wonder Gas

An oxyacetylene weld, as the name implies, derives its high temperature flame from the combustion of acetylene as the fuel gas and pure oxygen as the supporter of combustion. No more interesting commercial gas than acetylene is to be found for such purposes. To it must be credited the success of the best fusion welding of metals.

Calcium Carbide. Acetylene is made by dropping calcium

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carbide into water, not water on carbide. In the manufacture of calcium carbide (Fig. 2) two substances are forced into combination, i. e., lime and crushed coke, by fusing them in an electric arc furnace (Fig. 1), which has a temperature of about 7,000 deg. F. The fusing of the lime and coke produces a material of a dark brown or gray color, and as it contains calcium from the lime and carbon from the coke it is called Calcium Carbide, the chemical symbols for which are $Ca\ C_2$. The action of the electric furnace on the lime and coke is indicated by the following: $CaO + 3C = Ca\ C_2 + CO$. This means that 56 lb. of quick lime (CaO) and 36 lb. of coke ($3C$) produce 64 lb. of carbide (CaC_2) and 28 lb. of carbon monoxide. (CO). A cubic foot of calcium carbide weighs 136 lb. Its specific gravity is about 2.25, that is, it weighs 2.25 times as much as pure water.

If calcium carbide is exposed to the air it will slake like ordinary quick lime. Therefore it is always packed in steel containers sealed tightly to prevent air or water slaking. It will not explode or take fire, but it must be protected from accidental contact with water which would cause it to form acetylene, a combustible gas which might catch fire.

If calcium carbide is dropped into water the resulting chemical reaction would be $CaC_2 + 2H_2O = Ca(OH)_2 + C_2\ H_2$. That is the carbide ($CaC_2$) and the water ($2H_2O$) produce slaked lime $Ca(OH)_2$ and acetylene (C_2H_2), or 64 lb. of carbide required 36 lb. of water to produce 74 lb. of slaked lime and 26 lb. of acetylene. In simpler language this means that a pound of pure carbide will yield about 5 cu. ft. of acetylene, but as commercial carbide may not be absolutely pure the usual figure is from 4 to 4½ cu. ft. of acetylene per pound of carbide.

Properties of Acetylene. Acetylene is indicated chemically as $C_2\ H_2$, which means that it contains 24 parts of carbon and two parts of hydrogen, or 92.3 per cent carbon 7.7 per cent hydrogen by weight. It is easily seen therefore that acetylene is a hydrocarbon gas, and as such is also a combustible gas, and like all other combustible gases, such as

Fig. 3—Portable Oxyacetylene Welding Equipment

common illuminating gas for example, it will burn and explode.

Acetylene burns in air with a smoky, sooty flame, but with pure oxygen it gives a brilliant flame having a temperature of about 6300 deg. F.

When a hydrocarbon gas burns its products of combustion are carbon dioxide and water. The burning of acetylene is therefore represented by the following equation: $2C_2H_2 + 5\ O_2 = 4CO_2 + 2H_2O$, which shows that to burn two volumes of acetylene requires five volumes of oxygen and the combustion will yield four volumes of carbon dioxide and two of water.

Acetylene contains 1685 B. t. u. (British thermal units) per cu. ft. Its ignition temperature is 1076 deg. F. The specific gravity is 0.91; that is, acetylene is lighter than air

Fig. 4—Cross Section Through Acetylene Cylinders Showing Infusorial Earth Packing

in the proportion of 91 to 100. It would therefore cause a balloon filled with it to rise.

Endothermic Property. Some compounds throw off the heat developed in their formation, while others absorb this heat, storing it away for future release. In the latter group is to be found acetylene gas, and its property for absorbing heat is called *Endothermic.*

When calcium carbide is dropped into water it slakes, that is there is a chemical reaction between the lime in the carbide and the water. This reaction develops energy which is stored up in the acetylene gas. When acetylene is burned, as in a welding torch, its first temperature of combustion is about 4100 deg. F. Then its stored up energy is released and the temperature rises to about 6300 deg. F. This is due to the endothermic property of the gas, which amounts to about 225 of the 1685 B. t. u. per cu. ft. of acetylene.

Safety. Considering the combustibility of the gas, its extensive use and the fact that it is most always connected with metals in the red hot condition, acetylene is probably the safest burning gas in engineering practice.

Acetylene being composed of carbon and hydrogen, C_2H_2, is a hydrocarbon gas and will burn and if it will burn it is possible to make it explode. All combustible gases will explode, some much more easily than others. That is, some gases require a very exact proportion of gas and air to produce an explosion, while others are more sensitive and will explode easier. This proportioning of gas and air is called the Explosive Range, which for acetylene is from 3 per cent of acetylene and 97 per cent of air, to 35 per cent acetylene and 65 per cent air.

We have spoken of the explosibility of acetylene when mixed with air at atmospheric pressure. As most all acetylene is used when under a higher pressure let us now consider its safety in that condition.

If acetylene is compressed to about 22 atmospheres (an atmosphere is equal to about 15 lb. per sq. in. at sea level so that 22 x 15 equals 330 lb. at freezing temperature, or about 700 lb. per sq. in. at 70 deg. F., the acetylene gas will change to liquid, that is liquefy. Attempts have been made to use acetylene in this condition but it was found to be too dangerous. Do not confuse liquid acetylene with dissolved acetylene.

However, when compressed to one atmosphere or 15 lb. per sq. in. it is absolutely free of any risk of explosion due to its pressure, and this pressure is quite sufficient for any uses made of acetylene, such as in welding and cutting torches, transmission through pipe lines for such welding and cutting torches, etc.

Dissolved Acetylene. The safest way to compress, store and transport acetylene is in the dissolved state. The usual way of preparing dissolved acetylene is as follows: After the gas is made from the calcium carbide it is compressed into specially prepared steel cylinders (Fig. 3), and is then ready for the trade. These cylinders are carefully constructed of the best steel and in accordance with the regulations of the Interstate Commerce Commission. They are considered to be absolutely safe. Dissolved acetylene cylinders are packed with a porous material, usually asbestos or infusorial earth (Fig. 4). This packing is put into the cylinder before the bottom is put on. After welding the bottom in place, a colorless chemical, called acetone, is poured through the opening at the top of the cylinder into the packing. The cylinder is then connected to the compressor so that it may be charged with acetylene.

As the acetylene enters the cylinder it is absorbed, or dissolved by the acetone. This chemical will dissolve twenty-

Fig. 5—Weighing Dissolved Acetylene

four times its own volume of acetylene at ordinary temperature and pressure, and will increase its dissolving capacity an equal amount for each atmosphere which the pressure is increased.

As the acetylene is dissolved the acetone increases in volume, and when its pressure is reduced, as in the opening of the valve of an acetylene cylinder, the dissolved acetylene again becomes gas, and passing through a hose or steel pipe to a welding or cutting torch it may be used without danger of explosion. Even though the acetone has proved to be so valuable to the use of acetylene, it would be of little worth were it not for the fact that the infusorial earth packing, possessing a porosity of about 80 per cent, separates the acetone with its dissolved acetylene into small particles. This prevents the accumulation in pockets of free acetylene and the possibility of an explosion.

Measuring Dissolved Acetylene. The only accurate way to measure compressed acetylene is by weighing it (Fig. 5). The reading of the gage on the cylinder will give the pressure in lb. per sq. in. but that will vary with the temperature, even though the quantity of acetylene has not been disturbed. For example, a cylinder of dissolved acetylene filled to 250 lb. per sq. in. at 70 deg. F. would show a much lower pressure when the temperature was down to freezing. This of course is due to the contraction of the molecules of the gas as the temperature falls and to their expansion with the rise of temperature. But the important thing to remember is that this variation of temperature and pressure does not affect the quantity of acetylene in the cylinder.

A pound of dissolved acetylene is equal to 14.5 cu. ft. at 70 deg. F. and atmospheric pressure. It is therefore the commercial practice to charge the acetylene into the cylinders by weight and bill the customer by transforming the weight of acetylene to volume in cubic feet.

While under ordinary conditions it would be proper to determine the quantity of a gas from its pressure and temperature, the reasons for not being able to do so with dissolved acetylene are as follows:

1. The porous filler in the acetylene cylinder will vary in porosity to such an extent that the amount of dissolved acetylene it can absorb will not be the same for all cylinders.
2. The acetone used in the cylinders to dissolve the acetylene may vary in its absorptive powers enough to allow different amounts of acetylene to be dissolved in the different cylinders.
3. The temperature of the acetylene inside the cylinders is difficult to determine, due to the filler insulating the dissolved acetylene from the atmosphere surrounding the cylinder. It sometimes takes as long as 30 hours for the acetylene in the center of the cylinder to become of equal temperature with the air outside the cylinder. It would therefore be quite easy to obtain a false temperature reading for the dissolved acetylene.
4. Even though much care is exercised in the manufacture of acetylene cylinders, they are not near enough alike in size to allow their contents of acetylene to be determined from temperature and pressure observations.

(*To be continued*)

Squaring Device for Assembling Tender Trucks

In assembling trucks with cast steel side frames considerable difficulty is frequently encountered in alining and holding the side frames square both horizontally and vertically while the transverse members of structural steel are being riveted in place. The result is not only the expenditure of an amount of labor disproportionate to the actual work performed but the failure also to secure accurate results. A simple means of holding the truck in alinement until the riveting has been completed has been developed in the tank shop of the West Milwaukee shops of the

Trams for Squaring Tender Trucks While Assembling

Chicago, Milwaukee & St. Paul, where it is being used in the building of tender trucks.

The complete equipment for squaring up and holding the truck frames in place is shown in the illustration. It consists of four tram rods and two tie bars of angle section. The tram rods are of 1¼-in. round bar stock with the ends bent at right angles to the body for insertion in the pedestal bolt holes in the ends of the truck frames. The diagonal trams are applied from the top while the transverse trams, one at each end of the truck are applied from underneath and require supports to hold them in place. These rods hold the truck frames in proper horizontal alinement but do not insure the correct vertical relationship of the two side frames. This is secured by the use of the two angle tie bars which extend across the truck and are bolted up firmly against the faces of the journal box tie bar brackets.

In building the trucks the parts are first assembled and loosely bolted up after which the angle tie bars are securely bolted in place. The tram rods are then inserted in the pedestal bolt holes and the assembly bolts tightened up. The truck is then ready for riveting and not until this work has been completed are the tram rods and tie bars removed.

Speeding Up the Manufacture of Saddle Pins

Description of Tooling Arrangement Enabling National Acme Automatic to Turn Out Fifteen Pins an Hour

With the present wage scale it is highly important to install labor-saving machinery in railway shops, and wherever the demand for a given product warrants, it should be made on automatic, high-production machines. The saddle pin illustrated in Fig. 1, for example, can be made more quickly and cheaply on an automatic probably than on any other type of machine. On account of its design and dimensions, this pin will serve to illustrate a general class of motion pins which can be economically manufactured from bar stock on multiple spindle automatic screw machines.

These machines are not only fully automatic in nature, but designed for rapid production and accurate results without undue complication in the mechanism. They are made to stand up under heavy cuts and are indispensable in any plan for centralized production. Under this system there is sufficient work in a large shop to keep a battery of automatics busy all the time and no one can doubt the reduced unit production cost. Moreover by standardizing pins and similar parts they will be needed in sufficient quantity to warrant the installation of automatics, not only in large shops but in many smaller shops as well.

The following description refers to a method of machining saddle pins on a 4-in. multiple spindle automatic made by the National Acme Company, Cleveland, Ohio. A production speed of 15 pins per hour is readily obtained but by a change in tooling it is possible to get a higher production. This speeding up, however, would not permit of as good a

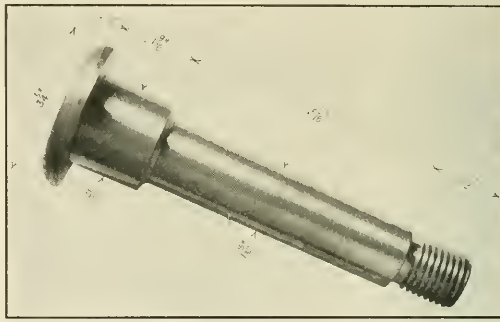


Fig. 1—View Showing Dimensions and Finish of Saddle Pin

finish to the parts. It is, of course, possible to go to the other extreme and use a number of finishing tools which

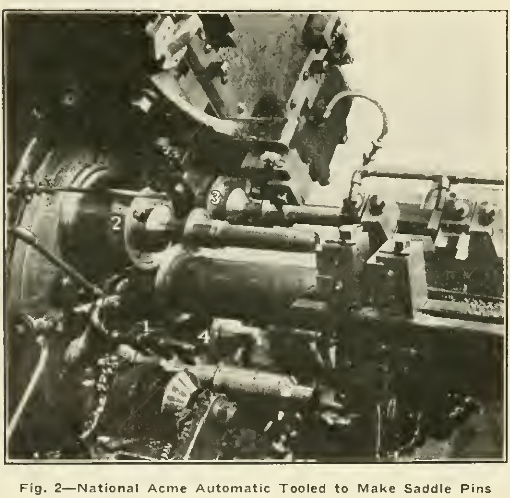


Fig. 2—National Acme Automatic Tooled to Make Saddle Pins

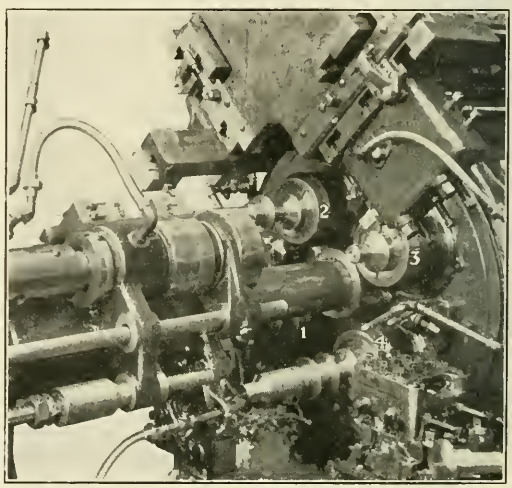


Fig. 3—Rear View Showing Cut Off and Feeding In Portions

would cut down the production speed. It is difficult to give an arbitrary time for the operation which is dependent upon many conditions, including the kind of steel and the quality of finish required. For example by changing the tooling set up a little and leaving out the finishing turn, the production quoted can be increased one and a half times.

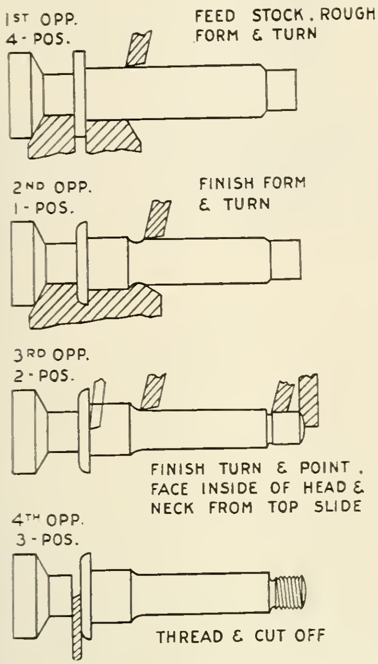


Fig. 4—Sketch Showing Detailed Operations at Each Position

The Operations in Detail

The saddle pin dimensions and in a general way the finish obtained is shown in Fig. 1. The tooling arrangement is shown in Figs 2 and 3 in which the revolving stations are marked *1*, *2*, *3* and *4*. It may be stated in advance that the stock is fed in in position *4* and as soon as the necessary operations in that position are complete, the stock advances to positions *1*, *2* and *3*, being threaded and cut off in the last. The operations performed at each position can perhaps best be understood by reference to Fig. 4.

As previously stated. the first operation takes place in sition *2* the pin is finished, turned and pointed, being faced The stock is then advanced to position *1* where the second operation consists of finish forming and turning. In position *2* the pin is finished, turned and pointed, being faced inside the head and neck from the top slide. The pin is threaded on the end and cut off in position *3*. The threading is done by means of a Namco self-opening die head, the cutting-off tool being held in the top slide.

It may be stated that roughing cuts only are taken in positions *4* and *1*, turning half the distance in each case. In position *2* the pin is turned the whole length with a light finishing cut. By performing the heavy forming and turning operations on the two lower tool positions, advantage is taken of the greater rigidity of the support which allows a higher running speed.

The minimum number of parts for which it will pay to set up an automatic together with other valuable information is included in an article entitled, "Automatic Machines an Aid to Economy," published on page 344 of the June, 1920, *Railway Mechanical Engineer*.

The Foreman's Responsibility to His Men*

Some Interesting Facts Which Should Be Kept Clearly in Mind by Foremen and Explained to Their Men

By Elisha Lee
Vice-President, Eastern Region, Pennsylvania System

BEFORE we can properly appreciate the foreman's responsibility to his men, we must first fix in our minds the foreman's strategic position in the railroad industry. Under our so-called factory system, men engaged in physical production have in many cases become very far removed from the executive officers of the companies by which they are employed. The days when the shop boss was also largely or entirely the owner of the business, are long since past

Strategic Position of Foremen

It has become necessary to weave into the industrial fabric of production a new element, which shall serve as the point of contact between those men engaged in actual physical production and those whose responsibility it is to dispose of the output and make its continued production possible. This very great responsibility has devolved upon the man who is universally known as the foreman; and in direct relation to the extent by which he becomes farther removed from the executive heads of his particular industry, as a result of its size, do his difficulties multiply and increase in importance. What should be emphasized is the responsibility of the foreman to his men because of the position which he occupies as the direct point of contact and in intimate relationship with the workingmen.

The management recognizes in smaller industries the men engaged in physical production and the executives are in sufficiently close touch with each other to have a clear understanding as to their respective problems, but in a large industry, like that with which we are connected, the impression which an employee will gain of the company will be largely that conveyed to him by the foreman. To the average worker, the foreman is the whole company, and the extent to which the foreman is tactful, well informed, and otherwise thoroughly competent, will in turn be reflected directly in the contentment and productiveness of the men

Diplomacy Needed; Eliminate Suspicion

But what does "tactful" mean as applied to the position of foreman? You have all had that word given you many

*From a talk before the Shop Foremen's Club at Harrisburg, Pa., February 17, 1922 times as describing, in a general way, how you can best handle men; and at the outset I want to acknowledge that it has a very wide significance and to a large degree can only be properly observed by intimate familiarity with the characteristics of the individual employee. But there are a few of the broader phases of the relations between the foreman and the employee which are particularly applicable to the state of mind of very many workingmen at this time, about which I want to speak.

The use of tact, in its most effective form, is to clear the worker's mind of those things about which it is disturbed, and among these things the first is "suspicion."

There is nothing so effective in distracting one's interest and attention as *suspicion,* and the seriousness of this is that that mental disease, as I think it should rightly be called, is and has been widely prevalent. Our great nations are suspicious of each other, statesmen of particular nations are suspicious of each other, citizens are suspicious of the men they have elected to office, men engaged in business are suspicious of each other, and in social life each is watching the other fearing he will try to "put something over." This is a most unfortunate state of affairs. The business man is afraid to plan the future course of his business because he is suspicious of what somebody might do, and the workingman is in turn suspicious of the motives of the business man by whom he is employed. Much valuable time and many opportunities are being lost by this very condition.

Employees Must Be Correctly Informed

In connection with the matter of policies as they affect employees, there is another feature, and that is the passing of these policies down through the foreman to the individual employee. This problem of having our employees understand, and as a result approve and be governed by the real intent of our rules, regulations and general methods of conduct and operation, is recognized as one of the most serious and difficult which confront the management at the present time. It matters little how carefully policies may be planned, or how eminently fair these policies may be to the men, if they are not properly presented by the foreman, they are likely to result in the greatest discontent and a discontented employee immediately becomes a less efficient employee, and sometimes a menace to the whole organization. It has been my observation that the great majority of discontented employees are in this state of mind because of misunderstanding or poor tact on the part of some of their superiors; also in the matter of strikes, which is the culmination of discontent, taken as a whole, the cause is generally directly traceable to something other than wages, although this is often brought in as part of the final demands.

With our great number of employees, representing practically every nationality on the face of the globe; involving some 1,500 different occupations, located in 14 different states, it becomes impossible for the management to convey policies in more than a very general way, and the responsibility of getting these operating rules and regulations to the individual men in the proper way rests largely with the foremen.

Instructions Must Be Interpreted

In many cases foremen dispose of this responsibility, or at least think they do, by means of posting notices, or handing typewritten instructions to the men. This unfortunately is a prolific source of misunderstandings. No foreman has fulfilled his responsibility in the issuance of instructions until he has satisfied every man under his jurisdiction as to what such instructions mean, why in a general way they have been issued, and that they are on the whole to the best interests of at least the great majority of employees; and if a foreman himself doesn't know, it is his and his superior's responsibility to find out through the regular channels.

A Foreman Must Have Faith in His Men

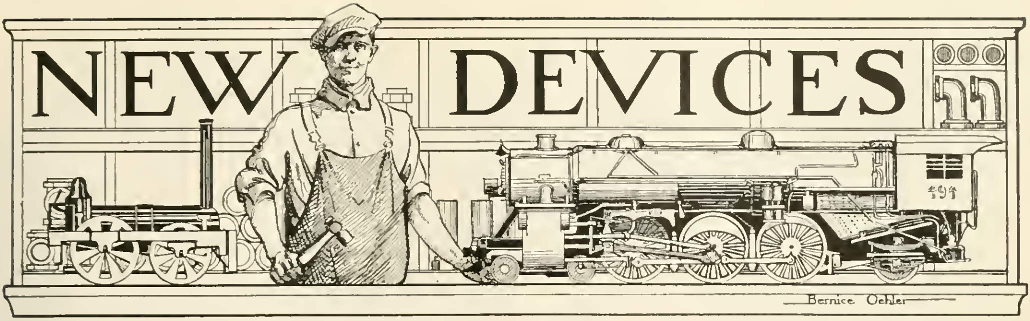
The great engineers have not been those with the greatest technical knowledge, but rather those who had the power to gather around them a staff of loyal men. It was these men who loved them so as to follow them across the seas, into the wilds of the forests, over the mountains, scoffing at danger and suffering, that made them great engineers. The great manufacturers are not those possessing vast mechanical knowledge, but rather those who have visions and dreams, the men with faith, courage and hopefulness. The great bankers are not those who can best analyze securities and statements. Seldom has a great accountant ever become a great banker. The great bankers are the men who have faith in their fellow men, who are willing to trust, help and boost those who come to them in distress. The real asset of every successful bank is not the securities in its vaults, but the hospitality personified by its officers and employees. The successful banks of every community have reached their present positions owing to some one or more persons possessing this spirit of hospitality.

Nothing today would do so much to bring about better conditions than a resolve on the part of every one to be hospitable and try to make all with whom we come in contact feel happy. I repeat; efficiency and happiness are largely synonymous! The development of hospitality among his men is another one of the important responsibilities of the foreman. And I believe many of you are wondering right now how it can best be done—maybe this little story of real life will help you. In Cleveland there is a very able banker who enjoys the rare distinction of being the man of a million friends—asked how he induced so many people to like him, he replied, "It's very simple—just like the other fellow first."

Results Accomplished by Efficient Leadership

I believe herein lies the secret to a large extent of having a spirit of hospitality prevail among your men—be yourself a leader in the practice of it. Men are most human and respond to what is in this day recognized as decent treatment. The average worker does not wish to be coddled; he regards such treatment as an affront to his self respect; he wants to be dealt with frankly, but on the other hand he feels the day is past when the foreman shall resort to so-called "driving tactics," and that this method of supervision has been replaced by the method of leading or directing is an attitude which clearly recognizes the worker as a man with every form of rights which we have come to cherish in this great country. It has been my observation that this modern method of managing men is by far the most effective today, and hospitality is one of the essential elements in this form of supervision.

There is just one more of the many responsibilities of the foreman to his men I want to touch on. Sometime ago I was at Niagara Falls and among other things observed the remarkable engineering feat where a considerable quantity of that great body of water was forced to transform its energy into electric current for use in the nearby cities. Huge channels were cut through solid rock, substantial structures were erected where the process of transformation took place, and cables of transmission went out in every direction,—all at great cost. But I said to myself, of what value would that all be if they had no dynamo! And what is the dynamo of men—it is enthusiasm—that is the generating power within us; it can salt and season even unpalatable work, but to be able to muster up enthusiasm you must believe in what you are doing—believe in the essential character of what it does, believe in the magnitude of its task, and believe in the thoroughness with which it does it.



Machine for Cutting Accurate Staybolts

DEFECTIVE or poorly fitted staybolts cause a large number of boiler casualties and much expensive boiler repair work. Perhaps the most striking feature of the new line of Lassiter-Millholland staybolt machines just placed on the market by the Dale Machinery Company, New York, is the provision of a lead screw insuring uniformly accurate pitch and continuous lead for all threads cut. The machines are made in two easily convertible types A and B. Model A, illustrated in Fig. 2, is made for reducing centers, turning and threading both ends of rigid side staybolts; also for cutting them off from bar stock. This is an entirely new machine, rigid and well-proportioned, with a special feed box, apron and lead screw designed to prevent lagging or creeping of the die head when threading.

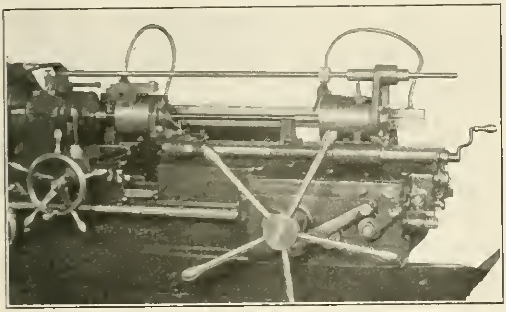


Fig. 1—Model B Equipment for Turning and Threading Crown Stays

The ground hollow steel spindle is equipped with a three-step cone pulley and a double friction back gear, giving nine spindle speeds. Speed changes are made through frictions without stopping this spindle. The automatic chuck and bar feed are operated by the turnstile engaging a rack and pinion. One set of one inch collet bushings is provided.

The hexagonal turret is mounted on a substantial slide moving directly on the ways and provided with taper gibs for adjustment. The turret binding bolt has a 1¾ in. hole to permit the bar to pass through. Automatic adjustable stops are provided for disengaging the feeds. The double plate apron is attached to the slide, being driven from the feed box by a lead screw. Two half nuts are engaged with the lead screw for threading, and bevel gears, driven by the spline through a friction, are used for turning the relief. The feeds are automatically disengaged at the desired points and are so interlocked that they can only be engaged separately. For relieving the middle portion of the bolt, a single cutter roller box mill of special design is provided as shown in Fig. 3.

For threading (Fig. 4), a modern automatic self-opening die head is so controlled by the lead screw as to produce accurate threads of uniform pitch and continuous lead on both

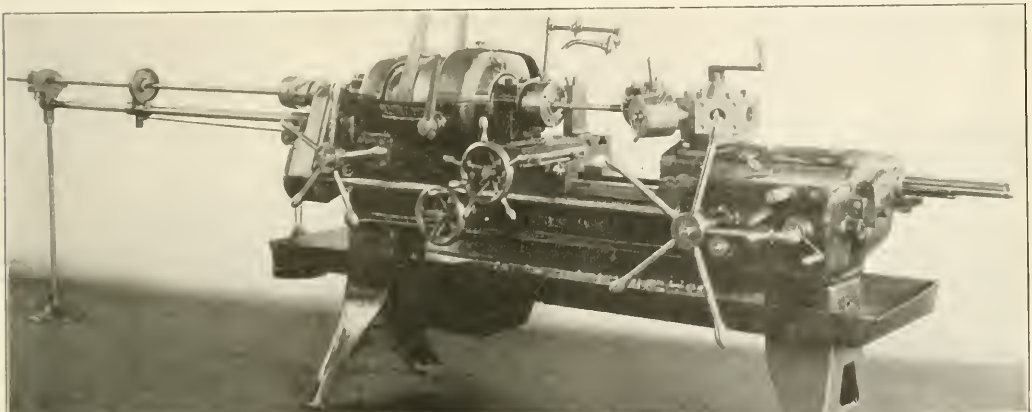


Fig. 2—Lassiter-Millholland Model A Machine Equipped for Cutting Side Staybolts from Bar Stock

ends of the bolt. As the die head completes the first threaded portion, the machine is speeded up by the headstock friction, passed quickly across the relief portion and then slowed up to the proper speed for continuing the thread, the lead screw being engaged until threading is completed. Staybolt threads of 11 and 12 per inch, and 2½ and 3 millimeter pitch may be cut by varying the change gears in the feed box. The cross slide provides for necking and cutting off staybolts.

The machine is provided with bar feed which moves the stock against a stop when the automatic chuck is released. With two sets of chasers the die head has a capacity to cut ⅞ in. to 1¼ in. bolts to any standard pitch desired. Bolts 12 in. long can be turned.

Model B Machine

The Lassiter-Millholland Model B staybolt machine is shown in Fig. 1, equipped to turn the taper and straight diameters simultaneously and thread both taper and straight surfaces in uniform pitch and continuous lead; also simultaneously. The turning and threading operations are done separately but both can be performed on the same machine

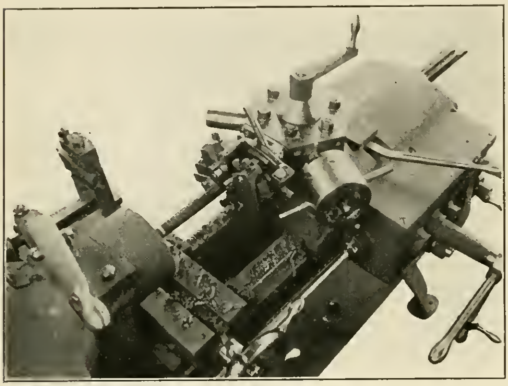


Fig. 3—Relieving the Middle Portion of a Rigid Side Stay

by replacing cutters by chasers. The bolt is gripped at the square end in a special collet with adjustable stop, the turning feed is then engaged from a friction in the apron and two turning heads on the slide are fed over the portion of the bolt to be finished.

Modern die heads with solid cutters for turning and chasers for threading are used. Both the cutters and heads readily operate as a hollow mill, the front head being equipped with a taper attachment and tapered cutter, giving its cutters a slight opening movement as it feeds forward. The cutters in the rear head are straight. Both heads are opened automatically at the correct instant and are closed by adjustable cams on a slotted bar. For threading the cutters in both heads are replaced by chasers, those in the front head being tapered, ground after hardening and accurate to within .002 in.

The heads are held in a constant relation on the slide which is fed forward by a nut and lead screw in the apron. The result is a bolt with threads on both taper and straight

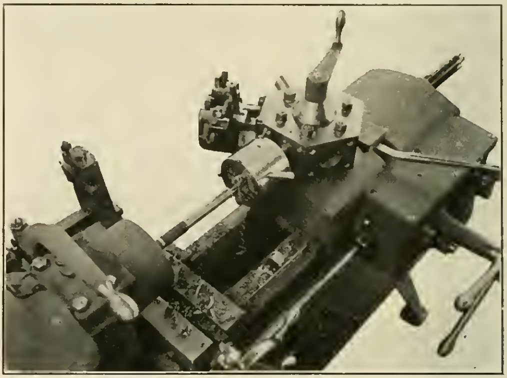


Fig. 4—Threading One End of a Rigid Side Stay

ends concentric and in continuous lead and uniform pitch. The rear die carrier is adjustable on the slide by means of a fine pitch screw and may be set for any bolt from 14 to 36 in. long. A V-block on the slide prevents the bolt from dragging in the chasers when the die heads are open. A permanent spacer bar, accurately made, is furnished with each machine to set the die heads in continuous lead when changing for length. For button head radial staybolts a cross slide is provided for facing the button heads.

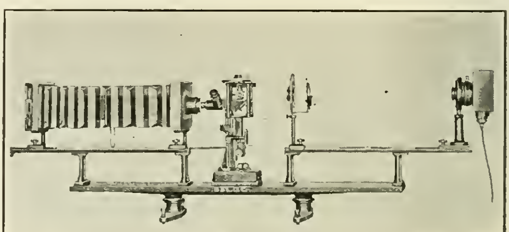
The machine has a capacity to turn and thread bolts ¾ in. to 1½ in. diameter by 14 in. to 36 in. long. The length of the slide is 34 in., the maximum turning length being 5 in. The approximate floor space is 2 ft. 8 in. by 8 ft., the approximate net weight being 3,500 lb. Both machines can be furnished in geared head type arranged for single pulley or motor drive.

Apparatus for Taking Microphotographs

Railroad men will be interested in the new type E camera illustrated which has been developed by the Bausch & Lomb Optical Company, Rochester, N. Y., for taking highly magnified photographs of sections of iron and steel structure. One essential object of this device is to determine the structure of a test piece of steel under consideration and it often proves valuable in determining the cause of failure of metal parts.

This new camera has been designed for maximum efficiency and convenience in use, being regularly supported on a low stand for use on a laboratory table or for use on a suspended platform. It is offered to those desiring a thoroughly efficient equipment for metallographic work with size of plate limited to 5 in. by 7 in., and with the possibility of using special accessories for low power work.

The stand is a heavy cast-iron rim plate supported on two feet with leveling screws having a spread of 15½ in. The two sections of the optical bed, each 25 in. long graduated in millimeters and marked in centimeters, are attached to the plate by means of four supports, one pair for supporting the



Bausch & Lomb Complete Metallographic Outfit camera parts and the other the illuminating system. The total overall length is 63 in.

The camera consists of two wooden frames connected by bellows, with a total extension of 24 in. from eye piece to plate, with cast iron supports attaching to the optical bed by clamping blocks. The rear frame is fitted with a hinged door with springs holding the plate holder firmly in position, while the front frame is fitted with a front board, flange and light-tight connector for connecting with the eye piece of the microscope.

The illuminant is either a Tungsarc with starting and controlling resistance or a 6-volt, 108-watt lamp with transformer in a housing supported by a single post, adjustable for height.

Unusually Powerful Vertical Surface Grinder

THE machine, illustrated, is one of the heaviest and most powerful vertical spindle surface grinders ever built, being a recent addition to the line of grinding machines made by the Blanchard Machine Company, Cambridge, Mass. Fig. 1 shows the front view of this machine, which is known as the No. 27-R. The overall dimensions of the machine are 12 ft. 6 in. long, 7 ft. 6 in. wide, 10 ft. high, and the total weight is 30,000 lb.

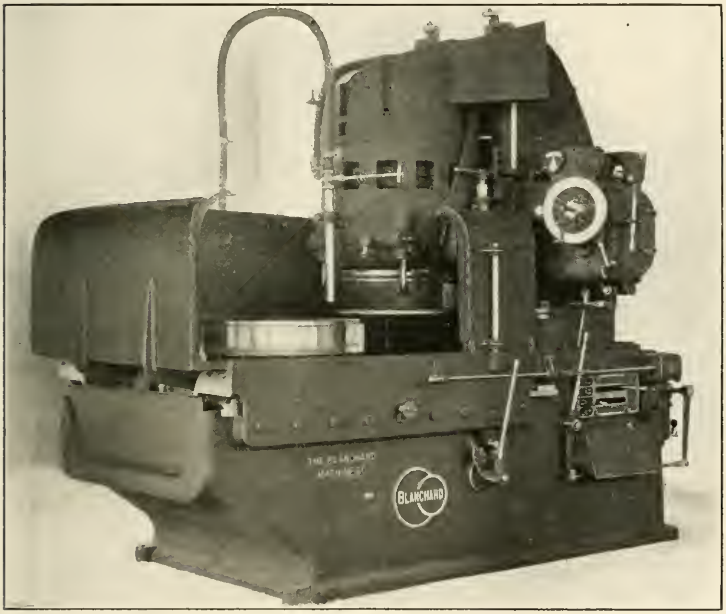


Fig. 1—Blanchard No. 27-R High Power Vertical Surface Grinder

In general arrangement it is similar to the No. 16 Blanchard grinder and operates in the same way. The work is carried on a rotary magnetic chuck, 48 in. in diameter, which is moved horizontally from the loading to the grinding position, and there rotated continuously while the wheel is gradually fed downward. Owing to its size and weight the No. 27 chuck and table is traversed by power. In other respects the operation is like that of the No. 16.

The grinding wheel is 27 in. in diameter, 7 in. deep, with rim either 2 in. or 3 in. thick. It is sulphur mounted in a cast iron retaining ring, attached to the faceplate by six screws, and is wire-banded. The wheel head weighs three tons and has built into it a 60 hp., 600 r. p. m. induction motor. The rotor is directly on the wheel spindle, which is $5\frac{1}{2}$ in. in diameter and is carried on two large radial-thrust ball bearings. A spring take-up at the upper end exerts an upward pull on the spindle which exceeds the weight of the rotating parts by 1,000 lb. This initial load on the lower or main thrust bearing eliminates all play or backlash. The main bearing has a rated thrust load capacity of over 25,000 lb. Fig. 2 shows the principal parts of the wheel head with a man of average size standing near them. The main bearing is in the left foreground of the picture.

The wheel safety guard is of 5/16-inch steel plate, carried on three heavy steel rods, and has a convenient rack and pinion mechanism for vertical adjustment. A wheel dresser attached to the head provides for dressing or sharpening the face of the wheel while grinding. There is the usual water supply to the inside of the wheel through a 2-in. pipe and to the outside nozzle through a $1\frac{1}{2}$-in. pipe.

The head is mounted to slide vertically on a massive column, whose proportions are best seen in Fig. 3. The usual Blanchard three-point support, is used to fasten the column to the base, thus making it easy to secure and maintain proper alignment.

The vertical motion of the wheel head is controlled by a heavy feed screw, $4\frac{1}{2}$ in. in diameter, carried in ball bearings in the column. This screw is driven through a gear box mounted in the column, receiving its power from the upper pulley in Fig. 3. Both hand and power feeds are provided by means of the box on the front side of the column. The power feed has an automatic stop, also a convenient adjustment, giving feeds from 0.0005 to 0.005 in.

Fig. 2—Relative Size of Wheel Head Parts

per rev. of the chuck. A single lever controls the engagement of the power feed, and the raising and lowering clutches, and is arranged so they cannot by any chance be simultaneously engaged.

Referring further to Fig. 3, in the lower portion will be seen a large pulley which drives the chuck rotation, and to the left of it, the pulley which drives the water pump and table traverse. The chuck is driven through a four-speed sliding-gear box, with friction clutch for starting and stopping, interlocked with the gear shift. Power for all purposes, except driving the wheel, is supplied by a 5 hp. motor on the farther side of the column seen in Fig. 3. This view also shows the pump and water piping, also the box containing the clutches for the traverse motion of the chuck.

The rotary magnetic chuck for holding the work is 48 in.

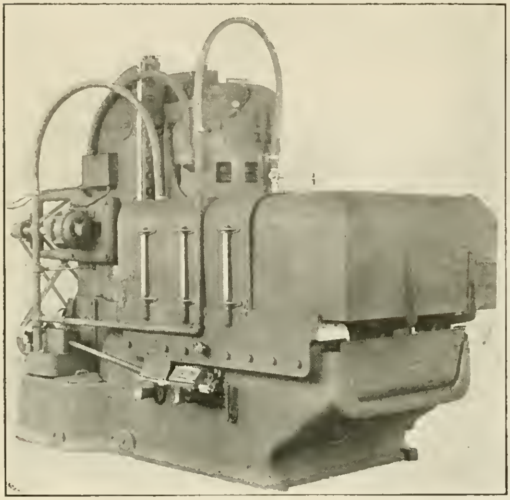


Fig. 3—Right End Front View

in diameter and is of the Blanchard one-piece steel type. It has closely spaced poles suitable for holding either small or large work. The face is of brass and steel, absolutely waterproof.

The chuck is carried on a substantial table, sliding on the base on one flat and one V way. Ample arrangements are made for cleaning the water tank. The pump tank is accessible for cleaning but rarely requires it. The total water capacity is 425 gals. Efficient waterguards, of $\frac{1}{8}$-in. steel plate, entirely surround the work and wheel. There is also a safety guard of 5/16-in. steel plate surrounding the grinding wheel.

The machine is constructed throughout with a view to

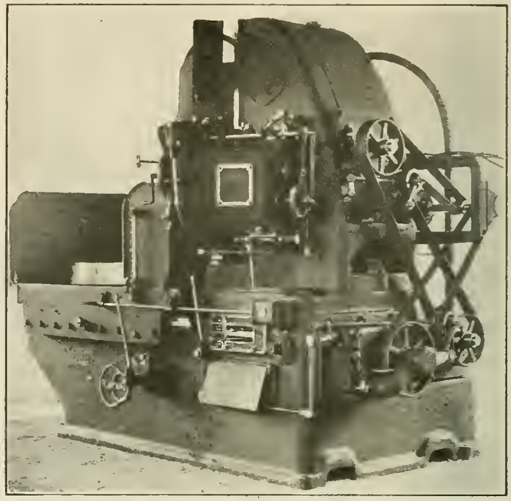


Fig. 4—Rear View Showing Table Drive Arrangement

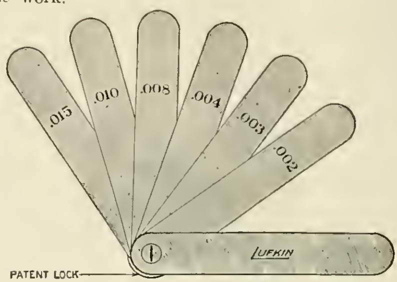
durability and low maintenance cost. The lubrication has been carefully studied, and both main gear boxes have pressure feed to every bearing from submerged gear pumps. Other important units have a reservoir of oil with means to circulate or splash onto all bearings. All gearing is of steel and the sliding gears are of heat treated alloy steel. The protection against dirt and water is very complete.

Work up to 60 in. in diameter and 16 in. high or 20 in. high (with standard 42-in. chuck) can be ground on this machine. A 27-in. wheel, either 6 or 7 in. deep, can be used. The recommended wheel speed is 580 r. p. m. and four chuck speeds of 3, 5, 8 and 13 r. p. m. are available. The hand and power feeds are 0.010 in. and 0.0005 to 0.005 in. per rev. of the chuck.

Thickness Gages With Locking Clamp

A PATENT lock for use on its thickness gage sets has recently been developed by the Lufkin Rule Company, Saginaw, Michigan. By means of a lock nut any one or more of the leaves can be locked and held firmly in any position. This feature is of particular convenience where the full length of the gage is needed to reach the opening the measurement which is desired. In this position the gage has a full length of $5\frac{1}{2}$ inches. The ability to lock the leaves at any other angle is also a matter of convenience in many cases. With any two or more leaves separated from the others, a convenient limit gage is provided. The gages are made in several sizes which include different ranges of measurements. Each leaf is accurately ground to thickness, tested and marked with its thickness.

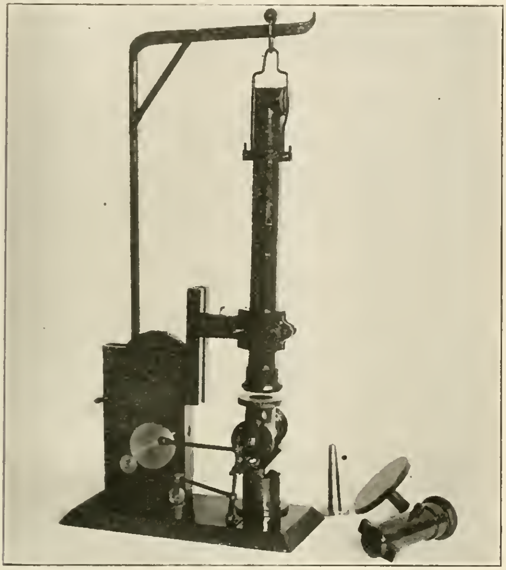
Besides being a valuable tool for machinists and foremen in railroad machine shops this patent lock thickness gage should prove of material assistance to locomotive inspectors. These men watch the work of assembling locomotives in the shops, making frequent inspections of those parts which are required by I. C. C. or railroad rules to fit within certain specified limits. A thickness gage with leaves which can be locked in any desired position would be extremely valuable for this work.



Lufkin Thickness Gages Provided with Patent Lock Nut Feature

Automatic Steam and Dry Pipe Grinder

A MACHINE designed to grind automatically and accurately the various steam-tight ball joints in connections of the main steam passageways from the locomotive throttle valve to the cylinder saddles has been



McGrath Automatic Steam and Dry Pipe Grinder

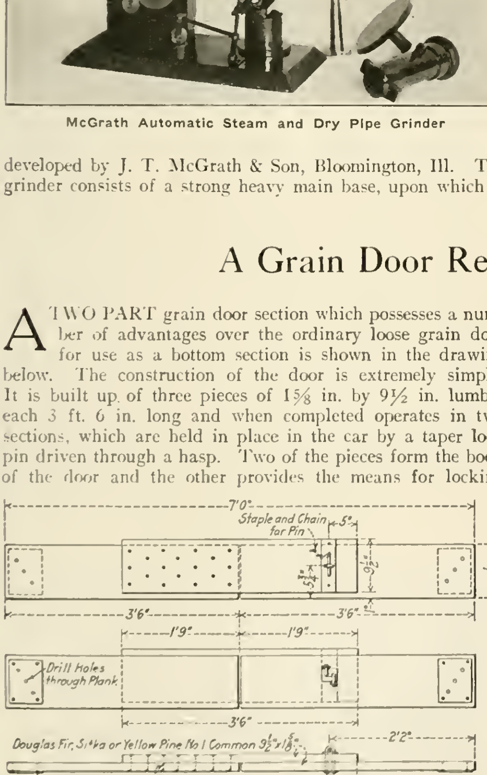
developed by J. T. McGrath & Son, Bloomington, Ill. The grinder consists of a strong heavy main base, upon which is carried the oscillating table, the raising and lowering cylinder, the timing cam and the automatic operating air valve. The main upright carrying the tilting, sliding head is cast solid with the base. It also carries the jib crane when this is used with the machine. The pinion gear engages the teeth in the tilting head and with the locking pin gives an easy adjustment to any angle desired as in the case of the various shaped steam pipes of the many different locomotive types.

The driving shaft and disc gear are connected to the oscillating table through a crank and connecting rod which impart the grinding movement. The raising cylinder carries the oscillating table on a ball bearing at the end of its piston rod. The vertical sliding rod is connected to the automatic air operated valve and ratchet wheeled cam. When the joints are being ground, this valve automatically operates at intervals, exhausts the air from the main cylinder and thus allows the oscillating table to drop so that the joints may be examined and more oil and emery applied if further grinding is necessary. This period of separating the faces also allows the oil and emery to change its location on the faces as the grinding operation goes on, obviating the possibility of scoring. The automatic grinder, arranged for either belt or motor drive, consumes little power. Many shops and large outside terminals are grinding locomotive steam pipes, dry pipes and branch pipes by hand, a more or less slow and expensive method since it often takes two to three men from 10 to 12 hrs. to grind in a branch pipe, for example, the McGrath machine is said to grind in a branch pipe in 1½ to 2 hr. with one operator, who may do other work while the machine is automatically in operation. The actual time consumed, of course, largely depends upon the condition of the faces to be ground.

In addition to the usual grinding job, the machine will also handle other repair work. For instance, when the ball seats are in bad condition and must be refaced with a concave or convex hardened steel cutter, a rachet post can be placed on the oscillating head and the cutting completed rapidly.

A Grain Door Removable Under Load

A TWO PART grain door section which possesses a number of advantages over the ordinary loose grain door for use as a bottom section is shown in the drawing below. The construction of the door is extremely simple. It is built up of three pieces of 1⅝ in. by 9½ in. lumber each 3 ft. 6 in. long and when completed operates in two sections, which are held in place in the car by a taper lock pin driven through a hasp. Two of the pieces form the body of the door and the other provides the means for locking



Grain Door Section Which Can Be Removed Easily Under Load

them in place against the pressure of the load. This piece, with half its length projecting beyond the end of the half door section is securely nailed to the section so that it projects 1 in. above the section along the upper edge. Near the projecting end of this piece is nailed a ⅛ in. metal hasp strip. The hasp is secured to the other half section of the door so that when in place it projects through a suitable opening in the hasp strip. The taper locking pin is secured to the door by a short chain and staple.

To protect the half door sections against splitting or tearing by the nails which secured them to the car door posts when the door is removed, light metal nailing plates are secured to the inside faces near the ends of the door. The nails are applied through holes drilled in these plates.

When a loaded grain car is to be unloaded it is frequently necessary to destroy the bottom grain door section to relieve the pressure against the door sufficiently to permit the sections to be removed. In the case of the removable door here described, it is only necessary to drive out the tapered lock pin to permit the two halves of the bottom section to be pulled outward, the nailing plates insuring that the nails will be pulled from the door posts without injuring the door.

This door is known as the Nelson-Snyder Grain Door and the patents are controlled by T. C. Rasmussen, Council Bluffs, Iowa.

GENERAL NEWS

West Australian to Build Locomotives

The West Australian government will shortly be in the market for the supply of drills, milling machines, plate rolls, grinders and other equipment to the value of £20,000 (or $97,200 at the normal rate of exchange), to enable the railway workshops to undertake the construction of locomotives.

Historic Iron Box Car Wrecked in Blast

Box Car No. 90190, of the Nashville, Chattanooga & St. Louis, was recently destroyed by the explosion of a case of dynamite at Hollow Rock Junction, Tenn. This car was the first metal box car ever used in the Southern States. It was commandeered by General Sherman as an ammunition carrier in his advance on Atlanta, in 1864.

Further Reduction in British Wages

A further reduction of 2 shillings a week (about 48 cents at the normal rate of exchange) in the sliding scale wages of the railway workers in Great Britain came in operation on April 1, 1922, owing to the fall in the cost of living index from 99 points in December to 86 points at the present time, both figures representing the increases over the 1914 level.

Strike on Western Maryland

Shopmen and trackmen on the Western Maryland struck on Saturday, March 25, against the action of the railroad in dismissing them and leaving them to work for contractors. According to press dispatches, considerable numbers left their work at Baltimore, Hagerstown and Cumberland, Md.; Elkins, W. Va., and Connellsville, Pa. Most of the work in these departments on the Western Maryland is now in the hands of contractors, the Dickson Construction & Repair Company, of Youngstown, Ohio, and the strikers are nearly all employees of this concern. Representatives of the contractors said, at Baltimore, on the 27th, that there was difficulty in filling the places of the strikers and that they would not be taken back. On the evening of the 28th, reports from Hagerstown said that there had been some rioting in the yards there, when non-union men were set at work.

Shopmen on the Western Maryland have the full authority and sanction of their union to go on strike, according to B. M. Jewell, president of the Railway Employees Department of the American Federation of Labor. The proper vote and compliance with union laws were fulfilled before the men walked out.

Machinists' Union Asks Limitation on Contract Work

The International Association of Machinists has filed a petition with the Interstate Commerce Commission referring to the charges which it made before the commission last year regarding the practice of the railroads in sending locomotives to contract shops for repairs and asking the commission to extend its investigation of the "contracting out" practices of the railroads to cover also the practice of closing their own shops and farming out work to existing private companies or companies especially formed for this purpose.

The commission is asked further to investigate the relationship of financial control, if any, between the carriers and the companies to which the work is transferred and to issue an order forbidding the letting out or transfer of shop work which was not wholly or in substantial part performed by the carriers at the time of the passage of the transportation act, except after obtaining from the commission a permit authorizing such work, such permit to be issued only for specific cases and subject to the conditions that the work could not be done in the railroad shops, that the contract prices are not excessive, and that the labor standards established by the Railroad Labor Board shall be observed in full by the contracting shops.

New York Central Shops on Piecework Basis

Three shops of the New York Central, which were idle for six weeks or longer, were reopened on Monday, April 17, with about 775 men at work at piecework rates. These are the shops at West Albany, N. Y.; Avis, Pa., and Collinwood, Ohio. It is said that the rates of pay will be about 25 per cent higher than those which prevailed in 1917.

Big British Locomotive Company Closes Plant

Sir W. G. Armstrong, Whitworth & Co., Ltd., has decided to suspend operation at its Elswick steel works and its forge and stamping departments, owing to the high costs of production. No new contracts can be obtained on the basis of the selling prices which must be charged, and as it would be impossible to keep the shops open except at a loss, there is no alternative to the closing of them down.

Exhibits and Entertainment at Fuel Association Convention

Detail arrangements are being completed for the convention of the International Railway Fuel Association to be held at the Auditorium Hotel, Chicago, May 22-25. The International Railway Supply Men's Association is arranging for exhibits and space is being taken rapidly. Entertainments are planned for Monday, Tuesday and Wednesday evenings, including moving pictures of coal mining operations, an informal reception and dance and a dinner.

Government Delegates to International Railway Congress

The corrected list of delegates appointed by the United States Government to attend the Ninth Congress of the International Railway Association at Rome, Italy, consists of the following four all of whom are now in Europe or on the way there:

General W. W. Atterbury, vice-president, Pennsylvania Railroad.

D. F. Crawford, vice-president, Locomotive Stoker Company.

J. W. Lieb, formerly vice-president of the American Society of Mechanical Engineers.

Walter F. Schleiter, vice-president, Dilworth, Porter & Co.

American Ability to Compete for Argentine Car Business

Commerce Reports gives some gratifying figures of American ability to compete against foreign bidders on railway equipment in Argentina in spite of adverse exchange rates. On bids for supplying 650 freight cars of 750 millimeter gage the bids were as follows: Belgian, 1,080,000 pesos; American, 1,160,000 pesos; British, 2,000,000 pesos; Germany, 2,480,000 pesos. The quotations include three years' interest. The American offer is based upon an exchange rate of 1.22 pesos per U. S. dollar, against a par of 1.04—or a disadvantage of 17 per cent. In spite of this fact, however, the American bid was but 7 per cent over the Belgian. Attention is called to the fact that Germany with exchange all in her favor quoted more than double the American price. All of which goes to show our strength in the market, which will become greater if the Argentine peso continues its move to parity with the dollar.

Fire at Pennsylvania Shops

The shops of the Pennsylvania Railroad at Meadows, N. J., were damaged by fire on the morning of April 16 to the extent of $175,000. The erecting shop, cabinet shop, paint shop and tin shop were a total loss.

Big Four Reopens Shops Under Contract

The Beech Grove (Ind.) shops of the Cleveland, Cincinnati, Chicago & St. Louis have been reopened for operation under contract by the Railway Service & Supply Corporation. The shops had been closed for more than a month.

Effective Date of Tank Car Specifications Announced

The Mechanical Division of the American Railway Association has issued a circular announcing that the effective date of the requirements of Section 7 (c) of the specifications for Class I and II tank cars, and the last paragraph of Section 7 (d) of the specifications for Class III and IV tank cars is further extended to July 1, 1923. The sections of the Tank Car Specifications referred to provide that no nipples, valves or other attachments shall project below the bottom outlet cap except while the car is being unloaded.

Harris Bill on Steel Cars Amended

The Interstate Commerce Commission in a report on a bill introduced by Senator Harris of Georgia, to compel the use of steel passenger cars, has recommended that a year be allowed for study of the matter, and the bill has been modified accordingly.

The commission told the senators that the proposed bill would introduce many complications where existing roadbed and structure would not be heavy enough to support steel cars; also that the progress in recent years in the construction of steel cars and cars with steel under-frames, had been voluntary on the part of the railroads; and that to prevent shortage the retirement of the remaining wooden cars would have to be extended over a period of years.

The opinion was also expressed that legislation at present should provide only that no wooden cars should be located in a passenger train between or ahead of steel or steel underframe cars.

Turbo-Electric Locomotive Being Tried in England

Trials are being made on the London & North Western Railway, England, of a turbo-electric locomotive constructed by Messrs. Armstrong Whitworth & Company, for the Ramsay Condensing Locomotive Company. The engine has a length over all of 69 ft. 7 in. and weighs 130¾ long tons, including coal and water. The boiler, which is in front, generates steam at 200-lb. pressure and 300 deg. F. superheat. The main three phase turbo-alternator and the auxiliary exciting turbo-generator are also in the front. The current is taken to four 275 hp. electric motors, two of which drive the wheels of the front part and two those of the back part or tender. The exhaust steam is conducted to the tender, where it is condensed in a condenser of special construction. The condensed water returns to the hot well and thence to the boiler. The object sought is economy of coal and water.

Labor Board Decisions

Management Is Judge of Qualifications.—In a case brought against the Delaware, Lackawanna & Western by the United Brotherhood of Maintenance of Way Employees and Railway Shop Laborers, it was shown that four carpenters were laid off while men younger in the service were retained. The contention of the management was that the employees in question did not have the qualifications necessary to perform high grade carpenter work in an efficient manner within reasonable time. The Labor Board sustained the railroad, stating that the language of the agreement definitely leaves the matter largely in the hands of the carrier to determine whether or not an employee is capable of doing work.—*Decision No. 807.*

Foremen Need Not All Be Paid the Same Rate.—During the government control period the Portland division of the Southern Pacific was under a different regional director from the rest of the Southern Pacific System, and this regional director did not advance the wages of bridge and building and water service foremen and assistant foremen on the same basis that advances were made on the rest of the Southern Pacific System. Wage advances under Decision No. 2, being applied to the rates of pay in effect on March 1, 1920, perpetuated these differences. In answer to a complaint of the employees, requesting that this differential be removed, the railroad said that the provisions of Decision No. 2 had been applied legally; and this contention was sustained by the Labor Board. The board stated, however, that its decision does not prevent negotiations between the railroad and the employees with regard to the salaries paid these foremen.—*Decision No. 798.*

Seniority Retained While Filling Temporary Position.—In February, 1920, a car repairman at the East Fitchburg shops of the Boston & Maine, with 19 years' seniority, applied for and was assigned to a temporary position as car inspector at the passenger station at Fitchburg. Later this job was advertised as a permanent vacancy and this man refused to bid on the permanent position, returning to the shops; and there he was informed that he had lost his seniority. The employees, through the American Federation of Railroad Workers, contended that in accepting the temporary assignment he did not lose his seniority at the shops. The Labor Board decides that in view of the fact that the position accepted by him was advertised as temporary, he should be restored to his seniority standing at the shops; and be compensated for any loss of wages which he later suffered by loss of seniority through a layoff on account of a reduction of forces at the shops. —*Decision No. 773.*

Brakeman May Act as Fireman in Emergency.—L. C. Roth, a fireman on the Missouri, Kansas & Texas, became ill and was relieved in the middle of a trip at Cushing, Okla., on August 13, 1920. H. G. Olmstead, a fireman regularly assigned to a switch engine at Cushing, who had been off duty about 12 hours at the time claimed that he should have been called, instead of a brakeman, to relieve Roth for the remainder of the trip. The carrier contended that while Olmstead was assigned to the switch engine at Cushing he was not entitled to work outside of his regular assignment and, further, that there was no assurance that Roth's illness would improve sufficiently to justify putting him in Olmstead's place on the switch engine. The Labor Board decides that the claim of the train service brotherhoods that Olmstead is entitled to a minimum day's pay for not being called is not supported by any rule of the agreement between the employees and the carrier; and the claim is denied.—*Decision No. 773*

Engine Crew Granted Run-Around On a Terminal Delay Feature.—Enginemen Diggs and Pannell were assigned to the extra list, "first in, first out" on the Missouri, Kansas & Texas, at Denison, Tex. Engineman Diggs was called at 4:45 A. M. for a turn-around trip between Denison and Greenville over the Dallas division; and engineman Pannell was called at 5:25 A. M. to take a light engine from Denison to Waco, also over the Dallas division. He left the terminal at 5:25 A. M., while engineman Diggs did not leave until 7 A. M. The employees claim run-around pay for the first crew called. The carrier claims that as engineman Diggs was called to move a train from Ray Yards, and engineman Pannell, although called 40 minutes later, was assigned to handle a light engine from Denison roundhouse, starting from a point three miles east of Ray, engineman Diggs at no time ran around engineman Pannell, although both were moving in the same general direction to different terminals. However, the Labor Board decided that the first crew called had been run around in the terminal and should be paid 100 miles.—*Decision No. 774*

Air Brake Association Transfers Convention from Washington, May 9, to Atlantic City, June 19

The executive committee of the Air Brake Association after careful consideration has decided to transfer the twenty-ninth annual convention from Washington, D. C., May 9-12, to Atlantic City, June 19-21. This change is made at the eleventh hour because of the culmination at this time of plans which have been developing during the past two or three years for the closer affiliation of the Air Brake Association with the Mechanical Division of the American Railway Association.

This change of convention place and time is decidedly advantageous to the Air Brake Association in that it now makes possible a closer co-operation with the work of the Train Brake and Signal Committee of the American Railway Association. The identity and individuality of the Air Brake Association is to be retained. The officers, membership and activities will be the same as formerly with no change in constitution or by-laws. The association will continue to be a distinctly educational organization working for improvement in air brake practices and a higher standard of maintenance.

Convention headquarters will be at Haddon Hall, conveniently situated on the boardwalk, where a spacious convention hall and ample room for exhibits have been secured. In addition to accommodations at Haddon Hall, special rates on the American plan have been obtained at Hotel Bothwell, Hotel Wiltshire and Avon Inn.

The usual exhibits of the Air Brake Appliance Association will be displayed at Haddon Hall and are entirely distinct from the extensive Railway Supply Manufacturers' Association exhibit of railway machinery at Young's Million Dollar Pier, which will be open to all members. Full participation in the entertainments of the A. R. A. Mechanical Division will be afforded members of the Air Brake Association and their families. This includes the grand carnival ball on the Pier, Monday, June 19, and the grand ball Tuesday evening. Free roller chairs will be available on the boardwalk for members from 9 A. M. to 5 P. M.

Master Boiler Makers' Convention Program

As previously announced, the thirteenth annual convention of the Master Boiler Makers' Association will be held at Hotel Sherman, Chicago, May 23, 24, 25 and 26, 1922. The program includes the following committee reports, papers and addresses:

Addresses

Hon. W. H. Thompson, Mayor of Chicago.

A. G. Pack, chief inspector of locomotives, Interstate Commerce Commission.

H. T. Bentley, superintendent of motive power, Chicago & Northwestern.

A. R. Ayres, superintendent of motive power, New York, Chicago & St. Louis.

Committee Reports

Autogenous Welding, T. F. Powers, chairman.

Oxyacetylene Welding, D. A. Lucas, chairman.

Electric Welding, H. H. Service, chairman.

Advantages and Disadvantages of Treated Boiler Feedwater, T. P. Madden, chairman.

Best Methods of Safe-Ending Locomotive Tubes, P. J. Conrath, chairman.

Crown Stays for Different Classes of Locomotives, Lewis Nicholas, Jr., chairman.

How Can Distortion of Firebox Sheets Behind Grate Bars and Supports Be Eliminated, C. E. Elkins, chairman.

Causes and Overcoming Boiler Shell Cracking Through Girth Seam Rivet Holes, A. S. Greene, chairman.

Best Types of Side Sheets, C. R. Bennett, chairman.

Committee on Law, G. W. Bennett, chairman.

Convention of International Railway Fuel Association

The International Railway Fuel Association was organized to bring together railroad men interested in the use of fuel or its purchase and the mine operators or oil producers who supply railroad fuel. The program for the annual meeting of the association to be held at the Auditorium Hotel, Chicago, on May 22 to 25, embraces topics of interest to all these groups and in fact to everyone who is in any way concerned with the railroad fuel problem. A list of the papers and addresses which have been secured up to the present time is given below.

Opening Address—L. W. Baldwin, vice-president, Illinois Central.

Fuel Conservation from the Standpoint of

(a) Division Superintendent—Sidney U. Hooper, division superintendent, Baltimore & Ohio.

(b) Representative of Department Operating—Coaling Stations—W. S. Burnett, district engineer, Cleveland, Cincinnati, Chicago & St. Louis.

(c) Locomotive Engineer—C. J. Barnett, Illinois Central.

The Economic Considerations Governing the Use of Oil as a Locomotive Fuel—M. C. M. Hatch, mechanical engineer, Missouri Kansas & Texas.

Colloidal Fuel—Lindon W. Bates.

Mechanical Mining of Bituminous Coal—George T. Peart.

Standard Grading of Coal or Stabilization of Bituminous Coal—George H. Cushing, managing director, American Wholesale Coal Association.

Assigned Cars for Railroad Fuel—C. G. Hall.

The Relation of Overdevelopment of the Bituminous Coal Industry to Transportation—C. F. Lesher, editor, Coal Age.

The Government and the Coal Industry—T. H. Watkins.

The Various Items of Saving by Using a Better Quality of Coal—Earl Cobb, president, Southwestern Coal Company.

The Effect of Tonnage Rating and Speed on Fuel Con-

The Effect of Tonnage Rating and Speed on Fuel Economy—J. E. Davenport, engineer dynamometer tests, New York Central.

Educational Work Along Fuel Economy Lines—D. G. Buell, director, Railway Educational Bureau.

Standard Railroad Coal Contract—W. J. Tapp, fuel supervisor, Denver & Rio Grande.

Incentives for Promoting Fuel Economy—A Survey of Existing and Proposed Practices—O. S. Beyer, Jr.

Effect of Circulation on Boiler Efficiency—F. G. Lister, mechanical engineer, El Paso and Southwestern.

Lignite Carbonization—Dr. E. J. Babcock, dean, Mining Engineering Department, University of North Dakota.

The Railroad Fuel Problem from the Standpoint of the Coal Operator—F. S. Peabody, president Peabody Coal Co.

Comparative Practice; United States, United Kingdom, France and Germany—Harrington Emerson.

Locomotive Fuel the Life Blood of Transportation—G. M. Basford, consulting engineer, Lima Locomotive Works.

Report, Special Committee on Locomotive Feed Water Heating—E. E. Chapman, engineer tests, Atchison, Topeka & Santa Fe, chairman.

Report, Standing Committee on Firing Practice—M. A. Daly, General fuel supervisor, Northern Pacific, chairman.

Report, Standing Committee on Front Ends, Grates and Ash Pans—E C. Schmidt, professor of railway engineering, University of Illinois, chairman.

Report, Standing Committee on Fuel Accounting—J. N. Clark, chief fuel bureau, Southern Pacific, chairman.

Report, Standing Committee on Coal Shortage—H. H. Stoek, professor, mining engineering, University of Illinois, chairman.

Report, Standing Committee on Fuel Stations—W. E. Dunham, assistant superintendent motive power and machinery, Chicago & North Western, chairman.

Meetings and Conventions

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

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City. Annual convention June 19-21, Haddon Hall, Atlantic City, N. J.

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

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Next annual convention June 14 to 21, 1922, Atlantic City, N. J.

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

Division V.—Purchase and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio. Meeting June 19, 20 and 21, Atlantic City.

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

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York, Railroad Division, A. F. Stuebing, 2201 Woolworth Building, New York.

American Society for Steel Treating.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention and exposition postponed until October 2-7, 1922, Detroit, Mich.

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

Canadian Railway Club.—W. A. Booth, 53 Rushbrook St., Montreal, Que. Regular meeting second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal.

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

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo. The next meeting will be held at the Great Northern Hotel, Chicago, May 8. H. H. Harvey, general car foreman of the Chicago, Burlington & Quincy, will present a paper on the Education of Car Inspectors.

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Next meeting May 11. Paper on Why Engines Fail will be presented by F. C. Pickard, master mechanic, D. L. & W., Buffalo, N. Y. Buffet lunch after adjournment.

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

Cincinnati Railway Club.—W. C. Cooder Union Central Building, Cincinnati, Ohio.

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

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich. Convention Hotel Sherman, Chicago, August 15, 16 and 17.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill. Next annual meeting Auditorium Hotel, Chicago, May 22 to 25, 1922.

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

Master Boilermakers' Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y. Next annual convention Hotel Sherman, Chicago, May 23 to 26, 1922.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting May 9. Paper on Maine, the Sportsman's Paradise, will be presented by E. S. Jones, official photographer, Boston & Maine.

New York Railroad Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y.

Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. The next meeting will be held May 11 at the Hotel Oakland, Oakland, Cal., being a joint meeting with the Western Division Club of the Southern Pacific. The general topic will be Automotive Competition, and some of the papers and speakers so far chosen are the Effect of Automotive Competition on the Indicidual Railroadman, by D. O. Herrick, foreman car department, Southern Pacific, and How the Railroadman Can Assist in Meeting Automotive Competition, by C. B. Olds, agent, Southern Pacific.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Regular meetings fourth Thursday in each month, except June, July and August, at Fort Pitt Hotel, Pittsburgh, Pa.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo.

Traveling Engineers' Association.—W. O. Thompson, Marine Trust Building, Buffalo, N. Y.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Annual meeting and dinner at the Drake Hotel, May 15.

Freight Car Orders

The Merchants' Dispatch will build from 1,000 to 1,500 refrigerator cars at its own shops.

The Northern Pacific has ordered 1,000 refrigerator cars from the American Car & Foundry Co.

The Central San Antonio, Cuba has ordered 10 cane cars from the Magor Car Corporation.

The Chicago & North Western has ordered 300 ballast cars from the Rodger Ballast Car Company.

The Northwestern Railway of Brazil has ordered 70 freight cars from the Standard Steel Car Company.

The Atlantic Coast Line has ordered 100 steel phosphate cars from the Chickasaw Shipbuilding Corporation.

The Southern Pacific will build 200 double-sheathed box cars of 40 tons capacity in its shops at Los Angeles, Cal.

The Chesapeake & Ohio has ordered 1,400, 40-ton plain box cars; 100, 40-ton automobile cars; and 200, 40-ton stock cars from the American Car & Foundry Company.

The Louisville & Nashville has ordered 1,000 hopper cars from the Chickasaw Shipbuilding Company and 1,000 all-steel gondola cars from the Cambria Steel Company.

Leonard Kennedy & Co., Inc., 67 Wall Street, New York City, has ordered 40 air dump cars from the Magor Car Corporation. These cars are for export to Brazil.

The United Fruit Company has ordered 50 flat cars of 20 tons capacity from the Magor Car Corporation. These cars are for use on the Truxillo Railroad, Honduras.

The Chicago, Milwaukee & St. Paul has ordered 4,000 cars distributed 1,000 each to the Pullman Company and the Western Steel Car & Foundry Company; 1,500 to the Bettendorf Company; and 500 to the General American Car Company.

The Chicago & North Western has ordered new freight cars as follows: 625 box and 500 flat from the Western Car & Foundry Company; 625 box from the Standard Steel Car Company; 500 stock and 250 gondola from the Pullman Company; and 250 refrigerator from the American Car & Foundry Company.

Pickands, Mather & Company, Cleveland, Ohio, has ordered from the Kilbourne & Jacobs Manufacturing Company, Columbus, 22 all-steel automatic air dump cars for shipment to the Balkan Mining Company, Bovey, Minn., and 12 cars of the same type for shipment to the Bennett Mining Company, Keewatin, Minn.

The Southern Pacific has ordered 2,000 automobile box cars from the General American Car Company. The cars will be 50 ft. long with side doors staggered, of a width of 10 ft. 5⅝ in., and with folding end doors of a width of 7 ft. 9¾ in. arranged to afford special facilities for handling automobile shipments. The inside measurement of the cars will be 50 ft. long, 9 ft. 2 in. wide and 10 ft. ⅝ in. high.

The New York Central has placed orders for 16,000 cars as follows:

Cincinnati Northern.	250	40-ton	Box	Am. Car & Fdy. Co.
	750	55-ton	Hopper	Pullman Company.
New York Central	1,000	55-ton	Hopper	Am. Car & Fdy. Co.
	1,000	50-ton	Box	Am. Car & Fdy. Co.
	1,000	50-ton	Box	Standard Steel Car Co.
	1,000	50-ton	H.S. Gond.	Pressed Steel Car Co.
Cleveland, Cincinnati, Chicago & St. Louis	1,000	55-ton	Hopper	Am. Car & Fdy. Co.
	2,000	50-ton	Box	Am. Car & Fdy. Co.
Pittsburgh, McKeesport & Youghiogheny	1,500	70-ton	Hopper	Pressed Steel Car Co.
	1,000	70-ton	L.S. Gond.	Standard Steel Car Co.
Pittsburgh & Lake Erie	1,500	70-ton	Hopper	Standard Steel Car Co.
	1,000	70-ton	L.S. Gond.	Standard Steel Car Co.
Michigan Central	2,000	50-ton	Box	Standard Steel Car Co.
	500	50-ton	H.S. Gond.	Gen'l American Car Co.
	500	50-ton	H.S. Gond.	Buffalo Steel Car Co.

Freight Car Repairs

The Texas & Pacific will start immediately to repair a large number of freight cars in its shops at Marshall, Tex.

The Grand Trunk is having 250 refrigerator cars repaired at the shops of the National Steel Car Corp., Hamilton, Ont.

The St. Louis Southwestern has awarded a contract to the American Car & Foundry Company for repairing 200 cars.

The American Refrigerator Transit Company, St. Louis, Mo., has awarded a contract to the American Car & Foundry Co. for repairing 200 refrigerator cars at Memphis, Tenn., and also has awarded a contract to the Missouri Pacific for repairing 100 refrigerator cars.

Passenger Car Orders

The Wabash has ordered 8 coaches, 9 chair cars, 2 buffet chair cars, 2 cafe chair cars and 4 dining cars from the American Car & Foundry Company. All these cars are to be of steel construction.

The Boston & Maine has ordered 65 coaches, 20 smoking cars, 8 combination smoking and baggage cars, and 5 baggage and mail cars from the Osgood-Bradley Car Company, and 25 milk cars from the Laconia Car Company.

The Louisville & Nashville has ordered 5 baggage cars, 5 combination baggage and horse cars, 6 coaches, 4 combination passenger and smoking cars, and 5 combination passenger and baggage cars from the American Car & Foundry Company.

The Pennsylvania Railroad has placed orders for 250 passenger cars, as follows: Pressed Steel Car Company, 75 coaches; American Car & Foundry Company, 65 coaches; Standard Steel Car Company, 50 coaches; Bethlehem Shipbuilding Corporation, Harlan plant, 35 combination passenger and baggage cars, and the Pullman Company, 25 combination baggage and mail cars.

Passenger Car Repairs

The Southern Pacific is rebuilding 23 mail cars in its own shops.

Locomotive Orders

The Mt. Hood Railroad has ordered one Mikado type locomotive from the Baldwin Locomotive Works.

The San Antonio & Aransas Pass has ordered 4, 0-8-0 type locomotives from the Baldwin Locomotive Works.

The Philadelphia & Reading has ordered 25 Consolidation type locomotives from the Baldwin Locomotive Works.

The Chicago, Milwaukee & St. Paul has ordered from the Baldwin Locomotive Works 25 Mikado type locomotives.

The Boston & Maine has ordered 2 Mallet type locomotives and 20 switching locomotives from the American Locomotive Company.

The New York Central has ordered 40 locomotives from the Lima Locomotive Works and 35 from the American Locomotive Company.

The New York, New Haven & Hartford has ordered 15, 0-8-0 type locomotives from the American Locomotive Company. These locomotives will have 25 by 28 in. cylinders and total weight in working order of 216,000 lb.

PERSONAL MENTION

GENERAL

M. J. McGraw has been appointed superintendent of motive power and cars of the Wheeling & Lake Erie, with headquarters at Brewster, Ohio, succeeding J. F. Hill, who has been appointed assistant superintendent of motive power and cars.

J. R. Sexton will resume his former position as mechanical superintendent of the Northern District of the Atchison, Topeka & Santa Fe, with headquarters at La Junta, Colo., succeeding E. E. Macchovec, acting mechanical superintendent, who has been assigned to other duties.

G. T. Depue, whose appointment as mechanical superintendent of the Ohio and Chicago regions of the Erie was announced in the April issue of the *Railway Mechanical Engineer*, was born December 2, 1872, at Hornell, N. Y., and was educated in the grammar schools of that city. On March 1, 1889, he entered the employ of the Erie as a machinist's apprentice. He afterwards worked as a machinist and extra gang foreman until March, 1901, when he was promoted to general foreman at Bradford, Pa. In August of the same year he became general foreman of the Hornell shops, and in July, 1903, master mechanic at Hornell. In 1908 he was transferred in a similar capacity to Galion, Ohio. In August, 1913, he became shop superintendent at Galion, and in 1916 was transferred in similar capacity to Susquehanna, Pa. At the termination of federal control he was appointed mechanical superintendent of the Chicago region and was appointed master mechanic at Marion upon the consolidation of the mechanical departments of the Ohio and Chicago regions, which took place in 1921.

G. T. Depue

PURCHASING AND STORES

R. M. Nelson has been appointed purchasing agent of the Chesapeake & Ohio and A. W. Hicks has been appointed assistant to the director of purchases and stores.

W. C. Bower has been appointed assistant manager of purchases and stores of the New York Central Lines. The title of general purchasing agent of the New York Central Railroad and the Pittsburgh & Lake Erie has been abolished.

H. H. Disher has been appointed purchasing agent of the Toronto, Hamilton & Buffalo Railway and of the Toronto, Hamilton & Buffalo Navigation Company, succeeding G. W. Holmes, resigned on account of ill health.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

Alexander Young has been appointed master mechanic of the Chicago, Great Western with headquarters at Des Moines, Iowa. Mr. Young was born on July 24, 1876, at Milwaukee, Wis., and began his railroad career as a machinist apprentice, subsequently serving as a machinist, a gang foreman, general foreman, master mechanic and assistant superintendent of motive power of the Chicago, Milwaukee & St. Paul, and superintendent of motive power of the Midland Valley. He resigned from the latter position, served 22 months with the American Expeditionary Forces in France, and on January 15 of this year became master mechanic of the Chicago, Great Western, as noted above.

Frank J. Dailey, assistant master mechanic of the Erie Railroad at Dunmore, Pa., has been appointed master mechanic of the Meadville Machinery Company, Inc., with headquarters at Dunmore. Mr. Dailey was born on August 30, 1874, at Coshocton, Ohio, and after attending the high school at Newark, Ohio, entered the employ of the Baltimore & Ohio on February 15, 1891, as a machinist apprentice at Newark, later working on railroads in the central states as a machinist and toolmaker. From June, 1900, to February, 1911, he was in turn machinist, traveling demonstrator, toolroom foreman, general foreman and superintendent for the Erie Railroad, the Pennsylvania Railroad, and the Columbus Pneumatic Tool Company. He then re-entered the employ of the Erie Railroad as a machinist at Hornell, N. Y., subsequently serving as toolroom foreman at Hornell, machine shop foreman at Dunmore, technical and practical instructor of apprentices at Susquehanna, Pa., traveling shop demonstrator on the staff of W. S. Cozard, superintendent of piecework and apprentices, and general foreman at Dunmore. On March 1, 1920, he was appointed assistant master mechanic at Dunmore.

F. J. Dailey

OBITUARY

L. M. Sullivan, purchasing agent of the Texas & Pacific, with headquarters at Dallas, Texas, died recently. He was born at Denison, Texas, on August 29, 1891, and attended school at the Christian Brothers College, St. Louis, Mo., until 1907, when he entered railway service on the Ohio River and Columbus at Ripley, O., as ticket agent. The same year he became bookkeeper for the American Coal Company at Ripley, but re-entered railway service shortly thereafter as an index and bill clerk on the Chicago, Rock Island & Pacific at Argenta, Ark. From December, 1908, to May, 1910, he was a stenographer in the chief dispatcher's office at El Reno, Okla., and later held various positions in the superintendent's office until the latter part of 1910, when he entered the service of the Cincinnati, Hamilton & Dayton, as a correspondence clerk in the engineering department. He was later promoted to secretary to the general superintendent and was subsequently made secretary to the assistant to the president at Cincinnati, O., where he remained until April, 1911, when he became a trainmaster's clerk on the Missouri, Oklahoma & Gulf at Calvin, Okla. Later in the same year he entered the employ of the Missouri Pacific as a stenographer in the office of the superintendent of transportation, from which he was later transferred to the office of the first vice-president. From November, 1911, to March, 1915, he was secretary to the vice-president, resigning in 1915 to become secretary to the first vice-president of the Texas & Pacific. From 1915 to October, 1916, he was chief clerk to the first vice-president, and on the latter date was transferred to chief clerk to the receiver and the president. He held this position until his promotion to purchasing agent in 1920.

L. M. Sullivan

SUPPLY TRADE NOTES

R. L. Wensley has been elected a vice-president of the G. M. Basford Co., New York.

E. T. Pelton, vice-president of the Armstrong Steel Castings Company, Huntington, Ind., has resigned.

Howard Cook has been appointed vice-president of the Columbia Nut & Bolt Company, Bridgeport, Conn.

E. H. Walker has resigned as president of the Standard Coupler Company, New York, to enter business for himself.

G. Fred Collins is now associated with the sales department at Chicago of the Gould Coupler Company, New York.

The Whiting Corporation, Harvey, Ill., has removed its Chicago sales office from 1245 Marquette building to 945 Monadnock building.

William F. Dougherty has joined the sales force at the Philadelphia, Pa., office of the Independent Pneumatic Tool Company, Chicago.

The Pennsylvania Pump & Compressor Company has opened a Chicago office at 105 West Monroe street, under the management of H. M. Montgomery.

The National Railway Appliance Company has removed its office from 50 East Forty-second street, to suite 3002, Grand Central Terminal, New York City.

The International Filter Company, Chicago, has moved its general offices from the First National Bank building to its works at 333 West Twenty-fifth place.

William E. Trubee, district representative of the Franklin Manufacturing Company, Franklin, Pa., has removed his office from 501 Fifth avenue, to room 1043 Grand Central Terminal, New York City.

The Power Plant Equipment Company, Kansas City, Mo., now represents the Combustion Engineering Corporation, New York City, in eastern Kansas, eastern Nebraska, western Arkansas and western Missouri.

W. W. Halsey, manager of the New York City office of the U. S. Light & Heat Corporation, Niagara Falls, N. Y., has removed his office from 30 East Forty-second street to room 5617, Grand Central Terminal.

Joseph B. Turbell, president of the American Brake Shoe & Foundry Co., New York, has been elected also chairman of the board, and James S. Thompson, vice president, has been elected also a director to succeed Otis H. Cutler, deceased.

The Reed Railway Supply Company has leased for general headquarters a four-story building at 113 N. Second street, St. Louis, Mo. Joseph Reed, formerly president of the Southern Hardware & Supply Company is president of the company.

W. C. Ames has been appointed district sales manager of the Sharon Pressed Steel Company, New York, with office at 20 East Jackson boulevard, Chicago, and Ralph E. Phillips has been appointed district sales manager with headquarters at 66 Broadway New York City.

T. W. Barnes, for many years factory representative of the Baker R & L Company in the Chicago district, and W. F. Hebard, national distributor of Buda industrial trucks, with headquarters at Chicago have formed an organization under the name of W. F. Hebard & Co. to handle a complete line of Baker industrial tractors, trucks, cranes and specialties in the Chicago territory.

J. B. White, president and general manager of the Exchange Sawmills Sales Company, has been appointed chairman of the board of directors, with headquarters at Kansas City, Mo. R. B. White, assistant general manager, succeeds J. B. White as president and general manager, and F. R. Watkins, central sales manager, has been appointed secretary, succeeding A. T. Hemmeway.

The Detroit Seamless Steel Tubes Company, Detroit, Mich., has established its own branch sales office in the Canadian Pacific building, 342 Madison avenue, New York City. H. C. Kensing has been appointed sales manager for the New York territory. Mr. Kensing was formerly manager of the steel tubing department in the New York branch of the U. T. Hungerford Brass & Copper Company.

Ralph Barstow, sales manager of the Greenfield Tap & Die Corp., Greenfield, Mass., has resigned, and Edward Blake, vice-president, has taken over his duties.

The Hulson Grate Company, Keokuk, Iowa, has recently established a grate assembling plant at 209 Johnson street, Keokuk, to which address it has also removed its general offices.

H. H. Bingham, vice-president, secretary and controller of the Charcoal Iron Company of America, Detroit, Mich., has been made general manager, succeeding F. W. Hutchings, resigned.

William Ochse, for the past two years sales representative of Manning, Maxwell & Moore, Inc., at Chicago, has been appointed efficiency engineer of the Ohio Machine Tool Company, Kenton, Ohio.

O. A. Lawrie has been appointed district sales manager in the New England territory, with headquarters at Boston, Mass., of the Ohio Brass Company, Mansfield, Ohio. For the past 16 years Mr. Lawrie has been with the American Copper Products Company, Bayway, N. J.

A. P. Blackstead, formerly chief engineer of the Camden Iron Works, Camden, N. J., and prior to that hydraulic engineer of the Henry R. Worthington Company, New York, has become associated with the engineering staff of the Dayton-Dowd Company, Quincy, Ill., manufacturers of centrifugal and fire pumps.

The Imperial Appliance Company and the Pressed Steel Manufacturing Company have been merged with the Union Metal Products Company. The business of the three firms will be continued under the name of the Union Metal Products Company, with headquarters at Chicago, and no change will be made in the location of the various offices or in the personnel.

W. N. Fenley, sales engineer of the Kerite Insulated Wire & Cable Company, with headquarters at Chicago, has been promoted to western manager with the same headquarters, succeeding B. L. Winchell, Jr., who has been appointed vice-president, with headquarters in New York. Mr. Fenley entered railroad service with the Cleveland, Cincinnati, Chicago & St. Louis in 1895, with which company he remained for three years; being yardmaster at Greenburg, Ind., during the latter two. In April, 1898, he entered the service of the National Switch & Signal Company, with which company he was engaged in construction and maintenance work until June, 1900, when he entered the employ of the Chicago Great Western at St. Paul, Minn. During the next 10 years he was successively foreman, inspector, office engineer, supervisor and signal engineer of that road, having been promoted to the latter position on February 9, 1908. He also acted in the capacity of consulting engineer for the McClintock Signal & Supply Company during 1906 and 1907. He left in 1910 to become sales engineer of the Union Switch & Signal Company, with headquarters at Chicago, which position he held until August, 1911, when he resigned to become signal engineer of the Panama Railroad. On September 16, 1913, the telephone, telegraph and signal departments of this company were consolidated, and Mr. Fenley was appointed superintendent of the combined organization. He resigned on June 31, 1915, and was appointed sales agent of the Kerite Insulated Wire & Cable Company, which position he was holding at the time of his recent appointment.

W. N. Fenley

S. W. Linheimer, formerly vice-president of the Walter A. Zelnicker Supply Company, St. Louis, Mo., has resigned from that company and has opened offices under his own name, at 428 First National Bank building, Chicago, as a dealer in second hand railroad equipment.

H. H. Roberts, chief engineer of the Franklin Railway Supply Company, New York, has been elected vice-president in charge of engineering; G. L. Winey, secretary, has been elected executive vice-president, and G. W. Floyd Coffin, vice-president of the company, has been elected vice-president in charge of production and service.

Edward B. Craft, assistant chief engineer of the Western Electric Company, has been appointed chief engineer, with headquarters at New York; Dr. F. B. Jewett, vice-president of the company at New York, who preceded Mr. Craft as chief engineer, is now in charge of the telephone department, which includes the engineering department, the telephone sales department and the manufacturing department.

The Westinghouse Electric & Manufacturing Company has separated the power and railway divisions of the Pittsburgh office. Barton Steveson, who has been manager of both divisions, will continue as manager of the power division, and F. G. Hickling has been appointed manager of the railway division; S. R. Shave has been appointed manager of the price section of both the power and railway divisions in the Pittsburgh office.

The Black & Decker Manufacturing Company, Baltimore, Md., has removed its Cleveland, Ohio, office from 6225 Carnegie avenue to 2030 East Twenty-second street. This office is in charge of Dan Paul, formerly manager of the company's Pittsburgh, Pa., office. W. C. Allen, former manager of the Philadelphia branch, and subsequently special representative, has been made branch manager of the Chicago territory; Mr. Allen was formerly connected with the Manley Manufacturing Company, as assistant sales manager and has been associated with the Black & Decker Manufacturing Company for about three years.

A. S. Duncan, storekeeper at the East Pittsburgh works of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has been appointed general storekeeper of finished stocks. H. L. Jones, assistant superintendent, has been appointed superintendent of the switchboard and detail department; A. J. Bastian, assistant superintendent, has been appointed superintendent of the insulating department; W. H. Miller has been appointed supervisor of tools and gages, and W. F. Ablauf has been appointed supervisor of mica and mica processes in the inspection and testing department—all with headquarters at East Pittsburgh.

Air Reduction Sales Company Acquires Davis Bournonville Company

The Air Reduction Sales Company, New York, on March 17, acquired all the assets, including the patents, trade marks and trade names, of the Davis-Bournonville Company of Jersey City, N. J. The consolidation brings together two large companies, whose histories have, to a great extent, been the history of the development of the oxyacetylene welding and cutting industry.

The Air Reduction Sales Company is a pioneer in the extraction of gases from the air for industrial use. Its principal product is oxygen, which is used to the greatest extent, in conjunction with acetylene, in producing the high-temperature oxyacetylene flame. The Air Reduction Company further produces nitrogen and argon for incandescent lamp manufacture, and neon for electrical devices, of which the new and highly useful Airco ignition gage is an example. Acetylene ranks second to oxygen in importance in the list of Airco products.

The Davis-Bournonville Company was organized in 1907 by Augustine Davis, Eugene Bournonville and C. B. Wortham and at once took up the manufacture of oxyacetylene torches. As success was attained in connection with the welding torch, the company's activities were directed to the development of oxyacetylene cutting torches, acetylene generators, and finally to machines for welding and cutting. It is the intention of the Air Reduction Sales Company to continue the manufacture of D-B torches, acetylene generators, special machines, etc., under the supervision of the men who developed them. The equipment will be marketed under the trade name of Airco-Davis-Bournonville.

TRADE PUBLICATIONS

Electric Rivet and Metal Heaters.—The design, operation and advantages of Berwick electric rivet and metal heaters are outlined in an attractive 26-page illustrated booklet recently issued by the American Car & Foundry Company, New York.

Recording Equipment.—A 12-page, illustrated booklet, Bulletin No. 112, covering a recently developed pyro-porus filter and other CO_2 recording equipment for checking fuel waste, has recently been issued by the Uehling Instrument Company, New York.

Oil Burning Appliances.—Kerosene burner outfits, welding torches, and other appliances for roofers, waterproofers, insulating contractors, railroads, etc., are described in Bulletin No. 20, recently issued by the Aeroil Burner Company, Inc., Union Hill, N. J.

Jacks.—A 24-page catalogue describing the construction of Simplex jacks and listing the various parts of each type has been issued by Templeton, Kenly & Co., Ltd., Chicago. This booklet is also printed in French and Spanish, Forms Nos. F22 and S22, respectively.

Gasoline Power Units.—The Buda Company, Chicago, has issued bulletin No. 388, describing a four-cylinder gasoline power plant, which it has recently developed for use in driving electric generators, arc welding sets, triplex or other types of pumps, hoists, concrete mixers, air compressors and for similar uses in machine shops, etc.

Boiler Tube Thimbles.—A folder describing the method of installing boiler tube protection thimbles has recently been issued by the American Boiler Tube Thimble Company, Providence, R. I. The folder outlines the advantages of protecting the ends of boiler tubes by this means and includes a price list for the different size thimbles.

Electric Headlights.—The Pyle National Company, Chicago, has recently issued a 22-page illustrated catalogue (No. 101) describing its line of electric lighting equipment and accessories for locomotives, shops and yards. Sectional views show the construction, adjustment and maintenance of headlights, turbo-generators, flood-light units and switches. Diagrams of the complete circuits for locomotives are given, together with lists of material and directions for installation.

Shay Geared Locomotive.—The Lima Locomotive Works, Inc., New York, has issued an interesting comparison showing the characteristics of a Mallet and a Shay geared locomotive of equal tractive effort. This points out the advantages of the Shay type due to the fact that all the weight is concentrated on the driving wheels and the dead weight of the Mallet type is eliminated. It is pointed out that on a 6 per cent grade the Shay type will haul 138 per cent more trailing load than a Mallet locomotive of the same rated tractive effort.

Powdered Fuel Equipment.—The general advantages and operation of a Grindle powdered fuel system are outlined and a description of the equipment given in a catalogue of 40 pages recently issued by the Grindle Fuel Equipment Company, Harvey, Ill. Cross-sectional views showing details of construction and a typical installation of a powdered coal system are included, also a chart showing the comparative B. t. u.'s secured for one cent at various prices for fuel oil, natural gas, producer gas, hand fired coal and powdered coal.

Fireless Steam Locomotives.—A neatly arranged catalogue of 32 pages has recently been issued by the H. K. Porter Company, Pittsburgh, Pa., describing its fireless steam locomotives which are particularly adaptable for switching purposes at industrial plants where the locomotive has to enter buildings, or where it is desired to reduce fire risks to a minimum. They are also economical where trips are too infrequent and too irregular to justify the expense of a steam locomotive of the usual type. Tables and data for selecting the right size and design of fireless locomotive or for checking up any recommendations the builder may make, are also included in this catalogue as well as illustrations of different types of Porter locomotives.

Railway Mechanical Engineer

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Eliminate Slack in Draft Gear

No one who makes a critical examination of freight cars in ordinary interchange service can fail to be impressed with the large amount of slack in the couplers and draft gear of many of the cars, even those of modern design. The trouble is not confined entirely to spring gears, as friction gears also exhibit a tendency to develop considerable lost motion. Any free travel in couplers or draft gears is a serious defect. The full normal travel of the gear provides a very short space in which to dissipate the energy stored in a heavily loaded car. If free travel exists, the distance over which the force can act is decreased still further and the action of the draft gear is lost during the most effective part of its travel. For example, if the travel of an ordinary gear is reduced one-half, the capacity is only one-fourth as great as before. Furthermore, any slack between cars adds to the severity of the run-in during brake applications and increases the shocks on the draft gear.

Slack in spring draft gear is usually caused by the springs taking a permanent set and should always be corrected by installing new springs, never by the application of filler blocks. Some friction gears may likewise develop slack by reason of permanent set in the springs but in many cases this seems to be due to an increase in the internal resistance which prevents the gear from returning to its normal position when released.

There seems to be a real need for educating car inspectors with regard to the serious effects of slack in draft gears as a majority of these men apparently think that the draft appliances cannot be defective unless they are torn entirely out of the car. Some railroad officers may contend that it would be impractical to try to eliminate slack in draft gear because it would overcrowd the repair tracks. There is no question but what the present condition is causing a great deal of repair work that could be avoided if the gears were kept in condition to function properly. The remedy may be found in more thorough inspection or in periodical overhauling of the draft gear. One or the other of these alternatives should be adopted.

Using Stokers Effectively

Since mechanical stokers for locomotives were first introduced, their construction has been given much thought and attention. The result is that the best designs of the present day not only fire locomotives entirely satisfactorily but are also remarkably free from mechanical defects. The stoker has now established a place for itself in locomotive practice, but the problems connected with its operation have not all been solved as yet. One point that has not been definitely determined is the field for the economical use of stokers. If a locomotive can burn 8,000 lb. of coal an hour effectively and the fireman supplies only 4,000 lb., the capacity is reduced and the wages per ton-mile increased. At some point, depending upon the weight of the locomotive, the class of service and similar factors, the stoker becomes economical, but just where the dividing line between hand firing and stoker firing lies no one seems to know. The relative fuel economy of hand and stoker firing is also important in this connection. A few comparisons of fuel performance under test conditions have been published but information as to the relative average economy of hand and stoker firing under normal service conditions would be far more valuable.

As a rule, stokers have been built and operated to fit existing conditions. If the best results are to be secured, these factors must be in a measure adapted to the stoker. The grate area on most locomotives is limited to the size which can be satisfactorily fired by hand. Since combustion efficiency is highest at comparatively low rates of firing, better performance could probably be obtained by making the grate area in all cases as great as the stoker could fire.

In operating a locomotive, the rate of combustion should be regulated to give the greatest overall economy, taking into consideration fuel, wages, repair costs and fixed charges. At very high rates of combustion, an increase in the supply of fuel may actually cause a decrease in the power output. This point may be reached in some cases by stoker firing. While it is apparent that the economical range is at a considerably lower rate, a study of the cost factors involved would indicate the maximum economical rate of fuel consumption. With such information available, the stoker manufacturers could insure the greatest economy of operation under full load conditions by establishing a corresponding limit for the maximum amount of coal which the stoker could supply.

Why Grind Piston Rods?

Railroad mechanical departments are well advised in requiring that all new methods and machines be thoroughly tested under actual working conditions, before installation in repair shops on an extensive scale. While an open-minded attitude should be taken on the question of trying out new methods, experience has shown that many of these fail to accomplish the results expected and a reasonable degree of caution in adopting them is justified. They should, however, be adopted when test results are satisfactory. The practice of truing both new and worn piston rods by grinding, for example, has certainly passed the experimental stage and thousands of ground locomotive piston rods are now in service giving uniformly satisfactory results. It is difficult to understand what justification can be found for still adhering in certain shops to the relatively slow and inaccurate process of turning and rolling piston rods.

Notwithstanding the almost universal approval of piston rod grinding, the innate caution of railroad men regarding new devices was strongly illustrated in a large railroad shop recently where it was proposed to install a machine to grind piston rods instead of continuing the older method of turning and rolling them. Those who hesitated to install the new machine said that it must first demonstrate its superiority in a comparative test. Accordingly, a new piston rod was turned and rolled as accurately as possible. This rod was then carefully mounted in a piston rod grinder and ground, with the abrasive wheel just lightly touching the rod. The grinding operation was then stopped and observers noted that more metal was removed at certain places on the piston rod than at others and in some places the abrasive wheel did not touch the rod at all. Micrometer calipers checked the accuracy of grinding both as regards taper and roundness of the rod. The fact that more metal was removed by grinding at certain places than at others proved conclusively that the rod, as rolled previous to grinding, was not a true cylinder. This was evidently due to the fact that the rod was non-homogeneous, being softer in some spots than in others with the result that the roll depressed these soft spots unduly. The grinding machine, on the other hand, exerted hardly any pressure on the rod and removed as much metal from the soft spots as the hard, producing a true cylindrical surface.

In the days of wick packing the accuracy of piston rods did not make so much difference, but now that metallic packing is used almost universally, it is evident that this packing cannot hold steam and last for any considerable length of time unless piston rods are accurately round, smooth and, practically speaking, without taper. That these qualifications are best obtained by the use of modern piston rod grinding machines is evident from the many ground piston rods now in daily use and giving satisfactory service.

Mechanical Design of Locomotives

Before the advent of the heavy modern locomotive, the mechanical features of the locomotive design did not demand very careful attention. In most cases the parts were light, clearance was not a limiting factor and stresses and pressures were well within the allowable limits for ordinary material. In the locomotive of today, conditions are entirely different. So many restrictions hamper the designer that it is often impossible to keep within the limits of good practice. As a result, the maintenance of machinery is becoming more and more troublesome. It is interesting to compare the designs of early locomotives with those of the present day. Such a comparison soon makes it evident that many locomotive parts as commonly constructed are merely overgrown specimens of designs that were in use when the prevailing type for passenger and freight service was the eight-wheel locomotive. Many of these designs have the merits of being simple and easily made, but has not too high a value been placed on simplicity and low cost in the design of motive power? There are opportunities for refinements that save weight, reduce the cost of upkeep and increase the proportion of time the locomotive spends on the road. There is a field for improved material that will give longer service between repairs. Such refinements can more than pay their cost, especially under present labor conditions.

It is natural to ask where refinements in the design of machinery should begin. The logical method would be to start with those parts which cause the heaviest expense for repairs and time out of service. Driving boxes should be redesigned to provide bearings that will withstand the thrust of the piston without excessive wear or to permit replacements to be made without dropping the wheels. Tire wear is another source of heavy expense. Locomotives with long rigid wheelbases should be especially designed to avoid excessive flange pressure and thus prevent the development of sharp flanges. Counterbalancing likewise is a serious problem, which involves especially improvements in rods, crossheads and pistons. Main rod bearings are now such a serious factor in roundhouse maintenance that their design should be given careful thought. High steam temperatures tend to shorten the life of piston rings and the cost of replacement is high; therefore both type of ring and the material need to be selected with a view to getting the maximum service.

These are a few of the more important points where service, rather than precedent or first cost, should cover design. Simple, straightforward construction will not give results on modern locomotives and today further refinements are essential. In the past simplicity has been almost an end in itself, but it is well to bear in mind that refined designs are not necessarily complicated designs, and that complicated designs are not necessarily expensive to maintain.

Air Pressure and Car Repairs

It is estimated on the best authority that there are over 700 car repair shops and almost 1,900 cripple tracks in the United States devoted to the repair of both wooden and steel cars. According to the latest statistics published by the Interstate Commerce Commission, railroad operating companies in the United States own over 2,600,000 cars, including freight cars, passenger cars and company cars. A large proportion of this equipment is in service and the task of maintaining it in good running order is not always appreciated. It is of great magnitude, employing the services of many thousands of men.

One of the things which make modern car repair work far easier than it was in earlier days is the use of pneumatic tools of all kinds, including presses, jacks, drills, rivet-shearing, punching and heading tools and many other pneumatic tools too numerous to mention. These save an immense amount of manual labor and are most effective in speeding up car repair work and reducing the unit cost of repairs. Because of the increasing number of pneumatic tools used, however, many air compressors now installed are proving of insufficient capacity. Either the shops have been enlarged since the compressor was installed or additional cripple tracks have been provided. The result is that the air compressor is too small to carry the load, or, in some instances, the initial pipe line is too small to carry an adequate amount of air and at the same time maintain the necessary high pressure at the end of the line.

It is important that pneumatic tools be operated as efficiently from the end of the line as anywhere else and the costliness of allowing insufficient compressor capacity or small pipe lines to reduce the air pressure has been demonstrated by experience and many tests. In a recent specific case an air hammer was tested cutting off rivets. When operating under the usual air pressure delivered by the compressor (80 lb. per sq. in.), the air hammer cut off rivets with approximately seven blows a piece. With the air pressure reduced to 50 lb., owing to excessive use of air at another point on the line, it took about 50 blows to sever each rivet head. This meant that there was an enormous waste of air and also of the operator's time. No argument is necessary to support the contention that adequate air compressor capacity and pipe lines of ample size should be provided if satisfactory results are to be obtained.

Another factor making it difficult to maintain air pressure is the leakage of air along the line; this in addition to reducing the air pressure and consequently the efficiency of pneumatic tools, represent a direct money loss through the coal pile. At plants of any appreciable size it has been found profitable to assign one man to continually inspect air lines, valves and fittings, making what repairs may be necessary to eliminate air losses at these points. The provision of an adequate supply of air and its efficient use in car repair work are highly important owing to the possibility of speeding up the work and saving coal which is lost whenever air is wasted.

Do You Read This Page?

We have been trying to get into more intimate touch with the individual readers of the *Railway Mechanical Engineer:* First, because it is your paper and will succeed only insofar as it proves of practical value and service to you. Second, its subscribers form a great club made up of the best minds in the railway mechanical departments; in the interests of the club as a whole, all of its members should co-operate in helping to make the *Railway Mechanical Engineer* a clearing house for the best ideas, methods, practices, etc., in the field.

We want you to feel a very direct responsibility in this respect. Write and tell us of the good things that you have observed, or are doing, or of ideas that you think will bear fruit if tested out. Or tell us of your problems and how we can help you. Or give us the benefit of your criticism if you do not agree with editorial comments or other articles. Remember, also, that the latch string always hangs out at our various editorial offices.

This month, with the conventions at Atlantic City, will be a busy one for us. Many of you will attend these meetings. We shall be glad to have you drop in at our offices, just inside the main entrance to Young's Million Dollar Pier, and get personally acquainted with the members of our staff.

Incidentally, this big June number—our annual Shop Equipment Number—will be followed by the eight issues of the *Daily Railway Age.* These will contain complete reports of the meetings of Division V—Mechanical, and Division VI—Purchases and Stores, American Railway Association; also of the Air Brake Association and the Association of Railway Electrical Engineers which also meet in Atlantic City.

It was necessary to close this number a little earlier than usual because of its large size, and reports of the meetings of the Master Boiler Makers' Association and the International Railway Fuel Association, both of which were held at Chicago late in the month of May, will be published in our July number.

Don't forget that we cordially solicit your individual help and co-operation in our efforts to make the *Railway Mechanical Engineer* a better and more effective paper.

Sincerely,

Roy V. Wright

NEW BOOKS

Design of Steel Mill Buildings. *By Milo S. Ketchum, director of the department and professor of civil engineering, University of Pennsylvania. 6½ in. by 9 in., 632 pages, 410 illustrations. Published by the McGraw-Hill Book Company, New York.*

This is the fourth edition of this book on the design of steel mill buildings; it has been rewritten and enlarged. In the original edition, it was intended to provide a short course in the calculation of stresses in framed structures and to give a brief discussion of mill building construction, with the underlying idea of presenting methods, data, and details on design and the making of estimates not ordinarily found available. The fourth edition, following along these lines, has been enlarged to include a discussion of the calculation of the stresses is statically indeterminate trusses and frames, several problems in framed structures, detailed designs of a crane girder, a roof truss and a steel frame mill building. The text has been divided into three parts and an appendix, the latter covering specifications for steel frame buildings.

The Engineering Index, 1921. *584 pages, 7 in. by 9½ in., bound in cloth. Published by The American Society of Mechanical Engineers, 29 West Thirty-ninth Street, New York.*

The Engineering Index has for years been considered an absolutely essential reference book by those who wish to keep in touch with current engineering literature and is always a welcome addition to an engineering library. Even those who have occasion to consult it only occasionally, appreciate its value and completeness when they find it necessary to investigate any of the numerous subjects covered.

The first volume of the Index appeared in 1892 and since 1906 has been issued annually. Up to 1918 it was prepared and published by the Engineering Magazine Company and since by the American Society of Mechanical Engineers. The current volume contains over 14,000 items referring to articles which appeared in some 600 engineering and other technical publications. In the preparation of the index the staff of the Society reviewed more than 1,200 periodicals, reports and other publications regularly received during the year by the Engineering Societies' Library, New York. These publications were printed in ten different languages and, as a result, the book is the most complete reference to scientific and engineering current literature in the world. The railway field is, if anything, even more completely covered than in former editions. This department includes rolling stock, terminals, shops, signaling, track and yards, together with all phases of construction, maintenance and operation.

Mechanical Appliances for Handling Railway Traffic. *By George Bulkeley. 132 pages, 5 in. by 7½ in., illustrated, bound in cloth. Published by the Railway Gazette, London, England.*

As the importance, and in many cases the absolute necessity, of material handling devices is being more clearly recognized every day, any book as suggestive as this will be of interest to many. While the author, who is connected with the Great Western Railway, has evidently had in mind primarily the needs of freight houses, transfer points, terminals and docks, many of the devices and methods shown are also of use at storehouses, shops, roundhouses and other places.

Of the 94 illustrations, the majority show different types of material handling machinery in actual service moving various materials under diverse conditions. In addition to these application photographs there are several diagrams showing principles involved also methods and arrangements that have been found to be successful.

Such commonly employed devices as wedges, jacks, chain and rope blocks, hand cranes, winches, ropes, hooks and derricks are treated first. Following this is a chapter on portable devices, including hand trucks, industrial power trucks, tractors, trailers, portable cranes, stackers and various types of portable conveyors. The next chapter treats of cranes, continuous conveyors and various combined appliances. Electric telphers and overhead carrier systems are described and shown in use. Chapters on highway cartage, dock working and the equipment for medium sized freight stations and storehouses complete the book.

Operating Engineer's Catechism of Steam Engineering. *By Michael H. Gornston. 428 pages, 4½ in. by 7½ in., bound in leather. Published by D. Van Nostrand Company, New York.*

This book is of special interest and service to younger operating engineers and students. It contains 1,300 questions and answers which, as a rule, are clearly and concisely stated. Its form will appeal particularly to those who are not accustomed to concentrated study and is, for this reason, rather elementary in its treatment of the different subjects. The author is a steam engineer in the department of education of the City of New York and in writing the book evidently had in mind the engineer who wished to prepare himself for such examinations as are required for civil service positions, municipal or state. The book, however, will also be of use in the library of older and more experienced engineers, for reference purposes. Among the subjects discussed are heat, steam, combustion, boilers, engines and condensers, together with chapters on the practical management of boilers, engines and auxiliary machinery. Pumping machinery, steam heating, stokers and also pulleys and belting are included. The book is well printed and of convenient size although it would have been improved by the use of more illustrations. An excellent index of 32 pages adds considerably to its value.

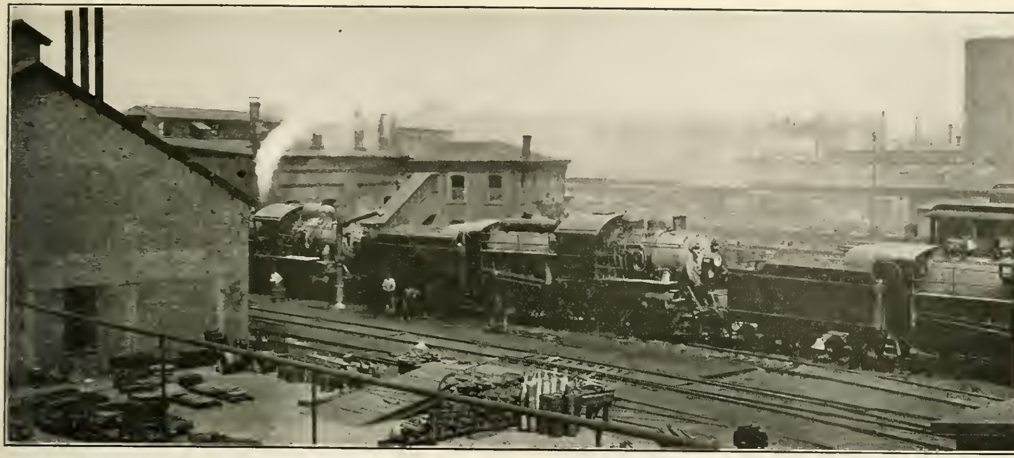
Fuel and Refractory Materials. *By A. Humboldt Sexton and W. B. Davidson. 382 pages, illustrated, 6 in. by 9 in., bound in cloth. Published by D. Van Nostrand Company, New York.*

This book is a revised edition of the well-known work by Professor Sexton, who was at one time president of the West of Scotland Iron & Steel Institute. The present edition has been practically rewritten and its scope enlarged by W. B. Davidson. Its real value is as a reference book and as such will be found valuable by those who wish to consult from time to time an authoritative work on the subject of fuels.

The different points taken up are treated in the thorough manner which is often characteristic of British writers, and although a greater attention to American fuels and practices would be desirable, the viewpoint is general and largely world-wide. The opening chapter takes up the theory of combustion. This is followed by information in regard to the heating power of fuels and the characteristics of wood, coal, peat, charcoal, coke, etc. Coal washing and the preparation of various fuels is described at length. The next two chapters treat of liquid and gaseous fuels, their characteristics, manufacture and use in various industries. The next subject discussed is that of by-products and low temperature carbonization. Considerable practical information is contained in the chapters on furnaces for various purposes, supply of air and smoke prevention. Pyrometry, calorimetry, utilization of fuel and the testing of fuels are covered in a complete and interesting manner.

The title of the book is slightly misleading as only 36 pages are devoted to matters in connection with refractory materials, such as bricks, and crucibles. A few tables and a very satisfactory index complete the book.

The Consumption of Fuel Oil in 1921 by locomotives of the railroads in the United States amounted to 38,824,000 barrels as compared with 45,847,000 barrels in 1920. Of the total now reported, 27,615,000 barrels were domestic oil and 11,209,000 barrels were Mexican.



Locomotives Are Washed While Taking Water

Expediting Enginehouse Work at Hoboken

Modern Machine Equipment and Efficient Labor-Saving Devices Show Good Results at D. L. & W. Enginehouse

As the eastern terminal of the Delaware, Lackawanna & Western, the engine house at Hoboken, N. J., occupies a position of prime importance. It contains 38 stalls, employs 273 men on three shifts, and under the direction of M. R. Feeley, general roundhouse foreman, despatches 127 passenger engines every 24 hours. Credit for despatching an engine is allowed only when it is held over four hours and the actual number of engines turned at Hoboken is about 165 in 24 hours. All kinds of locomotive running repairs are made at this point except dropping the wheels which cannot be done because the enginehouse itself is on made land and the drop pit below water level at high tide. Approximately 98 boilers are washed each month.

Modern Machine Tools Installed

In view of the heavy load carried by the principal back shop of the Lackawanna at Scranton, Pa., particularly in its machine department, it was decided about a year ago to make the enginehouse at Hoboken self-supporting as regards machine work. Sufficient reserve machine shop capacity was also to be provided to take care of the needs of the enginehouses at Jersey City, Secaucus and Port Morris, N. J. In accordance with this plan, four new production machines were installed at Hoboken, including a Bullard 36-in. vertical turret lathe, a Ryerson-Conradson 18-in. by 8-ft. heavy duty engine lathe, a Coulter 26-in. openside planer and a Fox monitor brass lathe. The extent to which work on these machines has been developed is highly interesting and shows that the best of modern machines are not too good for enginehouse work.

The argument is sometimes advanced that high production machines cannot be utilized to the fullest advantage in enginehouses owing to the lack of demand for a sufficient number of similar parts to keep the machine busy. In this particular case, however, the new machines do the machine work for four enginehouses and are kept in continuous operation eight hours a day and sometimes longer manufacturing new locomotive parts and trueing or resurfacing those which are worn. With ample power, good light, plenty of work to do and efficient operators, the new machines are just as productive as if they were in a back shop.

Their work is both rapid and accurate, two qualifications often more essential in roundhouses than in back shops. When a back-end brass is sent in from an outside point to be reduced and rebored, for example, the engine is usually wanted in a hurry. The sooner the brass can be machined the better and it is essential that the brass be bored accurately as to size and square with the strap and main rod. Otherwise when returned to the locomotive it will not fit, resulting in still further locomotive delay. It is an obvious and far too common mistake to assume that any old worn-out machine tool is good enough for use in an enginehouse.

The vertical turret lathe, a close-up view of which is shown in Fig. 1, is used for manufacturing cylinder packing, valve rings, bull rings, cylinder heads, piston heads, rod bushings, back end main rod brasses and other parts. The method of manufacturing cylinder packing is similar to that followed in up-to-date back shops, the packing pot being bored and turned simultaneously. The packing pot illustrated, is about as large as the machine will take, making up into thirty 27-in. rings, ⅜ in. wide and ¾ in. thick. (It is Lackawanna practice to use three relatively narrow rings in each piston.) Roughing and finishing feeds of about 1/16 in. and ¼ in. respectively are used, the cutting speed being 52 ft. per min. in each case.

The parting tool, shown in Fig. 1, cuts off five ⅜-in. rings at a time, each individual parting tool being set a little in advance of the lower one and cutting a groove 3/16 in. wide. Experience has shown that any attempt to use parting tools less than 3/16 in. wide causes more lost time in sharpening and resetting tools than is gained by additional rings obtained. A slow cross feed is used in cutting off rings in order that the sides of the rings may be finished smoothly and require no further machining. Including the time for setting up, boring, turning, parting and a fair allowance for keeping cutting tools in good condition, it takes seven hours on an average to work up a single packing pot into thirty 27-in. rings. The work of lifting heavy pistons, packing pots, etc., from the floor to the machines and down again is greatly facilitated by a small pneumatic hoist, the handles of which may be seen above the operator's head in Fig. 1.

In accordance with what is now quite generally recognized as the best practice, piston valve chamber rings have been standardized, the new bushing and ring sizes on Lackawanna locomotives being 8, 9, 10, 12 and 14 in. respectively. These bushings are allowed 3/8 in. wear before replacement and packing rings, made 14 3/8 in. in diameter, for example, will always be large enough for any 14-in. valve chamber. This enables all 14-in. packing ring dimensions to be standardized, except the outside diameter which is made 14 3/8

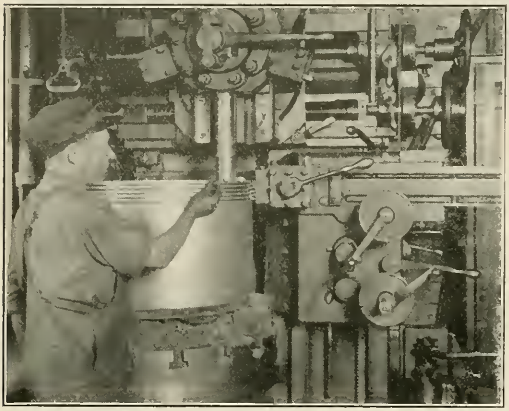


Fig. 1—Manufacturing Cylinder Packing On a Vertical Turret Lathe

in. to be later turned down as required by means of a special jig in an engine lathe. Moreover, 14-in. rings are standardized in sixteenths from 14 in. to 14 3/8 in. This makas possible the reclamation of worn rings by turning down to the next smallest sixteenth until the 14-in. size is reached. Standardization enables valve chamber rings to be made up in quantities in advance with two important advantages. They are always on hand in case of emergency and the cost per ring of making them in quantities is less than when made singly.

The time required to manufacture piston valve chamber rings was determined by a test made last February, the rings being T-rings 14 3/8 in. in diameter by 1 in. wide on the face. The original diameter of the packing pot was 15 in. outside and 12 in. inside and four rings were obtained from each pot. The cutting speed at the tool point was 52 ft. per min., the roughing and finishing feeds being .063 in. and .245 in. per revolution. The time for manufacturing the four rings complete, including the time of set-up, was 75 min. It was explained that while this time could undoubtedly have been reduced by speeding up the machine and using a little coarser feed on the roughing cut, more time would probably have been lost in grinding tools.

Twenty-seven inch piston heads are turned and the rod fit bored in approximately 2 1/2 hr. on the vertical turret lathe, removing about 3/8 in. of stock and using roughing and finishing speeds as before mentioned. A gang tool cuts the three piston grooves at one time. Approximately 20 min. is required to machine a 9-in. side rod bushing all over. In connection with reboring worn main rod back end brasses and making the bores square with the straps, a pair of parallels have been developed as shown in Fig. 2. The construction of these parallels is evident from the illustration and they are a great aid in lining up the brasses preliminary to boring. In fact, they practically prevent all chance of boring the brasses out of square.

As with the other new tools the modern 18-in. engine lathe, illustrated in Fig. 3, is held in high esteem at the Hoboken enginehouse for the reason that it is powerful, accurate and easily controlled by levers and hand-wheels within convenient reach of the operator. This lathe, with a hollow spindle enabling bar stock up to 3 in. in diameter to be passed through and held in the chuck, is used for

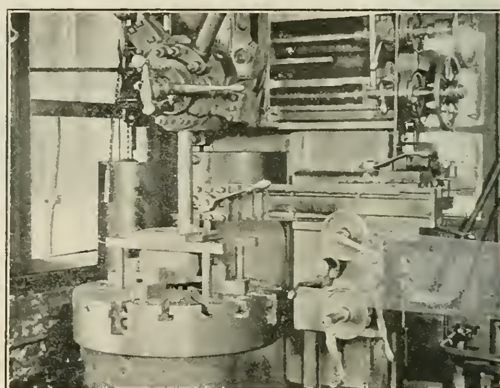


Fig. 2—Parallels Aid in Setting Up Back End Brass

making motion work pins and bushings, rod bushings (when the boring mill is busy), wrist pins, and miscellaneous pins, guide blocks, etc. A wide range of work is handled, sufficient to keep the lathe busy practically eight hours a day.

Second-hand engine truck axles are annealed, cut in two with the torch, and machined into wrist pins and knuckle

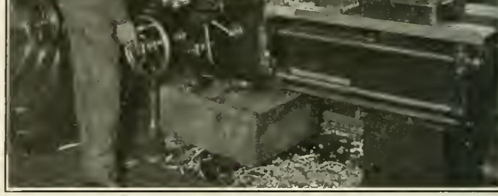


Fig. 3—Modern Engine Lathe Machining Wrist Pins

pins, as shown in Fig. 3. The pins are standardized as much as possible in thread size and crosshead fit, being left 1/8 in. large for the running fit in the main rod front end. This enables wrist pins to be manufactured in quantity for a given type of locomotive at a considerable saving in the cost of production.

The power of the lathe is evidenced by some of the roughing cuts taken on these engine truck axles. In spite of being annealed they are more or less hard and a cut 1 1/32 in. deep, or a 2 1/16 in. reduction in diameter is made with a cutting speed of 35 ft. per min. and 1/16 in. feed. Under this comparatively heavy duty no vibration is noticed and the thrust collars do not run warm. Fig. 3 shows the axle after it has been partially worked up into four wrist pins.

The open side planer, illustrated in Fig. 4, has also secured warm supporters at Hoboken owing to its flexibility, power and ready control. The machine was originally designed for a 24-in. maximum stroke, but arrangements were made to have the stroke increased to 26 in., thus accommodating slightly longer work. The machine is used for planing shoes and wedges, trueing the seats of Economy steam chests, shaping back and main rod brasses, engine truck boxes, driving box cellars, piston rod keys, main rod keys, etc. Ample power is provided and when occasion arises a cut of 1 1/16 in. or more can be taken on an oversized driving box shoe, the feed being about 1/32 in. and the cutting speed 40 ft. per min.

Special features of the machine are the wide range of work which can be handled on it and the ease of changing feeds and speeds while watching the progress of the cutting tool. A good idea of the range of work handled is afforded by Fig. 4. The machine may be shaping one of the big main rod brasses, or planing the extended driving box wedge in the foreground and the next minute be called on to shape the small rod key shown in the chuck.

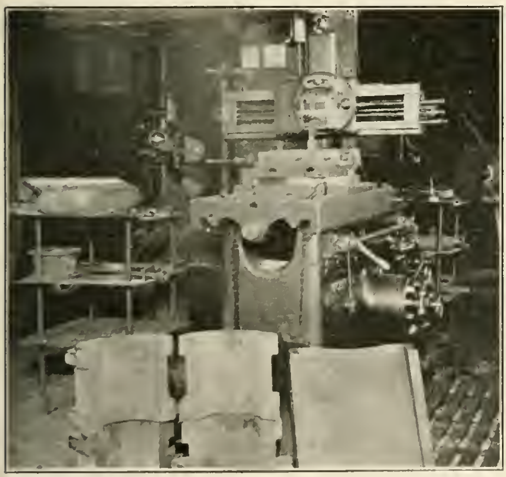


Fig. 4—The Openside Planer and Some of Its Work

A Fox monitor brass lathe, also installed with the other new machines, finds very continuous and useful service. It is used for general work in repairing and renewing parts of injectors, safety valves, boiler check valves, blow-off cocks, gage cocks, boiler fittings and other cab fittings too numerous to mention. Six turret stations are provided on this machine and the operator has developed a large number of special tools and jigs by means of which the work is greatly facilitated. Some of the jigs most commonly used, probably, are those developed for holding valve stem and piston rod packing while being bored.

General Labor-Saving Devices

A continual effort has been made at Hoboken to develop devices and methods which will save time or labor. One of the most interesting devices is a portable pneumatic oiler, credit for the development of which is due to M. R. Feeley, general foreman. Details of this oiler are shown in Fig. 5 and the method of using it in Fig. 6. It consists of a small riveted brass tank suspended from the shoulder of the oiler and arranged to fit comfortably around the left hip. The tank holds about 1½ gallons of an equal mixture of car oil and flange oil, pneumatic pressure being applied by means of a small hand pump and the oil directed where desired by a flexible tube and a bent brass nozzle. Control of the flow of oil is by a small valve under the operator's right thumb. A gage is provided to register the pressure

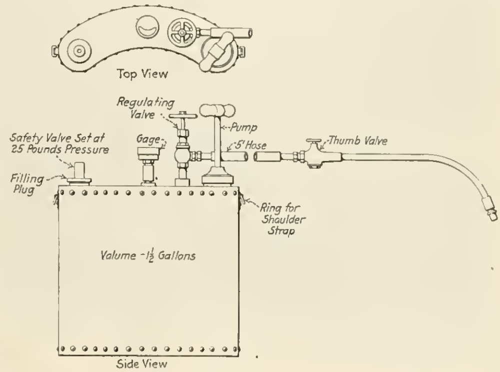


Fig. 5—Details of Pneumatic Oiling Device

and a safety valve (set at 25 lb.) also serves as the filling plug.

The particular advantages of this device consist in the ease and accuracy with which oil can be applied to driving, truck and trailer wheel hub liners, chafing plates, spring hangers which show evidence of wear, swinging cradle pins, and in fact any place where the engineman cannot get with his more or less bulky oil can. Oil can be applied just when, and where, and in the exact amount needed. It may be stated that the ease of operating this device keeps the oiler on the alert for places where a little oil will be of benefit and it is hard to estimate in actual dollars and cents the savings due to reduced wear and tear on machinery and better general lubrication.

Many places which were previously absolutely inaccessible can be readily reached with this oiling device. For example, when a crank-pin is on the top quarter it is perfectly feasible to get oil into the hub bearing. Solid engine truck wheels also make the oiling of hub bearings difficult and the way this difficulty is overcome is clearly shown in Fig. 6. Among other advantages it is estimated that at least a gallon of oil a day is saved by the pneumatic oiling device, owing to getting the oil exactly where it is needed and not wasting any.

The depressed track, illustrated in Fig. 7, while not new, is used at Hoboken for several purposes which may not be familiar to all roundhouse men. For example, it proves of great advantage in changing springs, spring hangers, spring rigging and equalizers in any part of the locomotive without the use of jacks. It is simply necessary to block the proper part of the spring rigging and run the pair of wheels into the depression. This relieves the tension on spring hanger pins and allows the required part to be taken out and repaired or renewed. Another use of the depressed track is in shimming tires. In this case a block is put between the binder and driving box and then by running the wheel in question over the depression it will be held clear of the rail, making it easy to heat the tire and apply shims.

One of the unusual jobs possible on the depressed track is the changing of engine truck wheels without the use of jacks. By blocking under the spring rigging and tying up the engine truck it is possible to move the truck wheels over the depression, take off the pilot and front pedestals, rolling the wheels out and applying a new pair. There is no particular labor-saving by this method over the use of a drop pit but it may on occasion be extremely valuable in roundhouses having no drop pit facilities.

With a proper understanding of how to do the job an engine truck spring can be changed using the depressed track

Fig. 6—Oiling a Solid Engine Truck Wheel Hub Through a Hole in the Plate

in about 15 min. The depression in the track is about 4 in. deep and 5 ft. long. Fig. 7 shows sections of rail put back in place so that an engine can ride over the depression easily. The first attempt to hold these sections of rail in place in the depressions was unsuccessful, the four guiding pieces welded on the sides of each section not being substantial enough to hold them. Experience has shown that about the best method is to provide three 1⅛ in. round plugs, spaced about 18 in. apart in each inserted rail section and engaging corresponding holes drilled in the depressed rails. It may be stated that where the lower rails are drilled to

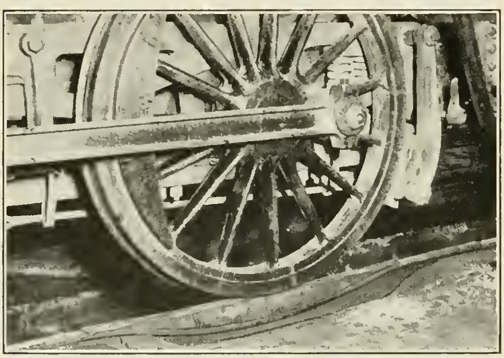


Fig. 7—Depressed Track with Rail Section Inserted

accommodate the plugs it is best to build up with electric welding around the web of the rail, thus providing additional stiffness.

The method of washing engines is of special interest due to the fact that the operation is performed while the locomotives are taking water. A mixture of hot water and oil is used, directed on the locomotive by a jet of air. With one operator working on each side no time is lost. The method is effective in keeping the locomotives clean and is relatively inexpensive, since the hot water is obtained through the boiler washing outfit from locomotives blown off on account of necessary boiler work. Arrangement is made for ample circulation of the water in cold weather and as a result

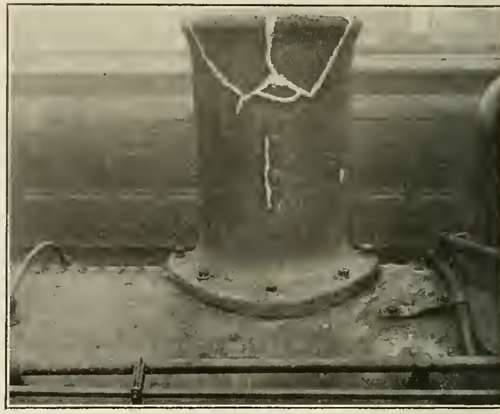


Fig. 8—Smokestack Repaired By Electric Welding

locomotives can be washed in the severe winter weather sometimes encountered in the vicinity of New York.

A great deal of effective welding work is done at the Hoboken enginehouse, including the building up of worn parts, welding broken cylinders, cracked valve ports, and in fact almost any part which fails in service. The smokestack, illustrated in Fig. 8, for example, was accidentally broken in removing a heavy steam chest with a stack crane. Three pieces of the stack fell out and were electric welded back in place as shown. (The chalked lines indicate the position of the welds.) These welds were made about six months ago and welders were getting 82 cents an hour, three hours being required for welding. The engine has since been to the back shop for heavy repairs and the inspectors evidently considered the stack good enough to go until another shopping for a new one was not applied. The preceding are but a few of many labor-saving devices and methods used at the Delaware, Lackawanna & Western enginehouse at Hoboken, N. J.

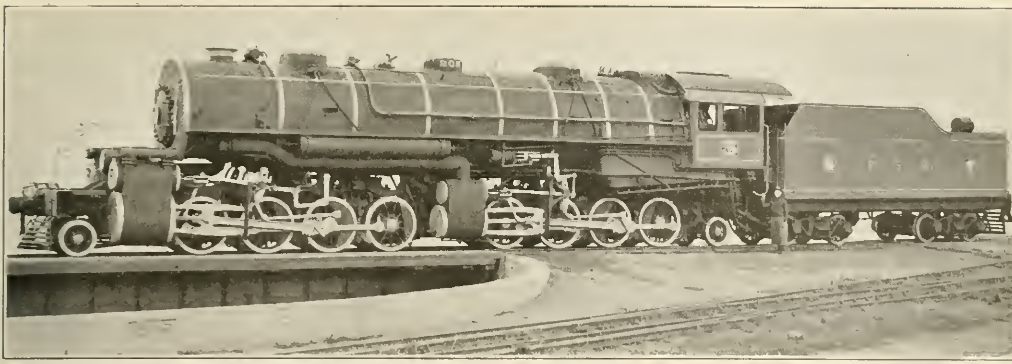
Tool Bit Cutting Tests

About 60 more tests of ¼-in. tool bits made of several grades of high speed steel when subjected to various heat treatments were recently completed by the Bureau of Standards, Department of Commerce. A preliminary summary of a portion of these tests for one steel containing .62 per cent carbon, 3.5 per cent chromium, 15.5 per cent tungsten and 1.6 per cent vanadium was made. An interesting feature is the effect of the temperature of preheating on the cutting qualities of the tools, as expressed by the pounds of metal cut. This is shown in the table below:

Preheating	Hardening	Lb. of metal cut per tool (four tools tested)
20 min. at 1,400 deg. F.	5 min. at 2,417 deg. F.—Oil	9.1
20 min. at 1,500 deg. F.	5 min. at 2,417 deg. F.—Oil	10.1
20 min. at 1,600 deg. F.	5 min. at 2,417 deg. F.—Oil	5.1
20 min. at 1,600 deg. F.	5 min. at 2,417 deg. F.—Water	5.1

Note—All testing conditions were the same.

The results obtained when using water as the quenching medium are about the same as when using oil.



The Largest Locomotive Outside of the United States Is Used on the Pekin-Suiyuan

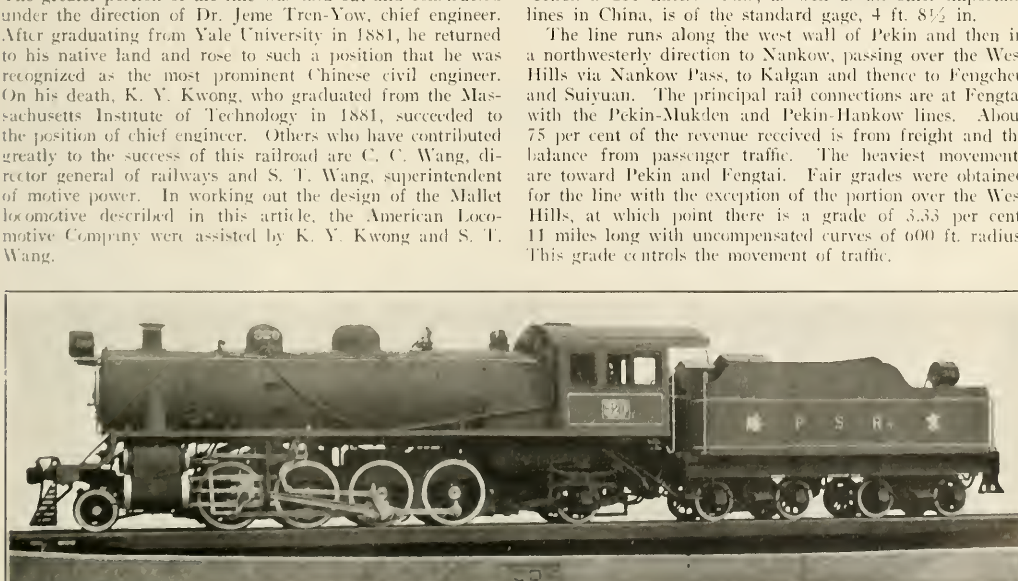
Heavy Mallet Locomotive for Pekin-Suiyuan

Largest Locomotives Exported or Operated Outside of the United States Now in Service in China

IT is somewhat startling to find that the largest locomotives that have ever been exported from this country and the most powerful in operation outside of the United States are those shipped by the American Locomotive Company to the Pekin-Suiyuan Railway in China. Although this ancient country is most inadequately provided with railroad facilities and most of the transportation is still carried on by the same methods that have been in vogue for centuries, this railroad is strikingly progressive. Moreover, it has been built and is now operated solely by Chinese. The greater portion of the line was laid out and constructed under the direction of Dr. Jeme Tren-Yow, chief engineer. After graduating from Yale University in 1881, he returned to his native land and rose to such a position that he was recognized as the most prominent Chinese civil engineer. On his death, K. Y. Kwong, who graduated from the Massachusetts Institute of Technology in 1881, succeeded to the position of chief engineer. Others who have contributed greatly to the success of this railroad are C. C. Wang, director general of railways and S. T. Wang, superintendent of motive power. In working out the design of the Mallet locomotive described in this article, the American Locomotive Company were assisted by K. Y. Kwong and S. T. Wang.

The first section of the Pekin-Suiyuan was built from Pekin to Kalgan, a distance of 122 miles, the work being begun in 1905 and completed in 1909. At this time it was known as the Pekin-Kalgan railway and the funds for the construction were appropriated yearly out of the surplus earnings of the Pekin-Mukden line. Upon completion of the section referred to, the Board of Communication recommended an extension to Suiyuan. This undertaking received imperial sanction in 1909 and construction was commenced in the following year. The length of the second section is 235 miles. This, as well as all other important lines in China, is of the standard gage, 4 ft. 8½ in.

The line runs along the west wall of Pekin and then in a northwesterly direction to Nankow, passing over the West Hills via Nankow Pass, to Kalgan and thence to Fengcheu and Suiyuan. The principal rail connections are at Fengtai with the Pekin-Mukden and Pekin-Hankow lines. About 75 per cent of the revenue received is from freight and the balance from passenger traffic. The heaviest movements are toward Pekin and Fengtai. Fair grades were obtained for the line with the exception of the portion over the West Hills, at which point there is a grade of 3.33 per cent, 11 miles long with uncompensated curves of 600 ft. radius. This grade controls the movement of traffic.



Mikado Locomotive Used on Level Sections

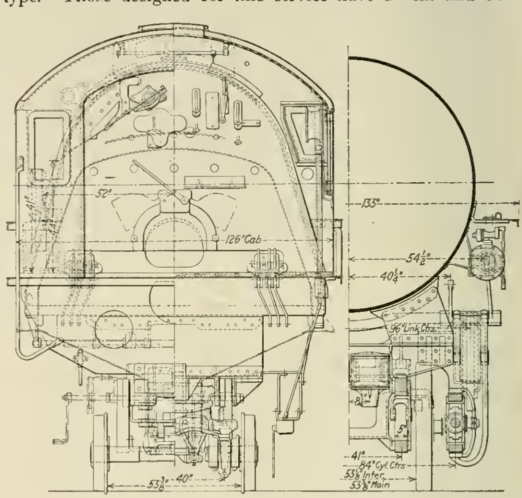
Table of Dimensions, Weights and Proportions

Cylinders, high pressure	24 in. by 28 in.
Cylinders, low pressure	38 in. by 28 in.
Valves and valve setting:	
Kind and size, H.P.	Piston 14 in., single ported
Kind and size, L.P.	Piston 16 in., double ported
Maximum travel	H.P. 6½ in., L.P. 6 in.
Outside lap	H.P. 1 in., L.P. 1⅛ in.
Exhaust clearance	H.P. ¼ in., L.P. 7/16 in.
Lead in full gear	H.P. ⅛ in., L.P. 3/16 in.
Weights in working order:	
On drivers	388,500 lb.
On front truck	28,500 lb.
On trailing truck	29,000 lb.
Total engine	446,000 lb.
Tender	192,700 lb.
Wheel base:	
Driving, each engine	14 ft. 9 in.
Total engine	53 ft. 11 in.
Total engine and tender	85 ft. 3 in.
Wheels, diameter outside tires:	
Driving	50 in.
Front and trailing truck	30 in.
Tender	33 in.
Journals, diameter and length:	
Driving, main	10 in. by 12 in.
Driving, others	9 in. by 12 in.
Front and trailing truck	6 in. by 12 in.
Boiler:	
Type	Straight top
Steam pressure	220 lb.
Fuel	Bit. coal
Diameter, first ring outside	94 5/16 in.
Firebox, length and width	126 1/16 in. by 108¼ in.
Height, grate to crown sheet, back	64 in.
Height, grate to crown sheet, front	76 in.
Arch tubes, number and diameter	5—3 in.
Combustion chamber, length	38 in.
Tubes, number and diameter	251—2¼ in.
Flues, number and diameter	48—5½ in.
Tubes and flues, length	24 ft. 0 in.
Tube spacing	¾ in.
Grate type	Finger-bar, rocking
Grate area	95 sq. ft.
Heating surfaces:	
Firebox, incl. coch. chamber and arch tubes	352 sq. ft.
Tubes, outside	3,534 sq. ft.
Flues, inside	1,652 sq. ft.
Total evaporative	5,538 sq. ft.
Superheating	1,433 sq. ft.
Comb. evaporative and superheating	6,971 sq. ft.
Tender:	
Water capacity	10,000 gal.
Fuel capacity	16 tons
General data and proportions:	
Rated tractive force, simple	111,000 lb.
Rated tractive force, compound	92,500 lb.
Weight on drivers ÷ total weight engine	87.1
Weight on drivers ÷ tractive force simple	3.5
Tractive force, compound ÷ comb. heating surface	13 27
Tractive force, compound × dia. drivers ÷ comb. heating surface	664
Firebox heating surface ÷ grate area	3.7
Firebox heating surface ÷ evap. heating surface, per cent	6.35
Superheating surface ÷ evap. heating surface, per cent	2.59
Tube length ÷ inside diameter	143.5

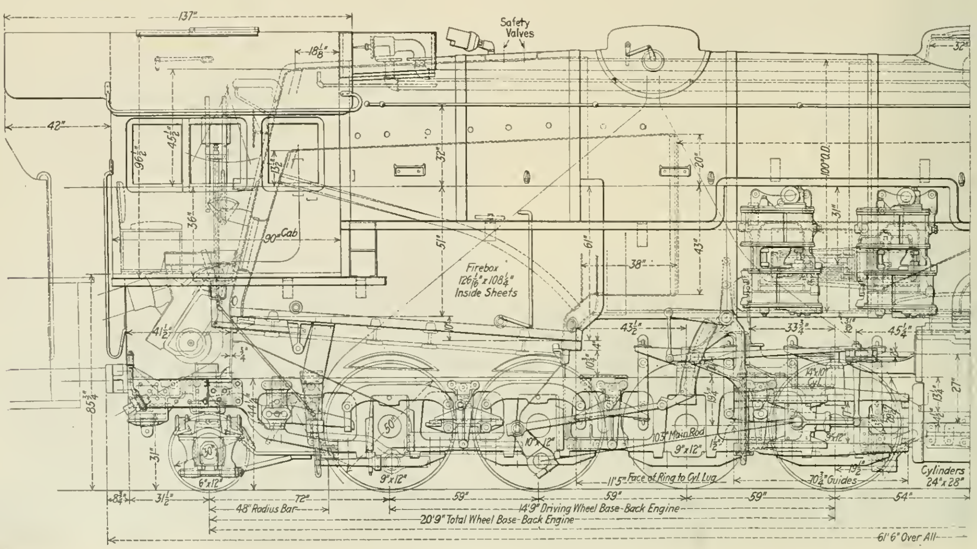
Most of the bridges were fabricated at the Shanhaikevan bridge works of the Mukden-Pekin railroad, while the rails came largely from the Han-Yeh-Ping steel works at Hankow. The majority of the passenger and freight cars were built at the Tongschau shops of the Pekin-Mukden. Practically all the locomotives, however, were built by the American Locomotive Company.

On the main portion of the road, except over the mountains, the heavier freight trains are hauled by Mikado type locomotives. A design largely employed weighs 188,500 lb. of which 137,000 lb. are on the drivers. The rated tractive force is 34,300 lb.: cylinders 20 in. by 28 in.; steam pressure 180 lb., and drivers 50 in. in diameter.

For handling the trains over the heavy West Hills grade it was deemed best to use Mallet locomotives of the 2-8-8-2 type. Those designed for this service have 24 in. and 38



View of Cab and Half Section

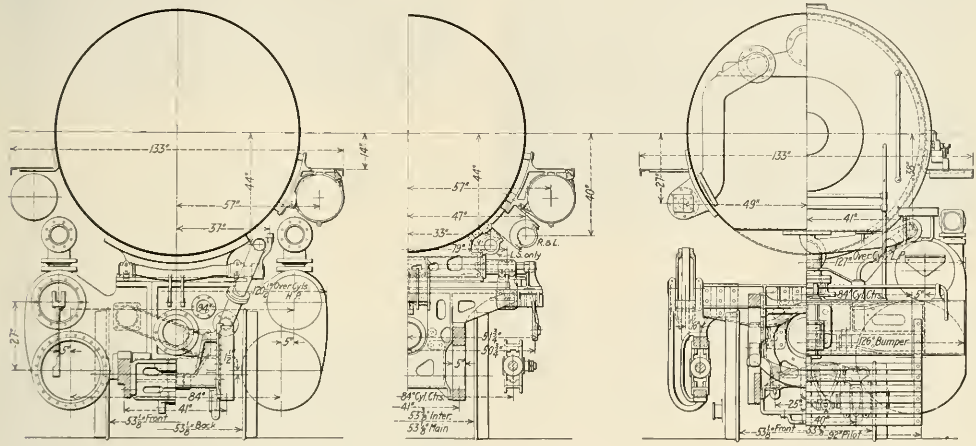


Rear Half of Elevation

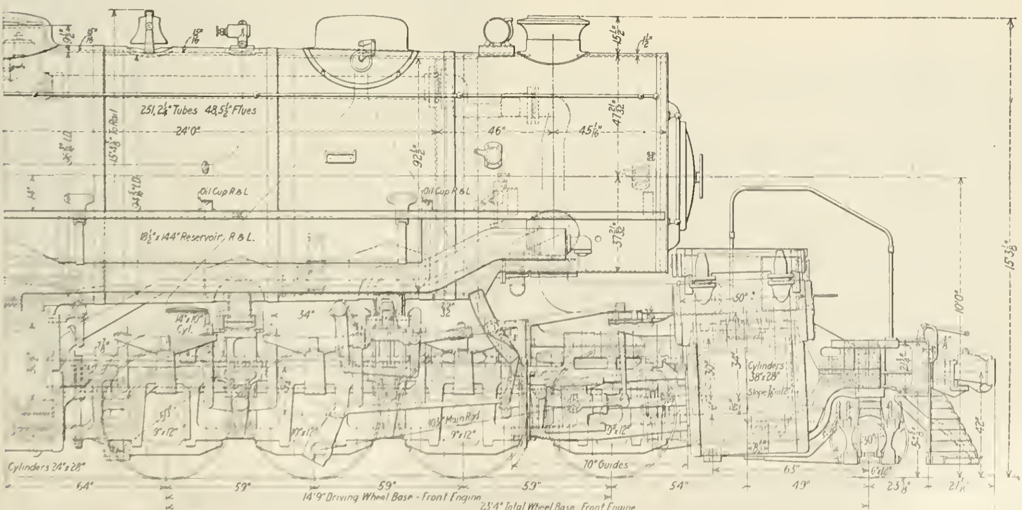
in. by 28 in. cylinders and a rated tractive force of 111,000 lb. when working simple, and 92,500 lb. when working compound. As the weight on drivers is 388,000 lb., the factor of adhesion is 3.5 when working simple and is 4.2 when working compound. The driving wheels are 50 in. in diameter and the boiler pressure 220 lb. These locomotives are capable of handling a freight train of 600 long tons at a speed of 5 m.p.h., or 500 tons at a speed of 10 m.p.h. Two Mallets are required to handle a train which is hauled on the level by one Mikado.

As a matter of comparison it is of interest to note that the U. S. R. A. heavy Mallet locomotives of the 2-8-8-2 type weighed 531,000 lb. of which 478,000 lb. were on the drivers. The rated tractive force was 121,600 lb. simple and 101,300 lb. compound. Cylinders were 25 in. and 39 in. diameter by 32 in. stroke; driving wheels were 57 in. diameter, and boiler pressure was 240 lb. per sq. in.

The general design of the Pekin-Suiyuan locomotives is in accordance with the best American practice, and the special devices are such as would probably be used in this country. The superheater has 48 units. The firebox has a combustion chamber and is fitted with a Security brick arch carried on five tubes. There is an Elvin type A mechanical stoker and a Franklin hand-operated butterfly firedoor. Other well-known attachments included are Nathan Simplex style BH 6,000 gal. capacity injectors, 4-in. Coale open pop safety valves, Hancock pneumatic cylinder cocks, Pyle electric headlight, Leach pneumatic sanders, Gollmar bell ringer, type D automatic couplers, Westinghouse N-12-A friction draft gear, Alco type E reverse gear, Flaman speed recorder and Westinghouse air brakes with two 8½-in. cross-compound air compressors.



Cross Sections and Half Front View



Front Half of Elevation

A Wide Variety of Reclamation Work Is Handled at Huntington

Scrap Reclamation on the Chesapeake & Ohio

Methods Used and Savings Effected in Reclaiming Locomotive, Car and Other Parts at the Huntington Shops

By E. A. Murray

Shop Superintendent, Chesapeake & Ohio Shops, Huntington, W. Va.

In recent years the principal railways of the country have been much interested in the matter of reclaiming locomotive, car and other parts which have been discarded and would ordinarily be sold as scrap. While the Chesapeake & Ohio has not up to the present time invested in a very elaborate reclamation plant, the results accomplished with the facilities available are indicated in the following report and speak for themselves.

Grinding Cast Iron Wheels.—During the year 1921, 466 pairs of cast iron car wheels were ground at a saving of $13.80 per pair, or a total saving of $6,432.03. It requires on an average 45 min. to grind out the flat spots on one pair of wheels. Experience has shown that the investment for the grinding machine pays a good dividend in addition to improving the condition of the wheels. With the great number of car wheels ground at this point we have never had one develop a flat spot after once being ground true. This strengthens the theory that the liability of a ground wheel to slide is much less than if new due to the fact that the ground wheel is truly round. When ground on the axle centers wheels must be concentric with the journals. It is our opinion that the journal bearings of the ground wheels, due to the smoother running of the wheels, are less liable to run hot. Smooth wheels prevent hammer blows which cause the journal box packing to leave the journals. Wheels from the entire system are sent to Huntington for regrinding on the car wheel grinding machine which is illustrated in Fig. 1.

Bolts and Nuts.—During the past year 726,474 lb. of old bolts were reclaimed at a saving of $31,369.62. A great many old bolts are removed from the scrap, straightened, cut off, rethreaded and placed back in stock. This is also true of old rods which are not deteriorated too much.

During the year 1921, 285,505 lb. of nuts were reclaimed by retapping at a total saving of $13,986.76. We use two six spindle nut tapping machines in the nut reclaiming shop which is located at the scrap bins and near the repair yards. The nuts and washers are taken to this shop where the nuts are separated and retapped. The hexagon nuts are then sent to the locomotive department and square nuts to the car department where they are placed in bins conveniently located to the work. The washers are also separated and used in making repairs to cars.

Reclaiming Car Brasses.—Especial attention has been given to the work of reclaiming car brasses. This work is done in the brass foundry and is handled by four men, one for sorting and delivering the brasses to the liners, two for relining, and one to operate the car brass trimmer. The equipment for relining brasses is illustrated in Fig. 2 and consists of the necessary babbitt furnaces, tables and forms. It will be noted that each operator works at a table on which

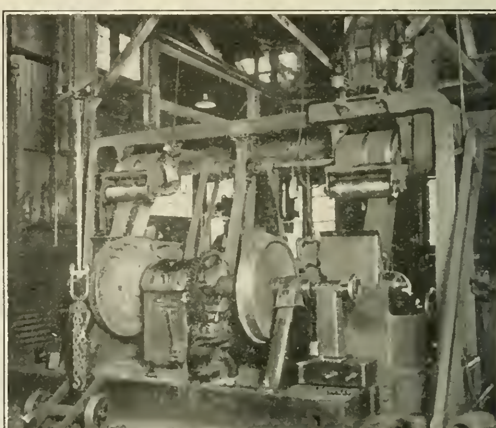


Fig. 1—Car Wheel Grinder Used at Huntington Shops

are two forms, arrangements being made for holding the brasses against the forms by means of a small air cylinder and plunger. The babbitt is poured and when cool the operator easily opens a valve releasing the air pressure and the brass. The car brass trimming machine, illustrated in Fig.

Fig. 2—Equipment for Relining Car Journal Brasses

3 is an efficient device, motor-driven through a belt. As in the previous case, arrangement is made to clamp the brasses pneumatically, a straight air valve being used to operate the air cylinder and plunger. Revolving cutters trim the ends of the brasses rapidly and accurately. A pile of brasses reclaimed and ready for service is shown in Fig. 4.

During January of this year 5,667 brasses were reclaimed (weight 136,005 lb.) at a saving of $3.30 per 100 lb., which amounted to $4,490.88. All of the scrap brass and copper

Fig. 3—Motor-Driven Car Brass Trimming Machine

on the entire system is shipped to this point, where it is reworked into new parts. It is not the practice of this company to buy any unfinished brass or bronze castings as all of these castings for the entire system are furnished from this point; also all bearings for new equipment built at outside shops. The illustrations show the old bearings as they are received at the shop, the process of relining the brasses, facing off the ends and the finished product.

Brake Beams.—During the year 1921, 8,079 brake beams were reclaimed at an average saving of $2.46 each, or a total saving of $19,874.34. The large number of brake beams reclaimed was due partly to the fact that a few cars have been let out to outside works for rebuilding, which made it necessary to remove a great number of beams, applying a heavier beam to the cars. These old beams were returned to the Huntington shops where they were put in good condition and used on lighter equipment. The table for assembling brake beams is illustrated in Fig. 5 and while a home-made device, it is effective in reducing the labor involved in assembling brake beams. Fig. 6 shows the furnace used for annealing brake beams.

Car Couplers.—During the past year 3,214 couplers were reclaimed and put in good condition for further service at a saving of $5.37 each, or a total of $17,259.19. A large number of couplers which have been reclaimed, but are minus the yokes, as shown in Fig. 7. Experience has shown that

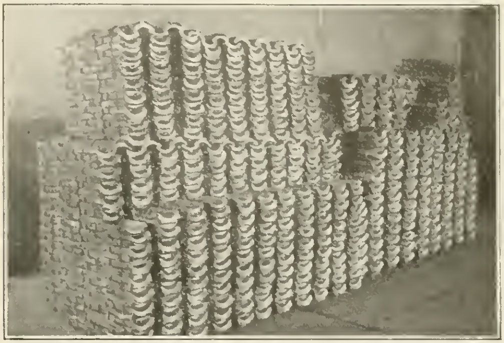


Fig. 4—Reclaimed Car Brasses Ready for Service

where the yoke intersects the couplers is the weakest point of the draft gear on freight cars and to eliminate this trouble we adopted the principle of swelling the coupler yoke rivets under the head to 1 5/16 in. and of sufficient length to have a full bearing in coupler and yoke. The hole in the coupler and yoke is 1 5/16 in. in diameter. It will be plainly seen that with this arrangement the yoke rivets fill the holes in the coupler and yoke and, therefore, make a good substantial job. This practice has been in effect for a good many years and we have never had any trouble with the yokes separating from the coupler when this practice is followed.

Fig. 5—Air-Operated Brake Beam Assembling Table

We have in our coupler shop one pneumatic riveting machine and one home-made pneumatic rivet shearing machine, illustrated in Fig. 8, which shears the heads off the rivets while they are in the coupler. The home made machine consists of a substantial shear blade operated through a long lever by a cylinder and plunger. The construction of the machine is substantial as shown, enabling it to withstand the more or less severe work of shearing coupler rivet heads. A small pneumatic hoist will be observed which facilitates the work of handling couplers and enables the operator to handle a large number in the course of a day without becoming unduly tired.

Rolled Scrap Wrought Iron.—During the year 1921, 1,113,092 lb. of scrap wrought iron were rerolled at a total saving of $20,720.46. All the scrap iron which is suitable for rerolling, including old defective arch bars, is sent to

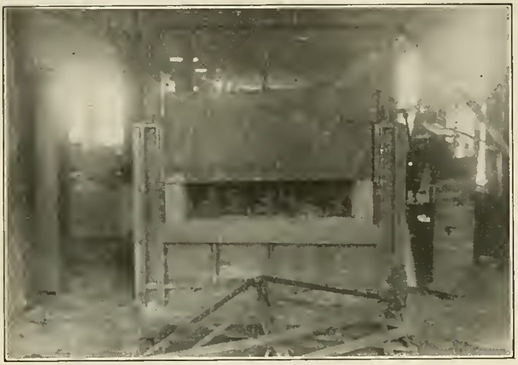


Fig. 6—Furnace Used for Annealing Brake Beams

the reclaiming plant at this point where it is reworked and used in car and locomotive repairs at a large saving. The class of scrap which is rerolled is shown in one of the views at the head of the article.

Coil Springs.—During the past year 885,739 lb. of coil springs were reclaimed at a saving of $38,380.26. The springs are shipped to this point where they are inspected and those with a permanent set are heated, reset, and tempered, after which they are used in repairs to locomotives and cars. They are also shipped to outside points. All locomotive driving, tender and passenger car springs are

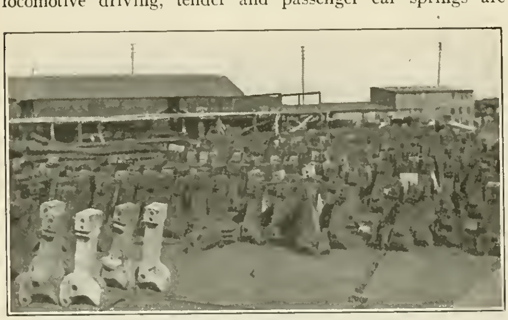


Fig. 7—Reclaimed Couplers Without Yokes

repaired at this point for locomotives and cars undergoing repairs; also sent to outside terminals. The average saving is an important item. The coil springs which are broken and beyond repairs are straightened out and the material used for cold chisels, pinch bars, punches and drift pins. We find this practice very economical. The springs which have been reclaimed are given a test at intervals to insure that they have been properly tempered and have the proper resiliency.

Reclaiming by Autogenous Welding.—Reclamation by autogenous welding is carried on at this point to the fullest extent justified by the relative costs of welding or buying new. A few parts which are reclaimed by welding are listed below. While we have no data at hand at present showing the savings made by using this practice, we are satis-

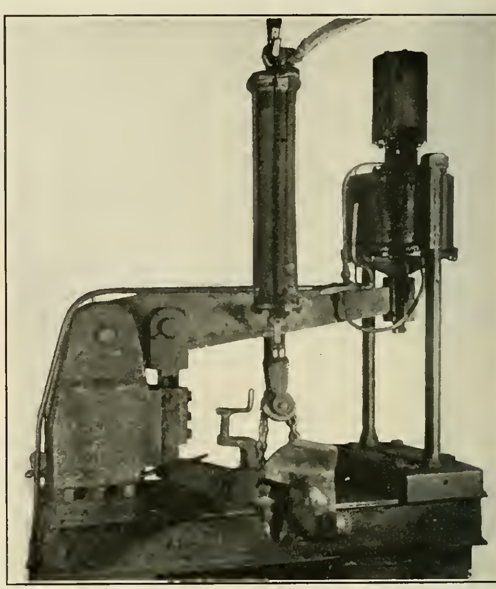


Fig. 8—Pneumatic Machine for Shearing Coupler Rivets

fied that they are very large in the aggregate and compare favorably with those made in important railway shops throughout the country.

List of Parts Reclaimeo in Locomotive Department

Engine coupler plates
Main equalizers
Cross equalizers
Spring equalizers
Trailer equalizers
Equalizer stands
Spring saddles
Post hangers
Boss spring bangers
Front end box bangers
Frame cross braces
Deck castings
Smoke arch braces
Reverse bar quadrant
Reverse bars
Reverse bar latches
Plug holes in reverse bar brackets
Plug boles in reverse bar straps
Plug holes in throttle levers
Plug boles in tbrottle straps
Frames
Driving boxes
Center castings
Expansion pad braces
Expansion pads
Fire door latcbes
Weld ends of cross bar brake rigging
Fulcrum sbafts
Fulcrum arms
Link blocks
Link plates
Link hangers
Links
Link saddles, boles plugged
Radius rod forks, holes plugged
Transmission rods
Transmission hangers
Reach rod forks
Guides built up
Weld bush crossbead boles
Cellar boxes
Trailer boxes
Main rod keys
Main rod front end blocks
Main rod wedges, front and back end
Weld oil cups on side rods
Plug grease cup holes in side rods
Flat spots on tires
Weld pinion to sbaft
Weld pinion teeth when broken out
Plug holes in housing
Weld smoke box rings
Weld mud rings
Weld stack brace to boiler
Weld cracks in release bar fulcrums
Weld truck frames
Weld truck cross brace
Weld truck cross brace caps
Weld truck swing hangers
Weld radial jaws
Weld truck boxes
Weld truck bottom braces
Weld truck hound braces
Plug wedge bolt holes in pedestal braces
Weld trailer jaws
Weld frame castings
Weld spiders for piston valve
Weld valve crossheads
Weld valve guides
Combination levers
Tail bars
Chafing irons
Plug holes in back main frame
Boiler head braces
Weld pins for ash pan sbafts
Weld stoker castings
Weld collars on stoker screws
Weld castings for stoker trough
Plug holes in lubricator brackets
Reclaim brake hanger pins
Brake hangers (all classes)
Brake heads (all classes)
Weld trailer carrier yoke blocks
Weld trailer spring hangers
Weld trailer carrier yoke hangers
Weld lugs on air pumps
Weld air pumps
Weld cracks in stoker engines
Weld engine cylinders
Weld slide valves
Weld slide valve strips
Weld bub liners
Plug holes in step iron brackets

Reclaim crank-pin washers
Weld dial on knuckle pins
Weld dial on crosshead pins
Weld grate shaker pistons
Plug holes in grate shaker rods
Weld trailer spring carrier yokes
Weld trailer spring carrier brackets
Weld trailer spring carrier bracket guides
Weld universal joints for stoker
Weld crank shafts for stoker
Weld stoker screws or worms
Weld rocker arm for stoker engines
Weld stoker shafts
Guide blocks
Weld cylinder heads
Weld cylinder cock slides
Weld air pump valves
Weld rocker arms
Weld spokes in driving wheels
Weld flag staff
Weld rocker arm boxes
Weld guide yoke boxes
Weld guide yokes
Weld guide yoke extensions
Floating castings
Floating columns
Weld main equalizer hangers
Weld crank arms
Weld strips on cross heads
Weld engine tank side frames
Weld engine tank bolsters
Weld draft castings
Weld draft casting blocks
Weld tanks chafing irons
Weld draft links
Weld main tank frames (cast steel)
Weld cracks in steel end sill
Truck pedestal (Built trucks)

List of Parts Reclaimed in Passenger Car Department

Cast-steel truck frames
Cast-steel truck bolsters
Built up worn equalizers
Plug holes in brake levers
Weld worn places in generator brackets
Weld bumper plates
Weld diaphragm or buffer plates
Weld buffer stems
Weld drawhead stems
Weld wing castings
Weld draft castings
Weld stringer irons
Weld spring blocks (for steel trucks)
Weld motor hanger or bush holes
Weld brake heads
Weld endsill plates
Weld generator shafts
Weld generator pulley wheels

List of Parts Reclaimed in Freight Car Department

Side frames
Truck frames
Truck bolsters
Body bolsters
Coupler heads
Miner draft castings
Carrier iron supports
Striking castings
Body center plate
Coupler yokes
Lift lever brackets
Door guides
Carrier irons
Draft links
Corner bands
Side bearings
Truck center plates
Spring seats
All kinds of miscellaneous shop tools

Triple valves, angle cocks, release valves, brake cylinders, auxiliary reservoirs and air hose are repaired, tested and placed back in service at a large saving. Globe valves, pipe fittings and miscellaneous items of a wide diversity of character, which usually find their way to the scrap, are reclaimed at a large saving and thrown back in stock. All switch stands which can be repaired economically are shipped to this point where they are put in good condition and placed back in service.

It might be well to state in concluding that we use a unique method at the shops in marking parts which should be scrapped and those which can be reclaimed and used again. This is done by the simple method of marking with white or yellow paint. White signifies that the material can be reclaimed and should be taken to the reclaiming shop; yellow signifies that the part is scrap and should be taken to the scrap bins. The men who are assigned to this work are thoroughly acquainted with the meaning of these marks and we have the assurance of the parts reaching their proper destination. The practice of reclaiming scrap is carried out at other shops on the system, but the main shops being located at Huntington, the work is done here on a larger scale.

Principles of Oxyacetylene Fusion Welding Part Two: Oxygen

By Alfred S. Kinsey*

Acetylene has wonderful possibilities as a gas for producing high temperatures, but in almost every instance its usefulness depends on the combination with pure oxygen to support its combustion. If a jet of acetylene were ignited and allowed to burn like a match,

Fig. 1—Burning Acetylene Before Compressed Oxygen Is Supplied

being supplied only with such oxygen as it could get from the ordinary air, it would burn with a low-temperature, smoky flame, Fig. 1, which would cause a shower of carbon particles, lampblack, to fall about, proving that there was not enough oxygen supplied to burn all of the carbon of the acetylene. Such a flame would not be hot enough to weld or cut metals.

If, however, the jet of acetylene were supplied through a blowpipe, like a welding torch, and another jet of pure oxygen mixed with it in the torch, practically all of the carbon of the acetylene would be consumed, and the flame would have a temperature of about 6,300 deg. F.

Now it will be seen that while acetylene has within its composition remarkable possibilities as a fuel gas, it is dependent on an abundant supply of pure oxygen to make them available. And the oxygen must be manufactured and supplied in such a manner and at a price which will make its use practicable, or the advantages of acetylene would be unavailable.

It should be of interest, therefore, to know how commercial oxygen is manufactured and furnished for the multitude of ways it is applied in oxyacetylene practice.

Manufacture of Oxygen

The two common ways of manufacturing oxygen for commercial purposes are by the Electrolysis of Water and by the Liquefaction of Air.

Electrolytic Oxygen.—In this method of producing oxygen distilled water is decomposed into its two principal elements, oxygen and hydrogen, by electricity. This is done in special cells, called unit generators, which may be coupled up to make as large a plant as desired. Each cast iron generator is divided vertically by asbestos into two compartments. On one side is a nickel plated cast iron electrode, called the anode, at which the oxygen is generated. On the other side is another cast iron electrode, called the cathode, at which the hydrogen is generated. The water flows from a

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reservoir down into the cell where it is decomposed by an electric current. The oxygen and hydrogen pass upward, each through bell jars to pipes leading to big gas holders. From these holders the gases are taken and compressed into steel cylinders for the market.

This method of making oxygen was one of the first used for commercial purposes. There is, however, liability of the oxygen being contaminated with a sufficient quantity of impurities, to cause an explosive mixture, and insurance rules prohibit the sale of electrolytic oxygen containing more than two per cent of impurities.

In some instances electrolytic plants are erected for the manufacture of hydrogen for the hydrogenation of fats in packing plants, and then oxygen is the by-product. In other instances the electrolytic plant is used to supply oxygen to the trade, which leaves hydrogen as the by-product. Electrolytic oxygen is sold in steel cylinders containing about 200 cu. ft. at 1,800 lb. pressure per sq. in.

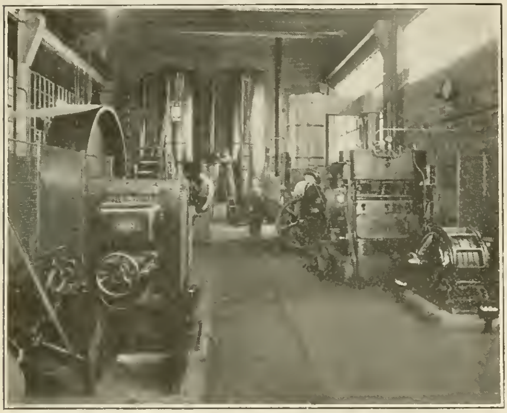


Fig. 2—Machinery Room for Manufacturing Liquid Air Oxygen

Liquefaction Oxygen.—The method used to manufacture the largest proportion of oxygen consumed in the United States is by the liquefaction of air, and probably the most successful process for that purpose is the one known as the Claude system. There is considerable machinery about such a plant, Fig. 2, which is used as follows: Ordinary air is made to pass through two towers of spiral tiles, Fig. 3, against a stream of caustic soda, which removes the usual 0.03 to 0.08 per cent of carbon dioxide from the air. The air is then taken into the low pressure cylinder of an air compressor, free of CO_2 but saturated with moisture, which is squeezed from it by compression to 95 lb. per sq. in. The air goes from the low pressure cylinder to a high pressure cylinder, where it is compressed to 450 lb. per sq. in.

So far the air has been purified, compressed and purged of its moisture. It then is made to pass through an exchanger, Fig. 4, circulating around a large number of small tubes carrying cold gases, which reduce the temperature of the compressed air from ordinary room temperature to about 170 deg. below zero Fahrenheit. Next the air is passed through a liquefier and cooled by the incoming cold gases so as to reduce its temperature on down to the point where it becomes liquid. The liquid air is drawn through an expansion valve where it expands from 450 lb. to 75 lb. per sq. in., which lowers its temperature on down to nearly 300 deg. below zero F.

Some of the compressed air, as the rest became liquid, was sent to an expansion engine, Fig. 5, which lowered its pressure to 75 lb. and its temperature far below zero, but it remained in the gaseous form. The combination of liquid air and air vapor is carried over into a vaporizer, where the vapor comes in contact with liquid oxygen and is cooled to where it becomes part of the liquid oxygen. While the oxygen was vaporizing, the nitrogen also was being separated from the oxygen and vaporized. Then the nitrogen vapor became liquid and was collected in the nitrogen pot. Thus the two gases were separated by partial liquefaction.

The next step is to expand the liquid oxygen again through an expansion valve from 75 to 4 lb. per sq. in., which causes its temperature to drop to 296 deg. below zero F., and the nitrogen being likewise expanded is lowered in temperature to 316 deg. below zero F. It is to be noted that it is the expansion of the oxygen and nitrogen in liquid form and not as gases which causes the drop in temperature.

After the further purifying of the two gases, they are taken separately to their storage tanks, from which they are drawn and compressed. The oxygen is charged into steel cylinders containing 220 cu. ft. at 2,000 lb. pressure, Fig. 6.

Oxygen made by this liquid air method is over 99 per cent pure, and the small amount of impurity it might contain would be nitrogen, which is an inert gas having no explosive characteristics.

The Handling of Oxygen

Making oxygen available for use in railroad and other shops has been an interesting problem. It now is quite a common thing to see cylinders of oxygen standing about wherever metals are being worked. These cylinders are manufactured under the rules of the Interstate Commerce

Fig. 3—Towers for Removing Carbon Dioxide from Air Oxygen

Commission enforced by the Bureau of Explosives. They are made of special steel, cold drawn so as to eliminate all longitudinal and circumferential seams.

The rules require that the cylinders must be tested at a hydrostatic pressure equal to one and two-thirds times the charging pressure of 2,000 lb. per sq. in., which would be 3,340 lb. The test is performed by filling the cylinder with water while it is submerged in a water jacket. The expansion of the cylinder under pressure may thus be determined by the rise of water it causes in the jacket. The test pressure is held in the cylinder for 30 seconds, and after the total expansion is measured the pressure is released and the permanent expansion noted, which must not exceed 10 per cent of the total expansion. This hydrostatic test must be repeated on every cylinder every five years.

A crushing test is also required in which one cylinder out of every 200 must be crushed between rounded knife-edges to a thickness equal to six times that of the wall of the cylinder.

All oxygen cylinders passing these tests are stamped with the I.C.C. specification number, the filling pressure and the date.

It will be seen that every precaution known to the art is taken to prevent accidents from the high pressure in the cylinders, and that such care has been successful has been proved by the exceptionally few failures of the hundreds of thousands of cylinders scattered over the whole country.

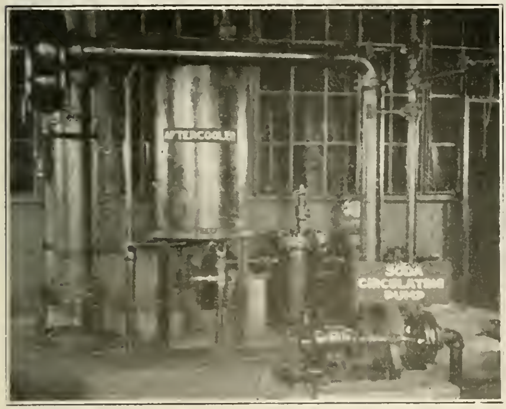


Fig. 4—Aftercooler for Reducing Temperature of Compressed Air

Air oxygen is distributed in cylinders of 110 and 220 cu. ft. capacity at 2,000 lb. per sq. in. and 70 deg. F., the larger size being the one mostly in use.

The needle valve on the oxygen cylinder is of a special design, which seats tightly at the bottom of the valve to close it, and will also seat at the top when opened all the way, to prevent any leakage about the valve stem. Only the strength of the hand is required to close or open the valve tightly

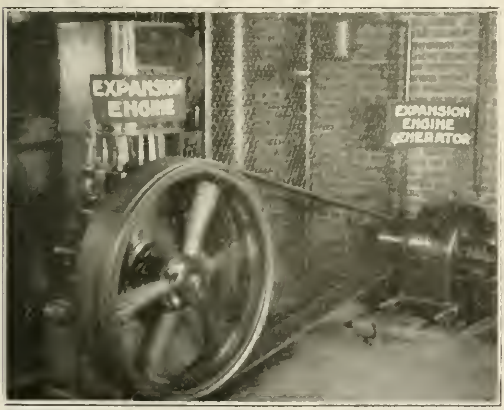


Fig. 5—Expansion Engine for Lowering Pressure and Temperature of Air

against the seats. The valve handle should not be struck with a hammer or any other tool.

Measuring the Consumption of Gases

The amount of oxygen discharged from a cylinder may be quickly determined from the cubic feet scale on the regulator pressure gage, but it may be more accurately measured by weighing the cylinder of oxygen on a platform scale before and after using the oxygen. The difference in weight in pounds multiplied by 12.08 will give the exact quantity in cubic feet, at 70 deg. F. This applies to the orange colored cylinders of the Air Reduction Company.

The same weighing method of determining the amount of gas used may also be applied to acetylene, the difference in weight, before and after, being multiplied by 14.5, which will give the cubic feet consumed. This applies to the Air Reduction Company's acetylene cylinders.

Combining the Gases

There are two principal types of oxyacetylene welding torches in use, the low pressure injector style using acetylene at a pressure of but a few ounces per square inch, and the medium pressure style using acetylene at a few pounds pres-

Fig. 6—Liquid Air Oxygen Filling Room

sure. The medium pressure torch is conceded to be the most efficient and economical.

Theoretically when one part of oxygen is mixed with one part of acetylene in the medium pressure torch the resulting flame should be neutral, the air supplying the remainder of the oxygen necessary to produce complete combustion. The temperature of this flame is about 6,300 deg. F. at the tip of the incandescent cone. For comparison, the temperature of the thermit reaction is about 5,400 deg. F. and that of the electric arc about 7,000 deg. F. The hardest steels and other shop metals melt at less than 3,500 deg. F.

If the torch is operated with an excess of acetylene it will give a carbonizing flame, while on the other hand too much oxygen will make the flame oxidizing in its action on the metal. It will therefore be seen that it is of first importance to have the welding torch of such design as will readily maintain the proper mixtures of the two gases and keep the flame neutral.

Again, the welder operating the torch must be sufficiently trained to recognize a true flame, even when it is pressed against the metal being melted and the flow of the gases is somewhat retarded by the back pressure.

(To be continued)

A Building and Loan Association has been started by the employees of the Pennsylvania Railroad, in the general offices at Philadelphia, to be called the "Broad Building and Loan Association." E. T. Kennan, superintendent of car service is president and Walton M. Wentz, vice-president; Charles P. Brady is secretary and William Lentz, treasurer.

Swedish Diesel-Electric Motor Car of 250 Horsepower

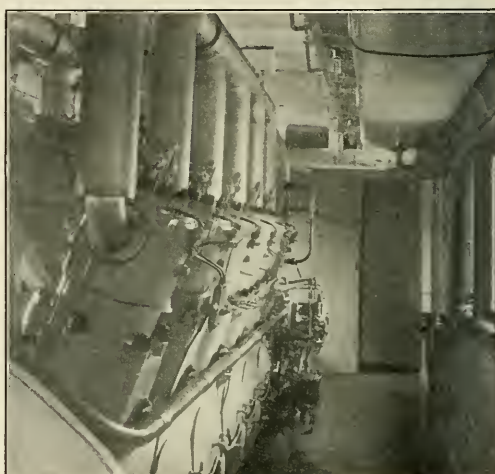
Diesel-Electric Motor Cars for Railway Service

Successful Operation in Sweden Has Led to the Introduction of 250-Horsepower Cars

SWEDEN is one of the countries which is obliged to import its supply of locomotive fuel and consequently the greatly increasing cost of coal is a serious factor in operating expenses. An abundance of water power has made electrification practical on a number of lines where the traffic is heavy but this change is not feasible on a large amount of mileage where the traffic is relatively light. Both improvements in steam locomotives and the substitution of other sources of power are receiving thoughtful attention. Considerable pioneer work in the application of Diesel engines for railroad motive power has already been carried on in Sweden. The system favored uses a Diesel engine to drive an electric generator which furnishes power to motors mounted on the trucks. The first car, built in 1913, had a 75-hp. engine. This was followed by several other cars with the same sized engine and later by others of 120 hp. These cars were built and equipped by the Swedish General Electric Company and the Atlas Diesel Company working in conjunction.

These early motor cars proved to be so satisfactory in operation that a separate company, the Diesel-Electric Car Company, Vasteras, Sweden, was organized to carry on further development work. The new company has turned out several cars of the smaller sizes and in addition built cars of 160 hp. and 250 hp. which are now in regular service. At the present time 12 Diesel-electric motor cars are in service on seven Swedish railroads. That none of the cars delivered has been taken out of service, except when impossible to obtain oil during the war, and that all orders recently received have been from roads that already had at least one car in operation is indicative of the success of the general design.

The cars with 75-hp. or 120-hp. engines were provided with compartments having seating capacity for a number of passengers or with space for baggage and mail. One or more small trailers were commonly hauled. The larger capacity cars lately built are not provided with accommodations for passengers but compartments for baggage and mail have been retained, passengers being accommodated in regular coaches hauled by the motor car.



Engine Room of 250 Horsepower Diesel-Electric Motor Car

Cars of 160 hp. weigh 37,500 kg. (82,500 lb.) and, when grades do not exceed one per cent, are capable of hauling a trailing load of 67½ metric tons (74¼ short tons) at ordinary speeds. This is a total train weight of 105 metric tons (115½ short tons). Cars of 250 hp. weigh 50,000 kg. (110,000 lb.) and under the same conditions can haul a trailing load of 115 metric tons (126½ short tons) which corresponds to a train of 165 metric tons (181½ short tons) including the motor car. Plain trucks are used on the engine compartment end of these cars and motor trucks, one motor for each axle, under the other end. The cars can be operated equally well from either end. With the passenger cars used in Sweden, which are much lighter than are customary on American roads, the 160-hp. car can haul a train with about 225 passengers while the 250-hp. car can haul a train holding 375 passengers.

When hauling full trains the fuel oil consumption for the 160-hp. engine should average about 0.7 kg. per train kilometer or 2.5 lb. per train mile, while the consumption for the 250-hp. engine should average about 1.0 kg. per train kilometer or 3.5 lb. per train mile. Oil records of a 160-hp. motor car for an extended period in regular service handling a train of 90 metric tons (99 short tons) showed a fuel oil consumption of about 0.5 kg. per kilometer or 1.8 lb. per train mile. By weight, the fuel oil consumption of the Diesel engines averages about six per cent of that of the coal used by steam locomotives of the same power.

The 160-hp. engine has eight cylinders and the 250-hp. twelve cylinders but otherwise they are similar in general design to the smaller engines. A number of improvements have, however, been introduced in the later designs of motor cars. The cooling water for the Diesel engines is now recooled in a number of radiators similar to those used for gasoline motor trucks, mounted on the roof of the car as shown in one of the illustrations. Cooling is effected by means of a fan-blower driven directly from the main engine and is thus independent of speed. The motors are now arranged to be connected either in series or in parallel.

In addition to low fuel costs, one man operation and little time or attention required at terminals, experience has shown that Diesel-electric motor cars can make a greater mileage per day, spend less time in the shop and run for much longer periods without a general overhauling than steam locomotives. They are capable of making 50,000 to 60,000 miles per annum. Even after being taken in for overhauling after some 60,000 miles it has been found that the largest item of expense is for dismantling and reassembling.

While the Diesel motor car or locomotive will undoubtedly be still farther perfected and adapted to a wider railroad field of usefulness, indications point to a much more general employment of this general type of motor in the near future.

Correcting Valve Setting Saves $20 Per Trip

Tests Show Slight Inaccuracies in Valve Motion Cause Serious Increase in Fuel Consumption

ONE of the striking peculiarities of steam locomotives is the difference in performance between engines of the same class and apparently in the same condition. Interesting information which shows how details that are often neglected make some locomotives much inferior to others was obtained in comparative tests conducted recently on one of the leading railroad systems of this country. The proposal to test two similar locomotives arose from a discussion of the effect of nozzle sizes, the condition of valve gears, cylinder and valve packing and the size of smokestacks in relation to making schedule time and the economical use of fuel.

For the purpose of comparison two heavy Pacific type locomotives, Nos. 318 and 319, were chosen. They are equipped with superheaters and outside valve gear. The standard valve travel is 6¾ in., the lead ¼ in. forward and backward, the lap 1 1/16 in., and the exhaust clearance 3/16 in.

At the beginning of the tests the only apparent difference between the two locomotives was in the stack and nozzle. Locomotive 318 had the stack bushed to 18 in. at the choke and a 7 in. nozzle. Locomotive 319 had a 6¾-in. nozzle, with a ⅜ in. bridge. Previously this locomotive had been running with a ½ in. split in addition to the bridge, but this was removed just before the tests. The coal consumption of the two locomotives was compared in passenger service and it was found that locomotive 318 used 80 lb. of coal per 1,000 ton miles and engine 319 approximately 100 lb. If the larger bridge had been left in place the fuel consumption of locomotive 319 on the tests would probably have been even higher. This class of locomotive when in good condition will operate best in summer with a 7 in. nozzle and in winter with a 6¾ in. nozzle.

It was felt that the standard 20½-in. stack should give fully as good results as the smaller stack and to determine the cause of the higher fuel consumption of engine 319 the valve motion, valves and cylinders were carefully checked. In examining the engine a large number of minor errors were found. The lead in forward motion on both sides was about ¼ in. but in the backward motion, only about 1/32 in. The lap on the right side was 1/32 in. too great and on the left side, 1/16 in. too great. The distance between ports was 3/16 in. too great on the right side and 7/32 in. too great on the left side. Minor errors were found in the length and throw of the eccentric crank, in the length of the eccentric and radius rods, and in the distance from the center of the cylinders to the center of the main axle.

The combination of these inaccuracies resulted in a serious distortion of the valve motion. The standard travel is 6¾ in. but in this case the actual travel on the right side was 6 in. and on the left side, 5 1/16 in. in full gear. In the running position the cut-off in the right cylinder was 12½ in. on the head end and 15⅛ in. on the crank end and in the left cylinder, 10½ in. on the head end and 13⅜ in. on the crank end. The effect of the incorrect valve setting is clearly shown in the set of indicator cards taken on the early run, shown in Fig. 1. It will be noted that at high speed the horsepower on one end of the cylinder is 36 per cent greater than on the other end and at all cutoffs the cards are distorted.

After these runs the valve motion parts were corrected and the dimensions were made as near as practicable to the standards for the locomotive. With this arrangement the cut-off in the running position in the right cylinder was 8¾ in. on the head end and 9 3/16 in. on the crank end and in the left cylinder, 10 11/16 in. on the head end and 10⅛ in. on the crank end. The indicator cards taken on the next run showed that further improvement could be made in the steam distribution in the left cylinder and the lead on the head end was made 1/64 in. greater than on the crank end. In order to equalize the work on both sides of the locomotive, the valve travel in full gear on the left side was reduced to 6 9/16 in.

The second set of indicator cards (Fig. 2) shows the results of the changes made in the valve motion. It will be noted that the distribution of work between the two ends of the cylinders is more nearly equal and the valve events are better.

After the valves were set properly the locomotive steamed more freely. It was found that a larger nozzle could then be applied due to improved distribution and more uniform steam flow through the tip, resulting in better drafting and a further reduction in coal burned. The performance of the locomotive was greatly improved and on the last three runs the fuel consumption averaged 73.9 lb. per 1,000 gross ton miles, a reduction of over 25 per cent. What this means to the railroad can be realized from the fact that on this run a saving of 25 per cent in fuel amounts to $20 approximately per round trip.

These tests show conclusively the importance of proper valve setting. The influence of valve motion on the economy of operation of the locomotive is very great. An engine may handle a train and not be reported as unsatisfactory and yet have the steam distribution so defective that it will burn from one-fourth to one-third more coal than is necessary. A fair sounding engine may have poor steam distribution. Enginemen's reports seldom differentiate between locomotives that are out of square due to errors of valve motion and those that sound out due to cylinder packing blows.

In order to correct the defects that were shown to exist in these tests, the railroad is now giving more attention to detail supervision and instructions of shop and enginehouse forces with particular attention to the former. In squaring valves every engine is put on rollers and extreme care is being used in the work, the maintenance forces being impressed with the fact that accuracy in small details has far-reaching effects.

SPEED 25.9 M.P.H.	Crank End	Head End
Card area, sq. in..	3.66	3.62
M.E.P. lb. per sq. in.	95.6	94.5
Hp. 2 cyls.	747	808
Initial press. lb. per sq. in.	140	145
Cut off, per cent..	55.3	55.9
Release, per cent..	88.2	85.1
Compression, per cent.	9.1	12.0
Av. back press. lb. sq. in.	8.62	12.3

SPEED 41.0 M.P.H.	Crank End	Head End
Card area, sq. in..	1.90	2.38
M.E.P. lb. per sq. in.	49.2	61.7
Hp. 2 cyls.	607	786
Initial press. lb. per sq. in.	120	160
Cut off, per cent..	41.4	36.0
Release, per cent..	78.8	82.3
Compression, per cent.	15.5	21.0
Av. back press. lb. per sq. in.	14.5	17.9

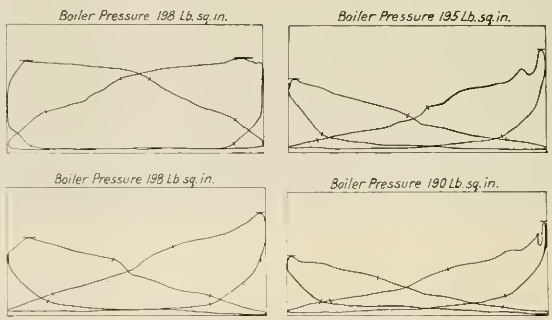


Fig. 1—Indicator Cards Taken Before Errors in Valve Motion Were Corrected

SPEED 58.7 M.P.H.	Crank End	Head End
Card area, sq. in..	1.45	1.83
M.E.P. lb. per sq. in.	37.7	47.6
Hp. 2 cyls.	666	868
Initial press. lb. per sq. in.	115	155
Cut off, per cent..	46.7	45.5
Release, per cent..	84.7	85.2
Compression, per cent.	13.2	17.1
Av. back press. lb. sq. in.	16.6	17.6

SPEED 68.3 M.P.H.	Crank End	Head End
Card area, sq. in..	1.11	1.47
M.E.P. lb. per sq. in.	28.6	37.9
Hp. 2 cyls.	589	805
Initial press. lb. per sq. in.	90	145
Cut off, per cent..	34.8	38.4
Release, per cent..	83.0	84.0
Compression, per cent.	13.1	16.5
Av. back press. lb. per sq. in.	13.7	19.3

SPEED 16.6 M.P.H.	Crank End	Head End
Card area, sq. in.	3.50	3.36
M.E.P. lb. per sq. in.	116.0	111.4
Hp. 2 cyls.	572	568
Initial press. lb. per sq. in.	162	158
Cut off, per cent..	49.2	48.7
Release, per cent.	83.5	83.7
Compression, per cent.	14.7	15.2
Av. back press. lb. per sq. in.	5.30	5.64

SPEED 38.8 M.P.H.	Crank End	Head End
Card area, sq. in..	2.81	2.50
M.E.P. lb. per sq. in.	93.9	83.4
Hp. 2 cyls.	1,081	993
Initial press. lb. per sq. in.	178	174
Cut off, per cent..	42.5	36.7
Release, per cent..	80.0	78.2
Compression, per cent	19.4	18.1
Av. back press. lb. per sq. in.	16.6	17.3

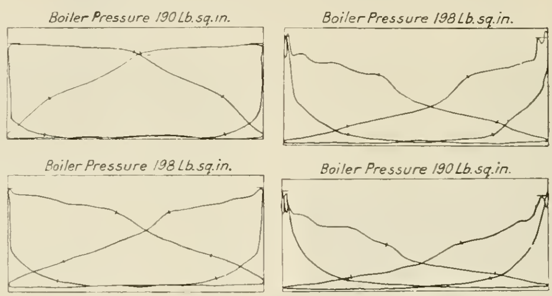


Fig. 2—Cards Taken After Valves Were Properly Adjusted

SPEED 60.8 M.P.H.	Crank End	Head End
Card area, sq. in..	2.04	1.83
M.E.P., lb. per sq. in.	66.2	59.3
Hp. 2 cyls.	1,200	1,110
Initial press. lb. per sq. in.	185	184
Cut off, per cent..	35.7	31.1
Release, per cent..	80.5	76.5
Compression, per cent.	24.1	21.1
Av. back press. lb. per sq. in.	20.4	18.8

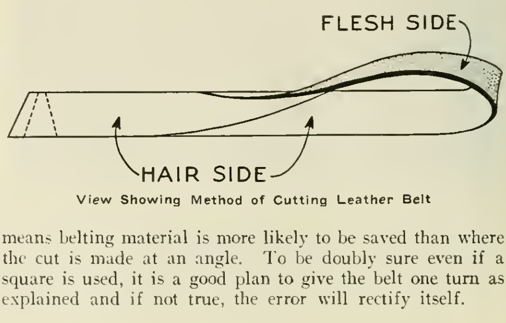
SPEED 69.2 M.P.H.	Crank End	Head End
Card area, sq. in...	1.40	1.16
M.E.P. lb. per sq. in.	45.2	37.4
Hp. 2 cyls.	930	795
Initial press. lb. per sq. in.	172	160
Cut off, per cent..	39.2	32.8
Release, per cent..	79.8	76.6
Compression, per cent.	25.5	23.0
Av. back press. lb. per sq. in.	21.6	20.6

Cutting Leather Belts

By W. F. Schaphorst

Several years ago the writer was taught a valuable kink for cutting belts, as illustrated. Mechanics are usually instructed, when cutting a belt, to use a square and make the cut absolutely square with the sides of the belt. However, if done in the manner illustrated, it is not necessary to make the cut square, the important thing being simply to make it straight. This is done by giving the belt one turn and laying the ends one over the other, in exact alignment. By making the cut straight, even though not square with the sides, it will then be found that the ends will fit accurately.

The cut may make an angle of 45 deg. or even more with the sides without harm. It is usually best, however, to cut the belt square or as nearly square as possible for by this means belting material is more likely to be saved than where the cut is made at an angle. To be doubly sure even if a square is used, it is a good plan to give the belt one turn as explained and if not true, the error will rectify itself.



View Showing Method of Cutting Leather Belt

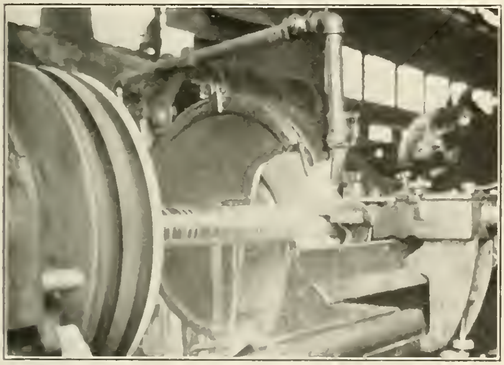
Getting Results From Modern Grinding Machines in Railroad Shops

By M. H. Williams

ARTICLES have appeared from time to time in the *Railway Mechanical Engineer* on the subject of grinding in railway shops but judging by the slowness with which grinders are installed there is need for further education on this subject. Apparently it has not been looked into as thoroughly as the advantages to be gained would warrant.

Abrasive Not Imbedded in Ground Surfaces

The old fallacy has cropped up again concerning the possibility of abrasive from grinding wheels embedding in steel journals and causing them to cut and run hot. Experience and scientific tests have amply proved that no fear of this need be anticipated and as proof attention is called to the piston rods, guide bars, etc., which are ground in railway shops and do not give trouble. Following this subject further: one of the most reliable tool manufacturers in this country specifically states that journals and shafts can safely be ground and lapped. Practically all automobile parts and motor shafts are ground owing to the reduced cost and superior finish as compared with other methods. When properly oiled, these do not cut. The bores of automobile cylinders on the better grades of cars are ground. Owing to these being of cast iron, which is more porous than steel, cutting would be expected if the abrasive imbedded in the metal. Hundreds of other cases could be cited of ground axles, shafting, flat surfaces and internal bearings which are operating in a satisfactory manner. Were this not the case, progressive machine tool builders, automobile manufacturers and shops generally would have abandoned this practice long ago. Such plants are installing grinding machines for practically all work coming within their range. Why should the railway shops not do the same?



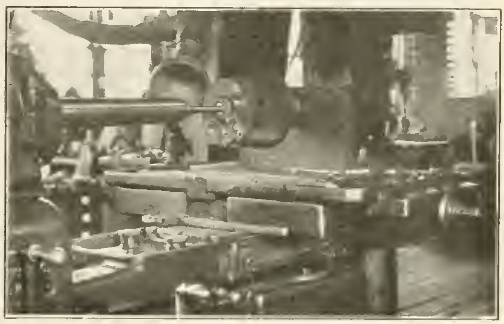
Powerful Gap Grinder Truing Piston Rod

It may be said in passing that there are ways to grind properly and, unfortunately, ways to grind improperly. As grinding has not been a well recognized practice in a number of railway shops it is feared that this work has not always been done to the best advantage owing to failure to follow necessary details. There are a number of minor details which must be taken into consideration in order to obtain a satisfactory finish and economical production. With the details properly mastered there is no question that the general run of cylindrical surfaces and flat surfaces common in railway work are finished better and more cheaply by grinding than by other methods. A number of matters requiring attention are mentioned below.

Condition of Wheel Surface Important

For all cylindrical work or flat surfaces, great care must be taken to keep the cutting surfaces of grinding wheels in a perfectly true condition by the frequent passing of a diamond, held in a proper holding device, over their surfaces. The principal value of frequent dressing is to clear the surface from imbedded particles of metal. This applies principally to the wheels used on cylindrical grinders; also to a lesser extent to ring wheels used on surface grinders. This truing not only clears the wheels from stray metal but also insures the wheel cutting faster and making smoother surfaces. For piston rod grinding it has been found good practice to pass the diamond over the wheel directly after the low spots are removed. After this dressing the rods are finish ground, resulting in the true and smoothly finished rod so much desired and also leaving the wheel in good condition for quickly roughing down the next rod. With ring wheels used on surface grinders it is now becoming the practice to true the wheels frequently with the diamond in preference to a wheel dresser.

Where the diamond is properly used the diameter is only reduced a small amount which, as far as life of wheels is concerned, is hardly worth consideration. The time required to true a wheel is rarely more than one minute, which is more than made up by the faster cutting. Some question may be raised as to the cost of diamonds. As generally used for railway work, diamonds cost from $15 to $20 each, lasting from one to three months; but this expense is saved many times over by the more satisfactory surfaces, greater output and smaller consumption of power.



Typical Internal Grinding Operation

Grinding Wheels Should Be Flooded

It appears to be the practice in some shops to operate grinding wheels dry, or with only a small stream of cooling compound. Experience has proved that the wheels should be flooded with cooling compound; the more the better. Cooling compound keeps the wheel and work cool, washing off loose metal chips, abrasive and dirt from the articles being ground. Clear water is at times used as a cooling compound but causes rusting of machine and work. Several good cooling compounds are on the market which make wheels cut more freely and prevent rusting

Another cause of inferior and slow grinding is the lack of proper steady rests for supporting the work. Articles such as piston and valve rods should be supported by two steady rests and other articles in like proportion. These rests have the effect of backing up the work, allowing more rapid cutting, greater accuracy and smoother finish.

Today the tendency is to traverse the work in front of the wheel more rapidly than in the past, the ideal traverse being from three-quarters to the full width of the wheel for each revolution of articles being ground. Most of the older grinders are not arranged for this rapid traverse which, however, should be large when roughing down, the finish being generally at a slower rate, possibly one-quarter of the traverse used when roughing.

A Free-Cutting Wheel Necessary

The grade and grit of a grinding wheel plays a very important part in the quality of finish and time required. The mistake is often made of using wheels which do not wear away under the mistaken notion of economy. The fact should be borne in mind that a grinding wheel is a cutting tool having thousands of cutting points to the square inch. These points naturally wear and become dull and if they remain in this condition the grinding will be slow and consume an excess of power. If the wheel is softer the dull points break off, presenting new sharp points.

The important problem is to select the happy medium between the wheel that lasts too long and the one that wears away too rapidly and also obtain the wheel best suited for the work. Here is where the grinding wheel experts come in These men make a study of grinding conditions and can generally recommend the proper grade and grit for any particular job. In other words, put the wheel selection up to the grinding wheel maker. If the first wheel does not fill the bill try another, keeping in mind the question of life of wheels versus free cutting qualities, economical and satisfactory output. Also remember that one kind of wheel will not answer to best advantage on soft steel such as is used in piston rods and guide bars, and likewise on hard surfaces such as casehardened knuckle pins. For locomotive repair work it is often necessary to change from soft to hard steel several times a day, where changing wheels consumes too much time. In this event a medium wheel is often used which will best meet conditions for both kinds of metal.

Wheel Speeds and Feeds

One very important point when grinding is the speed of wheel rotation and r.p.m. of the work. As a general rule grinding wheels used on cylindrical and surface grinders should have a surface speed between 5,000 and 6,000 ft. per min. Where these speeds do not exist the pulleys should be changed to obtain this range.

The rate of revolution of work is also a consideration, it being difficult to give a hard and fast rule governing all conditions. For work like piston rods, valve rods, etc., a surface speed of 60 per min. is generally considered satisfactory. This for a 4 in. piston rod equals about 60 r.p.m.

The in-feed of the wheel per pass when roughing down should, as a general rule be all the machine will stand. For work similar to roughing down piston rods, where output is the main consideration, the feed per traverse over the work can be from 0.001 to 0.002 inch. For ordinary surface grinding such as guide bars the feed can be a like amount. The sides of piston packing rings can be ground removing as much as 0.003 inch per revolution of the work. For the finishing operation the feed is reduced. The question of feed can readily be settled on the spot by placing the belts in first class condition, truing the wheel with the proper steady rest, afterwards gradually increasing the feed up to the point where belts slip or articles being ground show signs of chatter or jumping out of the machine. A trial of this kind makes it possible to check up the time required for most grinding jobs.

As an illustration: assume that a piston rod four inches in diameter and three feet long on the bearing surface has been removed from service and requires refinishing. In order to remove all worn spots the diameter must be reduced 1/16 or 0.067 in. Assume that the machine will stand 0.002 in. in feed and a traverse of 1 in. per rev. The r.p.m. of the rod is 60. The wheel would traverse the length of the rod when the latter revolves 36 times and 31 passes or traverses, each reducing the diameter 0.002 in. will make a total reduction of 0.062 in. in diameter. A total of 1116 revolutions of the rod, taking 18½ minutes will be necessary. Allowing one minute for truing the wheel, two minutes extra for slower traverse when finishing and four minutes for handling, this rod should be finished in about 26 minutes. The rod mentioned above, requiring 1/16 inch reduction in diameter was in worse shape than the average. Therefore, the time required should as a general rule be less than that mentioned.

In some shops it has been the practice to turn the rods first in a lathe in order to true down the worn surfaces, afterwards grinding. Advanced practice has shown that with the most worn condition, the rod can be repaired quicker when refinished completely in the grinding machine.

Where Grinders Should Be Used

The piston rod grinder has been principally mentioned owing to its more frequent use in railway shops. The good results obtained clearly indicates that cylindrical grinding machines should be used for other work such as new crank pins, new and repaired crosshead pins, etc. The material in these parts is similar to that in piston rods and the same grinding wheels will answer. In some shops these parts are ground on gap grinders by moving the tail stock up close to the gap. In other shops regular plain cylindrical grinders are installed for shorter pieces. The practice with the new pins of either class is to turn them 1/64 to 1/32 in. large at a very coarse feed, then transfering to grinders and finishing to the required size. By this plan the turning need not be to exact size and can be at as coarse a feed as an engine lathe or turret lathe will stand.

The pins when passed on to the grinder will be rough on their turned surfaces. The humps on the average surface are rarely more than 0.005 in. high which is removed by four or five passes. The grinding is continued until the article is about 0.002 inch large, the wheel then being trued and finish ground to the required size.

Assume that a crank pin is 8 in. long on the bearing surface and 8 in. in diameter. With a moderately strong grinder the pin diameter can be reduced about 0.001 inch per turn, the pin revolving about 25 times per minute. With a traverse of ¾ in. per turn there will be 11 turns per pass. To reduce the diameter 1/32 inch will require 31 passes, equalling 341 turns and taking 14 minutes, or about 16 minutes floor to floor. This is a conservative estimate that can be exceeded on the later grinders.

The general tendency at the present time is to use grinders for all work coming within their range and for all finishing operations in a manner similar to that mentioned above. Owing to the fact that the output of engine lathes, turret lathes or automatic machines can be increased when it is not necessary to hold these machines to close sizes important savings are affected. In other words grinders are used because they save money.

Where case-hardened parts such as knuckle pins, valve motion pins, bushings, etc., are used nothing takes the place of the cylindrical and internal grinders. No matter how carefully the parts are machined and heated they will warp and distort when case-hardened. The only way to insure these being true, fitting properly and having satisfactory bearing surface is to grind them. The cost of grinding is generally offset by the greater production and fewer spoiled pieces.

Mechanical Parts of Electric Locomotives

Comparison with Steam Locomotives; Details of Construction of Outside Frame Type

By H. A. Houston
Railway Mechanical Engineer, Westinghouse Electric & Manufacturing Company

MECHANICAL parts of electric locomotives may be defined as those parts of the locomotive which serve for its foundation, as the running gear and cab. This is illustrated by Figs. 1 and 12, which are end and side views of the mechanical parts of a Baldwin-Westinghouse electric locomotive built for the Chilean State Railways.

Electric locomotives may be divided into two major classes, namely, outside frame and inside frame locomotives. The former class includes those types of construction in which:

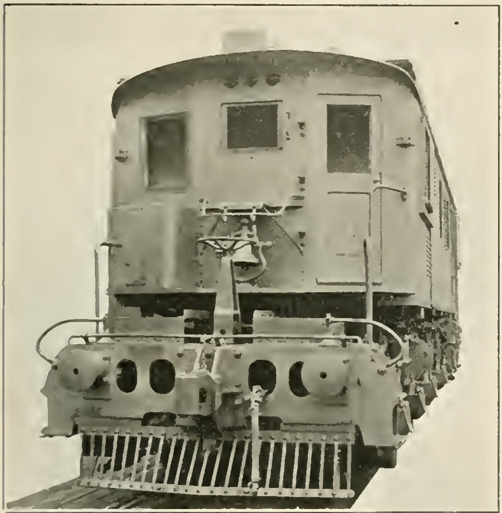


Fig. 1—End View of an Outside Frame Electric Locomotive for Foreign Service

first, the driving motors are mounted on and geared to the axle; second, the motors drive the axles by means of quills and springs; third, the motor armature is concentric with the driving axle. The latter class typifies construction, embracing: first, direct side rod drive in combination with a counter-shaft or jack-shaft; second, gear and side rod drive through a jack-shaft.

In this paper it is intended to comment on the construction of mechanical parts of the type utilizing outside frames, and axle-mounted motors with gear drive.

Comparison With Steam Locomotive Design

The electric locomotive possesses a peculiarity in that its design characteristics embody the fundamentals of both the steam locomotive and the modern all steel passenger car. Essentially it is one or more steam locomotive wheel arrangements, or running gears, with the equivalent of a car body resting upon it. The cab may be mounted directly on the main frame or have a center pin and side bearing support on each driving truck.

The similarity in the design of mechanical parts for electric and steam locomotives, constitutes one of the most logical steps in perfecting the art of electric locomotive design and construction. However, there are a few differences, such as double-end operation, the lack of conformity between driving wheel diameter and class of service of the locomotive, etc., which require diligent study to predetermine the tracking characteristics for a particular design.

The wheel size is dependent on the gears, motor and clearance under the gear case. This results in a variety of wheel sizes for the same class of service and is a design limitation. Electric locomotive design, contrary to that of the steam locomotive, may embrace large diameter driving wheels, as 80 inches, for freight or pusher locomotives, and small diameter driving wheels, as 42 inches, for passenger locomotives. Further, the designer is limited in the number of driving axles, the weight per axle, rigid wheel base, etc., and at the same time must, for competitive and other reasons, keep the total weight to a minimum.

Tracking Characteristics

The study of tracking characteristics generally includes: (1). Wheel arrangement. (2). Class of service. (3). Height of center of gravity. (4). Relation of cab length to center pin distance. (5). Method of articulation between driving trucks under one cab and between the cabs. (6). Behavior of locomotive and limiting position of the running gear on curves as restrained by the wheel flanges against the rail head. (7). Behavior of locomotive on tangent track. (8). Track stress.

One of the best aids for making a study of tracking characteristics of locomotives is the "Roy" diagram. The

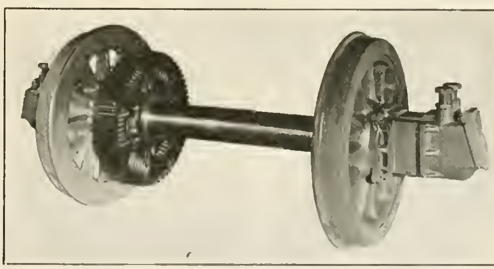


Fig. 3—Driving Axle Ground Finish from End to End with Flexible Gear, Wheels and Boxes Mounted

"Roy" method will determine whether a locomotive with a certain wheel arrangement can actually pass through a curve when running in either direction. It will quantitatively indicate the cramping of the various wheels, enabling one to determine the set-up laterals or the necessity of using blind tires on certain pairs of wheels. Idle or weight carrying trucks can be investigated for proper functioning with radial action only, or with the addition of set-up laterals. Other studies on tracking characteristics can be made by this method. An illustration of the use of the "Roy" diagram is shown in Fig. 2. In this figure a 260 + 262 wheel arrangement is used in order to show the effect of the guiding axle and radius bar length, whereas the photographs shown herein are for an 060+060 wheel arrangement. However, both locomotives are substantially alike except for the idle axle at each end. The former is a passenger locomotive and the latter a freight locomotive. The notes on the diagram are self-explanatory.

attention to the general conditions which determine the structure.

In addition to the static weight per driver at the rail, steam locomotive design must necessarily consider the additional effect due to dynamic augment. The influence of this effect is oftentimes felt in the design of electric locomotives by having the axle loading at the rail limited to

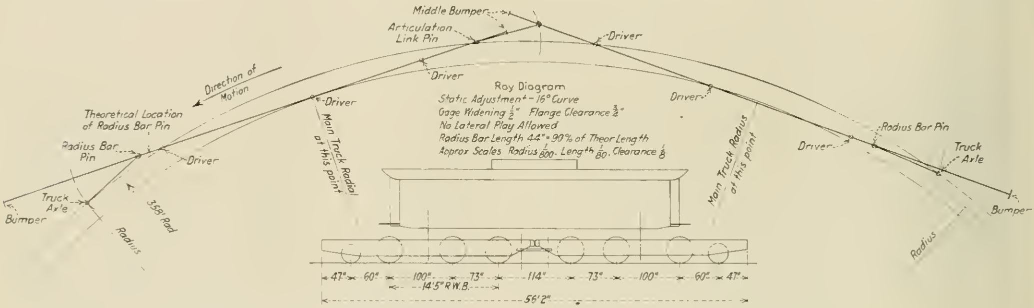


Fig. 2—The Roy Diagram Shows Whether Locomotive Will Pass Through Curve

Track stress analysis may be made along the lines indicated by the report of the Joint Committee of the A.R.E.A. and A.S.C.E.

Factors Affecting Design

Two of the remaining features connected with the design

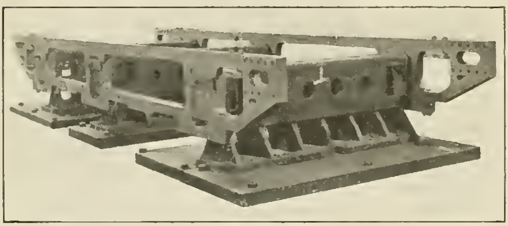


Fig. 4—Jig for the Accurate Assembly of Main Frames, Cross-Ties and Bumpers

are most important; they are first cost and maintenance. The former is dependent upon the weight, type and simplicity of design of the locomotive; the latter upon strength

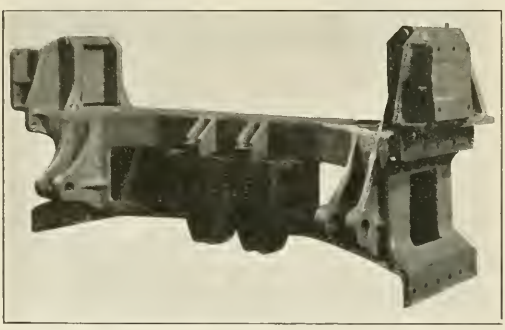


Fig. 5—Main Frame Cross-Tie with Motor Nose Spring Support in Position

of materials, simplicity of design and ease of inspection and repairs. As stated heretofore no attempt is here made to go into the details of design. However, it is pertinent to draw

the same amount. This is not necessary, due to the absence of reciprocating movement and the more perfect balance of all rotating parts. Advantage should be taken of this fact.

In the following paragraphs a brief description of the major mechanical parts is given with illustrations of their construction and assembly.

A pair of mounted driving wheels with journal boxes which have grease plugs for lubricating the hub liners is shown in Fig. 3. Fig. 4 depicts a jig or template upon which the main frames, cross-ties and bumpers are assem-

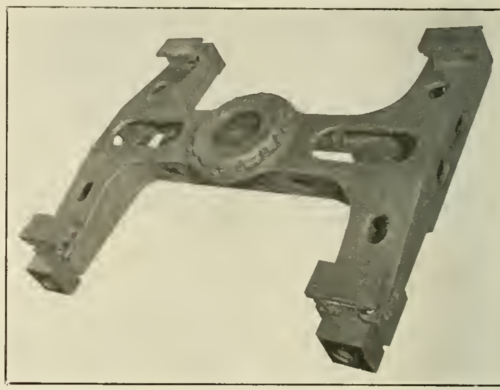


Fig. 6—Main Truck Bolster Casting Which Receives Center Pin Loading

bled. These are arranged to properly gage and locate the several parts.

Fig. 5 shows one of the cross-ties machined ready to be placed in position. Attached to it is the spring support for the motor nose which is used to give the motor an easy riding effect, to cushion vibrations and permit movement and adjustment as required by the tracking conditions. This suspension also acts as a stop for the safety lugs which are mounted upon the motor, in case the motor nose fails.

Fig. 6 portrays the main truck bolster casting, which carries the female center pin casting. This is spring supported and provided with four side blocks which act as cross-heads and are held by the guides shown on the cross-ties in Fig. 5. Such construction permits the center pin location over a driving axle or at any intermediate point between truck cross-ties.

After the main frames are properly tied together the assembled frame is moved forward to another assembling table where all the necessary fixtures are added as shown in Fig. 7, and the whole finally trammed and checked before

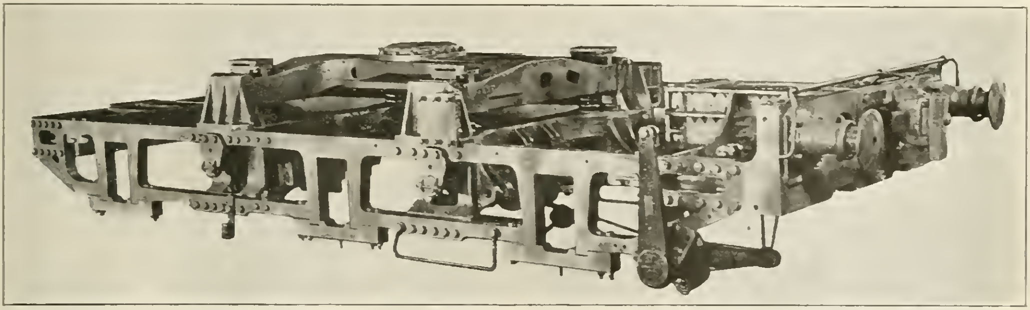


Fig. 7—Main Truck Frames with Cross-Ties, Bumper Beams and Truck Bolster All Assembled

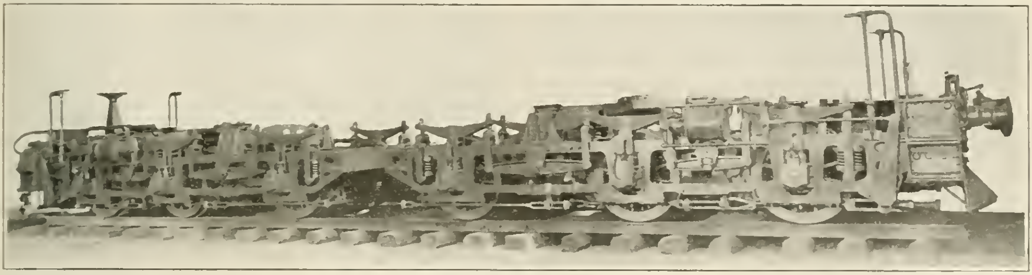


Fig. 8—Running Gear Assembled

going to the wheeling pits. Attention is drawn to the fact that where outside frames are used the distance between centers is 82 in. instead of 42 in. as with inside frames. Also there is no diagonal bracing, therefore it is necessary to provide cross-ties and bumpers with sufficient strength and rigidity to receive their portion of vertical and impact loads in conjunction with the main frame without undue stress or distortion. With these salient features accepted

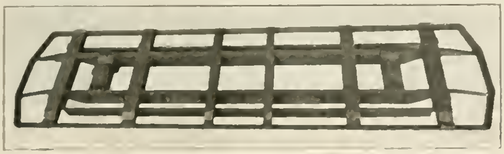


Fig. 9—Electric Locomotive Cab Underframe

each cross-tie, bumper and main frame should be so designed that the resultant fibre stress due to vertical bending under direct loading plus that due to lateral bending, does not exceed a predetermined value. Where cross-ties and bumper beams are cored out to permit the passage of levers, piping, etc., the sections at such points should be carefully investigated and designed to give proper section moduli.

The application of the springs and equalization system after the main frames are mounted on the wheels, along with coupling the trucks together at the articulation joint, presents a view as shown in Fig. 8. The locomotive running gear is now ready to have the center pin distance checked, after which the cab is placed in position upon the trucks.

The design and construction of the cab underframe for proper strength is a problem which receives earnest consideration. Unlike a car underframe there is not sufficient room below the floor for the center sills, as all the space between the wheels is filled with motors and electrical equipment apparatus. Fig. 9 illustrates the framework of a cab underframe. It will be seen that one center pin is restrained in both the fore and aft position, whereas the other is restrained laterally only. These underframes must be built

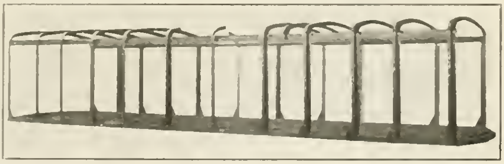


Fig. 10—Electric Locomotive Cab Superstructure Framing

to possess sufficient strength to withstand repeated stresses from vertical bending in conjunction with the effects of surge and lateral stresses. It is ordinarily true that heavy electric locomotive cabs do not carry the draft gear, as the buffing force is carried through the main frames. But it is further understood that a cab cannot be relegated to the back shop for repairs, as a car body may be sent to the rip track for frequent attention. Too much investment is tied up in the locomotive, sometimes 50 to 75 times as much as in a car.

The super-structure framework of the cab is shown in Fig. 10. This is built with templates and secured to the underframe. Likewise the ends are built on forms and to templates as depicted in Fig. 11. As in the case of the running gears the work is very exact and all parts are thoroughly interchangeable. The side sheeting is then applied, also floor and deck work. After painting the assembled mechanical parts appear as shown in Fig. 12.

In following the various steps above indicated in the design and construction of mechanical parts of electric

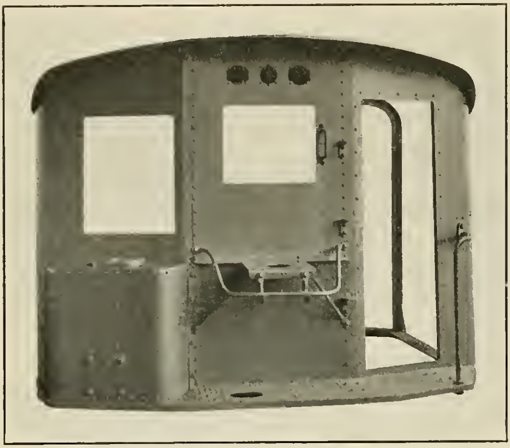


Fig. 11—Electric Locomotive Cab End

locomotives, simplicity is paramount; first for cost; second for maintenance. Inspection as a component of maintenance is most important. Unlike the steam locomotive the electric locomotive is expected to work continuously for 24 hours in every day for several days, as the lubrication, cleaning and trip inspection can be given when changing crews or when on passing or side tracks. It is not unusual to require from 10,000 to 12,000 locomotive miles per month, with continuous runs as long as 750 miles, all of which can only be done when inspection and maintenance are assured. The solution is simplicity.

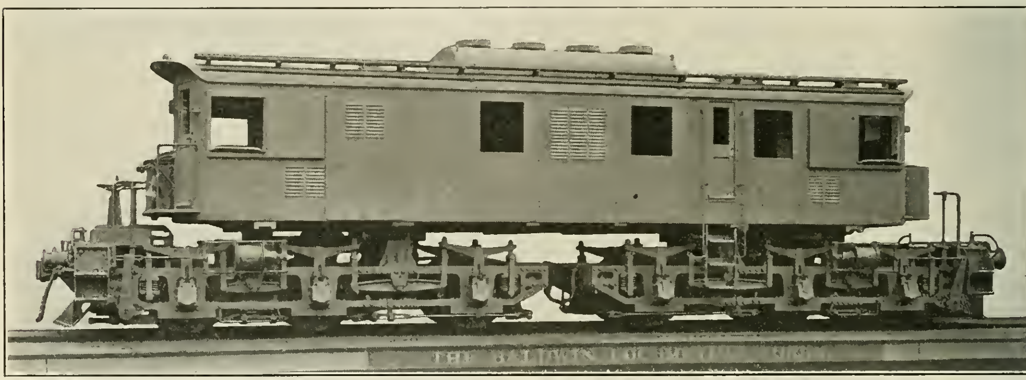


Fig. 12—Assembled Mechanical Parts of an 060-060 Electric Locomotive without Electric Equipment

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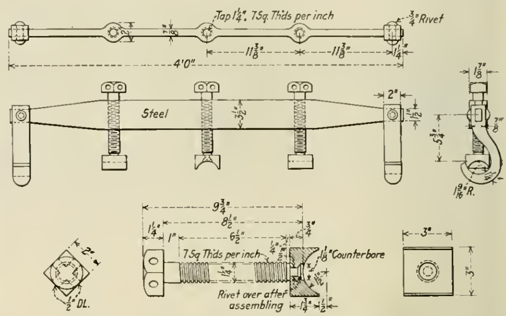
The Illinois Central has furnished its employees in Mississippi with cards containing a statement of the road's annual operating costs in that state. The number of employees in the state is 9,424 and the amount paid out yearly in wages is given as $13,645,052. Material and supplies purchased and taxes paid amounted to $3,003,572. This statement will be a "talking point," for employees who come in contact with the public.

Tool for Straightening Arch Pipes

By E. A. Miller

When locomotive arch pipes become bent owing to overheating, supporting excessive weights, or any other cause, the tool shown in the illustration can be used to straighten the pipes quickly and without the expenditure of very much energy. The device consists simply of a beam,



Details of Arch Pipe Straightening Tool

two hooks and three screw bolts, the details and arrangement as assembled being illustrated.

The body of the beam has a cross section of ⅞ in. by 3½ in., being made of steel with the ends tapered and squared to allow for the application of hooks. Three bolts, having 1¼-in. square threads, seven threads per inch, are provided to screw into the beam as shown. The head of each bolt is square and drilled with ½ in. holes for the insertion of a small bar to give greater leverage in turning. The other end of each bolt is turned down to ½ in. and after being turned into the beam, half round blocks are applied, as shown in the illustration. The ends of the bolts are then riveted over to hold the blocks from falling off but not enough to prevent swiveling.

In straightening an arch pipe this tool is applied so that the convex side of the bend is toward the beam and the pipe is readily straightened by turning the screws the right amount, a method which shows considerable savings over what it would cost to remove the bent pipe and apply a new one.

Boring Bar for Air Cylinders

By J. H. Hahn

In ordinary shop practice air compressor cylinders which become worn in service must be unbolted and removed from the center castings in order to be placed on the mill for reboring. Breaking the center casting joints and rebolting requires considerable time and expense which is avoided by means of the portable boring bar shown in the illustrations. The boring bar is self-centering and requires practically no setting up. The radial drill as illustrated in Fig. 1 is probably the best type of machine for the operation.

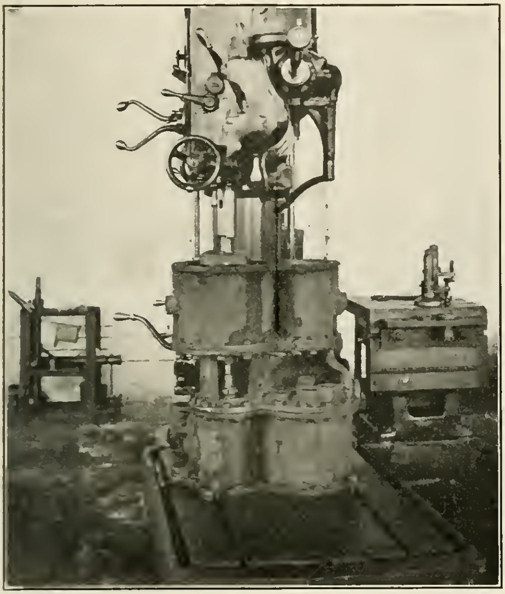


Fig. 1—Radial Drill Equipped With Cylinder Boring Bar

A cross-section through the air compressor and boring bar is given in Fig 2 which also indicates the boring bar arrangement when assembled. It will be noted that a taper shank on the boring bar proper is arranged to fit in the drill spindle. The boring bar is accurately guided by means of two sleeves held against the stuffing boxes by means of the nuts shown. Two sizes of tool holders are provided, one for the high and one for the low pressure cylinder, each being arranged to carry two tool bits 180 deg. apart. As shown in the detail drawing (Fig. 3), these tool bits are readily adjustable in and out and held firmly by means of bolts with taper heads.

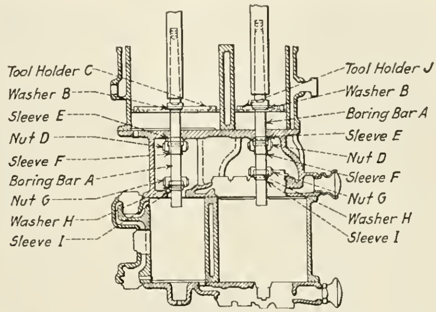


Fig. 2—Cross Section Showing Boring Bars Assembled for Use

The self-centering feature of the boring bar will be evident from an examination of the drawing, also the ease of setting up. This boring bar is being used with considerable success on the Norfolk & Western.

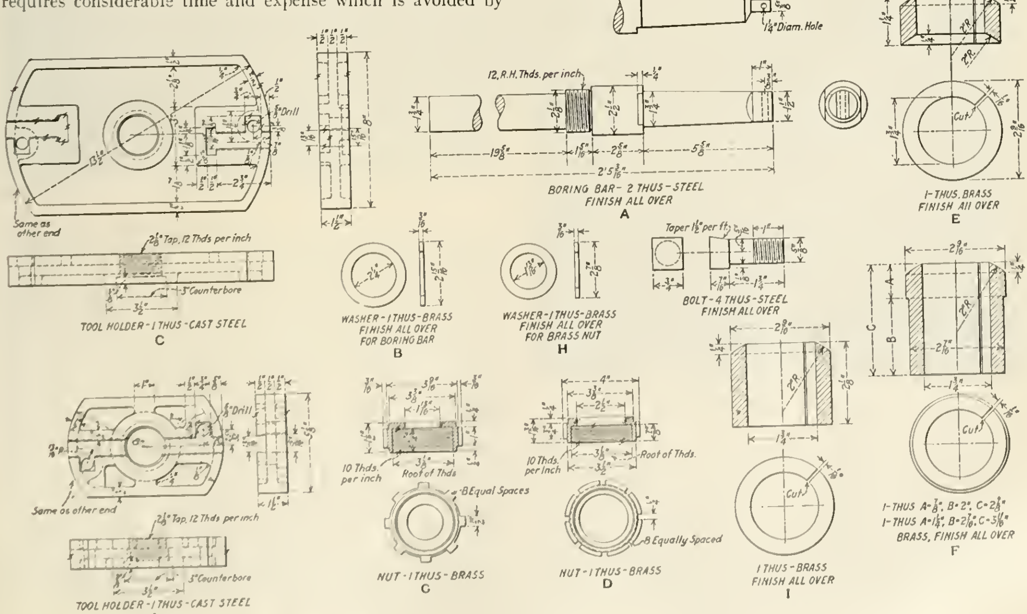


Fig. 3—Details of Boring Bars Used for Truing Worn Air Compressor Cylinders

Renewing Fireboxes at Sayre

THE method of renewing fireboxes at the Sayre shops of the Lehigh Valley, while not particularly new, effects a material saving in repair costs. Briefly the operation, as shown in Fig. 1, consists of cutting the rivets along the throat sheet, mud ring and up over the wrapper sheet so that the entire back of the boiler can be removed and sent to the boiler shop for application of a new firebox. It is comparatively easy to strip the cab and fittings which would have to be removed in any case, and little time is required to cut off and punch out the rivets. Then the work of applying a new firebox, being performed in the boiler shop, is conveniently located for workers and supervisors. When the new firebox is applied, the back end of the boiler is sent back to the erecting shop and fitted in place, new rivets being driven in the old holes as shown in Fig. 2.

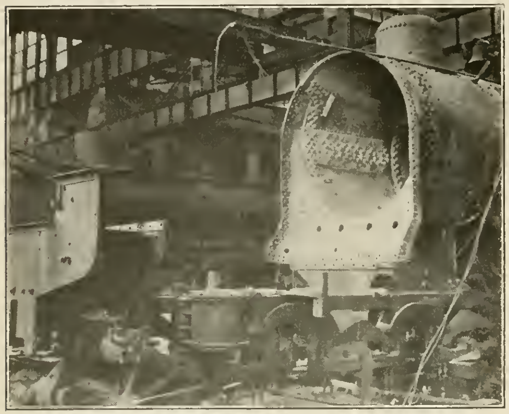


Fig. 1—View Showing Boiler Back End Removed for Application of New Firebox

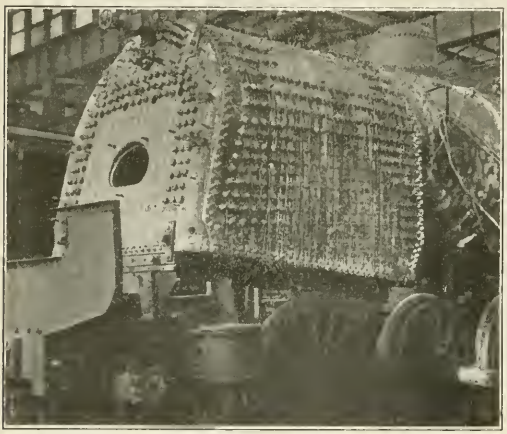


Fig. 2—View of Boiler with New Firebox Applied

This method of renewing fireboxes has a big advantage, both as regards labor and material costs, over the former method of disconnecting and removing the entire boiler from the engine frames. In that case it is necessary to strip the jacket, lagging and fittings from the entire boiler, all running boards and brackets also being removed. Cylinder saddle bolts and expansion pads must be removed.

It takes two men about 16 hours to disconnect and remove the back of the boiler, as shown in Fig. 1, and about 20 hours are required to put it back in place and rivet it, as shown in Fig. 2. The old method of removing the entire boiler would probably take four men about 24 hours and approximately twice as long to put it back on again, including the time required to ream saddle bolt holes and drive new bolts.

Crown Bolt Drilling Device

In connection with applying new fireboxes, a device has been developed at Sayre, as shown in Fig. 3, for drilling, tapping, facing off and driving crown bolts. These operations formerly required a staging built in the firebox and the boilermaker who operated the standard air motor was obliged to work in cramped quarters, feeding the drill or other tool upward by means of the motor feed screw. To facilitate performing this work, the device shown in Fig. 3 was made, consisting essentially of one section of 2½-in. pipe *A* (to which is attached the air motor *M*) turned down at the lower end and packed to make a sliding, air tight fit in a similar pipe section *B*. This lower section of pipe acts as a cylinder so that when the air pressure is turned on through valve *V* pipe section *A* together with motor *M* is forced upward. The combined length of pipes *A* and *B* is sufficient to reach from the level of the grate bars to the top of the firebox and pipe *A* has sufficient travel in *B* to accommodate variations in this distance. The lower end of *B* (not shown in the illustration) is provided with a ball joint, and two handles *HH* facilitate handling.

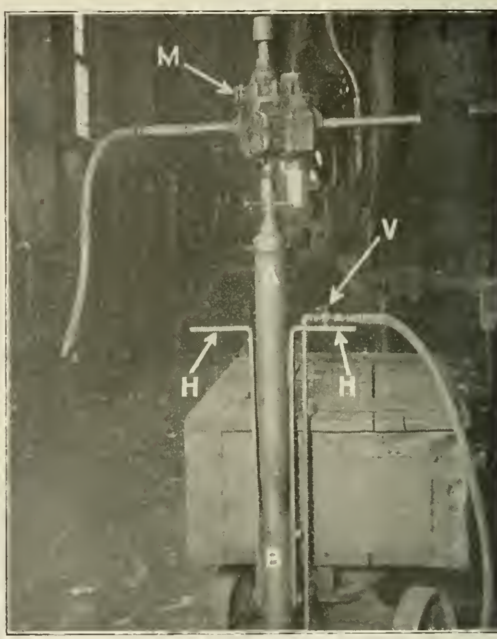


Fig. 3—Device for Drilling Crown Bolts

In operation the device is set up under a crown bolt to be drilled and the air pressure turned on. This forces the pipe section *A* and air motor *M* against the crown bolt and when the air motor is started, provides automatic feed. Much less time is required for drilling crown bolts with this device than by former methods.

Railway Shop Grinding Practice in England

Interesting Machines Developed for Grinding Locomotive Cylinders, Car Journals and Mounted Crank-Pins

It is generally conceded by those in a position to know that English locomotive and car repair work in many details is carried out with greater accuracy than is considered necessary in American practice. Possibly this is the reason that grinding as a machine operation has been received so favorably and introduced so extensively into English railway shops. While most of the grinding machines are relatively smaller and lighter than those of American make there is no doubt that they have been developed to handle a far greater diversity of work.

In addition to many types of cylindrical, surface and internal grinders, a machine has been developed for grinding crank-pins mounted in the wheel centers. This machine, made by Beyer, Peacock & Co., Ltd., Manchester, England, resembles in appearance an American quartering machine into which the driving wheels are set and clamped at the required position. The grinding head is located in a horizontal position, the planetary principle of grinding being used to rotate the revolving spindle and grinding wheel around the crank-pin as it is held in the wheel center. An arrangement of eccentric sleeves enables the wheel to be fed up to and over the crank-pin in truing it. The outer edge of the grinding wheel is rounded over so as to provide the necessary filet on the crank-pin shoulder. This machine could doubtless be used for grinding crank-pins on American locomotives but only in the smaller sizes as English crank-pins are seldom over six or seven inches in diameter.

Another interesting English machine is a double vertical spindle hole grinder corresponding to the duplex rod boring machine familiar in American railroad shops. Boring bars and cutting tools are replaced by spindles and grinding wheels revolving in two similar wheel heads. These duplex wheel heads are adjustable along the base of the machine to suit different lengths of rods and the vertical grinding spindles have automatic feed for truing the holes. The double spindle rod grinder is made by the Churchill Machine Tool Company, Broadheath, Manchester, England, as is also a locomotive cylinder grinding machine which has no counterpart on the American market and a plain grinding machine for truing worn car journals.

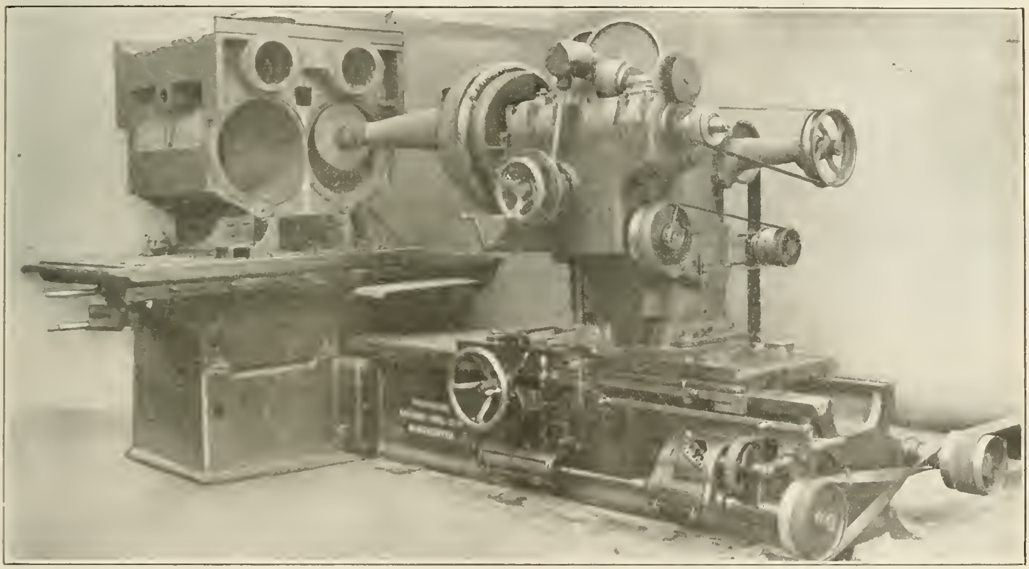


Fig. 1—Churchill No. 3 Internal Cylinder Grinder Truing a Pair of English Locomotive Cylinders

Grinding Locomotive Cylinders

Any suggestion to grind locomotive cylinders would probably be looked on with considerable skepticism in this country but this operation is actually performed in English railway shops, as shown in Fig. 1. It will be noted that the cylinders are a new pair of the inside type, fitting between the locomotive frames. The grinder is of ample power and capacity to handle this work, the claim being made that grinding affords the most rapid and accurate method of finishing cylinders smoothly to size.

In general the practice is to rough bore the cylinders on a horizontal boring machine and finish them to size on the grinding machine illustrated. The cylinders are bored within .020 in. of the finish size, the remainder of the metal being removed by grinding. An accuracy limit of .0012 in. for both roundness and parallelism is claimed, this enhanced accuracy in machining locomotive cylinders tending to provide greater efficiency and longer life.

The general construction and operation of the Churchill No. 3 cylinder grinder is evident from the illustration and need not be entered into at great length. Briefly the locomotive cylinders are supported on a heavy table provided with cross adjustment only for positioning the work, the table remaining stationary during the grinding operation. The table is carried on a base reaching directly to the floor and rigidly bolted to the other section of the machine. The grinding wheel and spindle of generous proportions are provided with the necessary planetary motion and are carried on a slide with a 12-in. vertical adjustment on the column. The column is mounted on a horizontal slide provided with automatic rotary motion along the heavy bed and controlled by adjustable reversing dogs for varying the stroke to suit the length of hole to be ground. This slide is provided with three changes of speed for eccentric motion and five for the traversing motion. There is also additional quick traverse.

Grinding Car Journals

The grinding of car axle journals has been developed quite extensively in England and Fig. 2 illustrates the type of machine used for this purpose. It has been supplied to most leading English railroads and car manufacturers. The advantages of grinding may be summarized briefly as follows: The journals are more accurate and hence have longer life with less tendency to produce hot boxes. The journals are smoother with a similar result. The cost of truing by grinding is less than by turning and rolling due to the fact that it is more rapid and present labor charges are high.

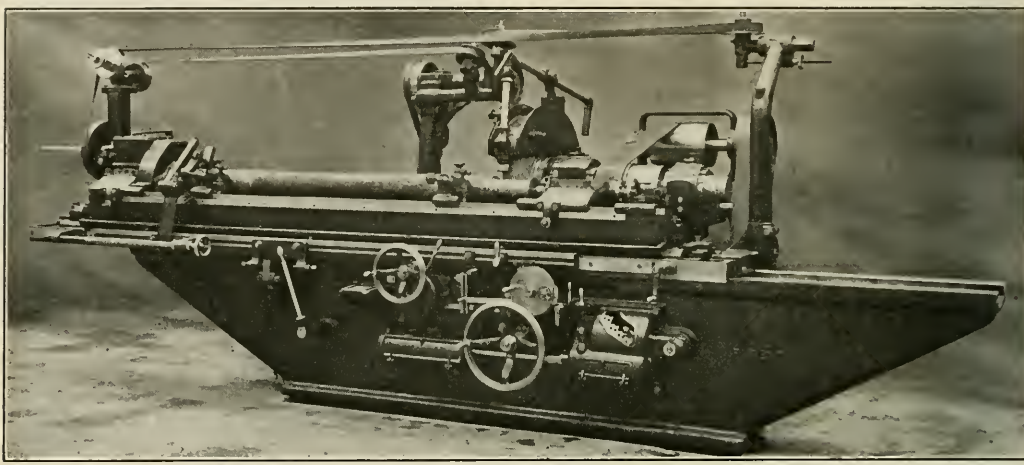


Fig. 2—Churchill Plain Cylindrical Grinder Used for Finishing Car Axle Journals

The grinding wheel spindle is easily detached on the main spindle and can be changed in a few minutes for larger or smaller holes. A large range of adjustment to the grinding wheel is available so that wheels can be used considerably smaller than the holes to be ground. The machine is self-contained, being driven by a direct-coupled motor.

The machine illustrated is capable of grinding cylinders 22 in. in diameter by 48 in. long, but two smaller grinders are available and it is understood that a still larger one has been made with a capacity up to 32 in. in diameter by 84 in. long, being developed especially for grinding Diesel engine cylinders. This machine would be large enough to grind American locomotive cylinders if it were considered advisable to follow that practice but the cylinders would have to be removed from the frames. If a portable cylinder grinding machine could be made, an interesting possibility would present itself in the use of cast-steel cylinder bushings, bronze-faced pistons and cast-iron cylinder packing rings. It would be interesting to determine whether the increased life of bushings and rings, fewer locomotive delays due to defective cylinder packing and steam economy due to accurate fitting rings would not more than offset the increased cost. It would, of course, be useless to provide accurate cylinders and piston packing without similar attention to the valve chambers and main valve rings.

While American railroads are not now, and possibly never will practice the grinding of locomotive cylinders, there are many smaller cylinders which practical railroad men say should be ground instead of simply bored. Among these may be mentioned air compressor cylinders, cylinders of feed water pumps and other large cylindrical parts. If the 22-in. by 48-in. grinder is considered too large for this work, one of the smaller sizes can be used.

In addition, a smaller amount of stock is removed to true up a worn journal. Consequently the journal can be trued a greater number of times before it is down to the limit of size and has to be scrapped.

In general, the method of machining journals in English railway shops is to first rough turn them within .020 in. to .030 in. of the required diameter, transferring them to the grinding machine as shown in Fig. 2 for the final operation. The ideal combination for rapid production is to have two machines on the rough grinding operation and one finishing as the roughing down takes just twice as long as finishing. Removing the above-mentioned amount of metal from the wheel seats and journals and finishing the journals takes from 30 to 35 min. per axle. The positioning device on this machine takes care of the accurate dimensioning demanded in the spacing of the journals and obviates any possibility of errors in this connection due to varying depths of center holes.

Drill Press Turning and Facing Tool

An effective and convenient tool for performing turning and facing operations on a drill press is shown in the illustration. The particular operation indicated consists of truing a worn Baker valve gear yoke and facing off electric welding which has been applied to take up side play. This operation is performed at the Portsmouth shops of the Seaboard Air Line.

On account of the shape of the valve gear yoke it is difficult to clamp on a vertical faceplate and to swing it on a boring mill requires a large table, so it is advantageous to handle it on a drill press.

The tool consists of a steel cutter ground with the proper rake and clearance and held in a block forming part of the square horizontal section which is an accurate running fit in the fixture attached to the drill spindle. Horizontal movement of the square section and therefore of the cutting point is controlled by the handle indicated at the right, attached to a long screw through the body of the fixture.

It is evident that in using this tool the drill spindle is lowered until the point of the cutting tool comes down to the

Upright Drill Equipped with Adjustable Turning and Facing Tool

surface to be trued. The handle is then turned to give a chip of the required thickness when operation of the drill press will turn a cylindrical surface, of the required length. When the cutting point of the tool gets down to the required depth the spindle feed is stopped and with the spindle revolving slowly the handle is turned a little on each revolution, gradually feeding the cutting tool out. This trues up the metal deposited by electric welding, leaving a shoulder which is smooth and square with the cylindrical surface.

Reduced Cost of Thermit Welds

As a result of an investigation it has been found that economies amounting to 10 per cent or over can be made in the amount of Thermit required to make Thermit welds. This is accomplished by reducing the size of the collars or reinforcements of Thermit steel; also, by narrowing the gap and changing considerably the proportions of gates and risers, it is possible to weld the smaller sections, such as 2 in. by 3 in. up to 4 in. by 6 in. with very much less Thermit than was ever believed possible before. For instance, a weld on a 2-in. by 3-in. section for which 40 lb. of railroad Thermit was previously recommended, now can be made with only 10 lb of Thermit. On a 3-in. by 4-in. section, where 55 lb. was formerly recommended, 25 lb. only is needed, providing the size of collar, width of gap and size of the various gates are proportioned in accordance with the dimensions now found best. On the average locomotive frame section, of about 4-in. by 6-in., the new method will give a perfect weld with a saving of over 10 per cent in the Thermit required.

Investigation has proved that in no case will the saving for the average frame be less than 10 per cent when this new method is followed while, on the smaller sections the saving runs into larger figures especially when advantage is taken of the use of pneumatic rammers, smaller mold boxes and other labor-saving devices which have been introduced in the past year.

The accompanying table gives the width of gap, width and thickness of collar, size of gates and quantity of Thermit which should now be used in welding all sections from 3 in. by 2 in. in size up to 7 in. by 7 in.

WELDING PORTIONS FOR WELDING LOCOMOTIVE FRAMES

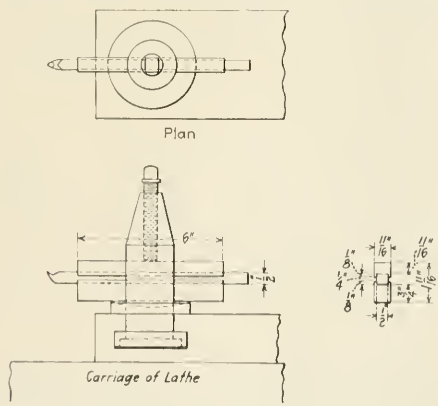
Width of frame (inches)	Depth of frame (inches)	Width of gap (inches)	Width of thermit steel collar (inches)	Thickness of thermit steel collar center (inches)	Heat gate (Dia. in inches)	Pour gate (Dia. in inches)	Riser (Dia. in inches)	Recommended Amount (pounds)
3	2	1/2	2 1/2	1/2	1	1	1 1/4	10
3	2 1/2	9/16	2 3/4	9/16	1	1	1 1/4	12
3	3	5/8	3	5/8	1	1	1 1/2	16
3	3 1/2	11/16	3 1/4	11/16	1	1	1 1/2	20
3	4	3/4	3 1/2	3/4	1	1	1 1/2	25
4	4	7/8	4	7/8	1 1/4	1 1/4	2	40
4	4 1/2	7/8	4	7/8	1 1/4	1 1/4	2	45
4	5	7/8	4	7/8	1 1/4	1 1/4	2	50
4	5 1/2	1	4 1/2	1	1 1/4	1 1/4	2	60
4	6	1	4 1/2	1	1 1/4	1 1/4	2	65
4 1/2	4 1/2	1	4 1/2	1	1 1/4	1 1/4	2 1/4	60
4 1/2	5	1	4 1/2	1	1 1/4	1 1/4	2 1/4	65
4 1/2	5 1/2	1 1/8	5	1 1/8	1 1/4	1 1/4	2 1/4	70
4 1/2	6	1 1/8	5	1 1/8	1 1/4	1 1/4	2 1/4	75
5	5	1 1/8	5	1 1/8	1 1/4	1 1/4	2 1/2	75
5	5 1/2	1 1/8	5	1 1/8	1 1/4	1 1/4	2 1/2	80
5	6	1 1/4	5 1/2	1 1/4	1 1/4	1 1/4	2 1/2	85
5	7	1 1/4	5 1/2	1 1/4	1 1/4	1 1/4	2 1/2	90
5 1/2	5 1/2	1 1/4	5 1/2	1 1/4	1 1/4	1 1/4	2 3/4	85
5 1/2	6	1 1/4	5 1/2	1 1/4	1 1/4	1 1/4	2 3/4	90
5 1/2	7	1 1/4	6	1 1/4	1 1/2	1 1/2	2 3/4	105
6	6	1 1/4	6	1 1/4	1 1/2	1 1/2	3	100
6	6 1/2	1 1/4	6	1 1/4	1 1/2	1 1/2	3	115
6	7	1 3/8	6 1/2	1 3/8	1 1/2	1 1/2	3	125
6 1/2	6 1/2	1 3/8	6 1/2	1 3/8	1 1/2	1 1/2	3 1/4	130
6 1/2	7	1 3/8	6 1/2	1 3/8	1 1/2	1 1/2	3 1/4	140
6 1/2	8	1 3/8	7	1 3/8	1 1/2	1 1/2	3 1/4	150
7	7	1 3/8	7	1 3/8	1 1/2	1 1/2	3 1/2	150

*Diameters shown above for pouring gates are mean diameters. In practice these pouring gates should be tapered, the bottom diameter being approximately 1/4 in. less and top diameter approximately 1/4 in. greater than the dimensions given.

High Speed Steel Tool Holder

By E. A. Miller

The tool holder illustrated differs from others in that the high speed steel tool bit need not be broken into short lengths but can be fed forward as necessary. It can be used on small shapers and when used on a lathe can be set at the proper height with relation to the work by means of a small curved



Tool Holder Designed for Use with Long Tool Bits

adjusting piece which fits into a corresponding concave washer. The holder is 6 in. long and 11/16 in. wide, the groove being made for 3/8 in. or 1/2 in. tool steel in this size. For use on large shapers, planers or lathes, the holder can be increased in size. The parts are made of machine steel and held in the tool post as any ordinary tool.

WHAT OUR READERS THINK

Building Up Sharp Driving Wheel Flanges by Autogenous Welding

Deer Lodge, Mont.

To the Editor:

In the April number of the *Railway Mechanical Engineer* I noticed an article on building up sharp flanges by welding. The Chicago, Milwaukee & St. Paul has been doing this on large electric freight locomotives for about ten months, doing the welding with the electric process. At first tire steel drawn out into welding rods was used, but we are now buying nickel steel, using the ¼-in. rod and obtaining much better results.

Electric welding is preferable to acetylene, for the reason that with the electric welding it is possible to make what we call a cold weld. The metal of the tire is not heated except at the point of the weld, and by welding about three inches and then skipping three inches we do not have the danger of high local heating. We have found this to be the dangerous part of welding tires both for flat spots and flange welding.

About 100 flanges have been welded to date and there have been no failures due to welding and have had to rebuild only two that were previously welded. They had made 11,000 miles.

Apparently we are going to get very good mileage from the welded flange. We do not turn the flanges after welding, but make a very smooth job and then fill in the crevices with hard pin grease. This gives sufficient lubrication to do away with any cutting that might start due to roughness of flanges, and in a very short time the flange is perfectly smooth.

Inasmuch as we are shopping our equipment on a mileage basis, this serves to keep the motors in service up to the time when we can take them into the shop and also makes a large saving as to maintenance without removing drivers. If the truck is removed from the locomotive we have to pay for the removal of the truck wheels, the stripping of the armature from the truck and the wheels for turning and then have the tire loss due to the turning of the tire for a new flange.

However, from past experience I do not believe it is desirable to weld flanges after the wheel tread has run approximately 100,000 miles for the reason that the rolling effect on the tread causes a hardening of the surface of the tread which in time will cause contractions that will develop into hair cracks and then later on into breakage of tires. On a road with which I was connected, I had an experience of this kind on tires which made a large mileage between turnings due to the small flange wear on account of straight track.

We have found by our experiments that the acetylene welded flange costs more to weld. It takes higher heat at the point of the weld, this heat having considerable spread through the body of the tire and causing more or less distortion of the metal in the tire, which puts it under considerable strain, increasing the tendency for breakage, while as above stated, the electric welding heat is very much localized and the operator can at all times place his hand on the tread of the tire near the point welded, as it practically remains cold.

E. Sears,

Division Master Mechanic, Chicago, Milwaukee & St. Paul.

Unbalanced Steam Pressure on Pistons

Schenectady, N. Y.

To the Editor:

I have read with interest the communication in reference to unbalanced steam pressure on pistons by Thomas E. Stuart, published in the April issue of the *Railway Mechanical Engineer.*

I cannot agree, however, first with the inference that an unbalanced pressure due to the exclusion of steam from between a portion of the wearing face and the cylinder wall—if such a thing be possible—is any greater on a Z-type piston, having the limited wearing face, than it is on any other form of piston of the same width and arrangement of rings.

All pistons are turned smaller than the bore of the cylinder when applied, and are therefore surrounded by steam to the first packing ring and to some extent at least to the opposite ring. If then we assume that it is possible to exclude the steam from under any portion of the wearing face, the piston, no matter what the shape, will bear on the barrel to an extent equal to the actual area, not the projected area, of the surface affected, times the steam pressure.

Second, it is inconceivable to me that any piston through service could "grind" itself to the absolutely perfect contact with the lower wall of the cylinder barrel for the entire length of stroke which would be required to exclude the thin film of steam necessary to balance the pressure.

If it were possible for such a condition to occur, it would be possible also for the packing rings to wear to a similarly perfect contact with the barrel for their entire circumference, and therefore be loaded with, for instance, 12,000 lb. on a 27 in. diameter ring and this, of course, is not the case as the wear of the rings will testify.

I believe the contention in regard to an unbalanced pressure on any piston is practically without foundation and that where excessive wear between piston and barrel occurs the cause is mechanical—poor lubrication, improper alinement, inadequate driving facility, etc.

The American Locomotive Company has applied Z-type pistons having the 90 deg. bearing and reduced upper portion to the majority of locomotives with cylinders over 23 in. in diameter, built by the company in the last eight years, probably 3,000 or 4,000 engines. That this design of piston has been satisfactory is a matter of record.

The service given by the old design of box piston which was the American Locomotive Company's standard equipment prior to the adoption of the single plate type, is certainly unquestionable. Yet this piston, the use of which dates back to the beginning of things, has the same width of bearing, although continuous, as the corresponding diameter of Z-type and is therefore subject to the possibility of the same unbalanced pressure.

I fully agree with Mr. Stuart that there is no excuse for the heavy piston which until recently has been general practice in locomotive design. The remedy for this is the Z-type which is the lightest form for a given strength, weighing not much over two thirds that of the corresponding box type.

The use of a single packing ring would seem rather extreme but certainly three are not necessary and add useless weight.

Personally, I am unable to see much philosophy in the use of the piston rod extension and guide. The deflection of the rod may almost equal the clearance of 1/32 in. given the piston and the wear of the shoe can hardly be maintained as near zero as would be necessary to make the arrangement efficient. The added reciprocating weight and extra set of packing are further objections.

Harry S. Burnham.

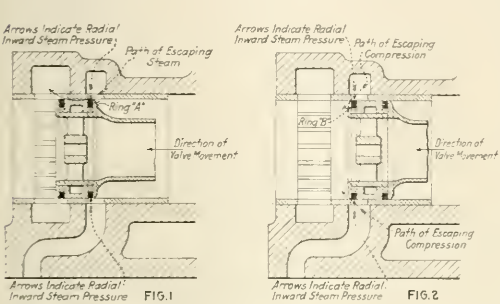
Some Defects of Piston Valve Designs

Council Bluffs, Iowa

To the Editor:

The piston valve has been generally adopted for modern locomotives as it possesses a number of advantages over the flat slide valve. The most important of these are: a practically perfect balance of pressures, a larger port area with a reasonable size and weight of valve and a reduced cost of manufacture and maintenance. It is not our aim, however, to call attention to well-known advantages but to mention some of the less commonly recognized shortcomings of the inside admission type of piston valve as generally used.

The first defect is that of a large clearance space in ports



Diagrams Showing Action of Steam Pressure on Packing Rings

and passages between the valve and the piston at the beginning of its stroke. This space must be filled with live steam at each working stroke and if unduly large is productive of a considerable waste of steam.

The piston valve, by reason of its cylindrical form, necessitates a comparatively large clearance space, for the ports in the bushing at the upper part of the circumference are at a considerable distance from the cylinder. Now it is true that these ports are of little value for the purpose of admitting steam, but are essential in attaining a balanced condition of the valve. They should therefore be reduced to the smallest size compatible with this result through at least the upper two-fifths of the circumference, and the remaining port space carefully proportioned so that the clearance space is kept at a minimum. The clearance space is, moreover, materially enlarged by an increase in the diameter of the valve, being approximately proportional to the square of the diameter. Undoubtedly there are valves in use on some freight locomotives which are larger than necessary. The diameter of the valve should always be kept down to the minimum.

Excessive clearance not only causes a waste of steam but also brings about a reduction of compression. In the present-day locomotive with often unduly heavy reciprocating parts, a considerable degree of compression is absolutely necessary to absorb the momentum of these parts. A proper amount of compression gradually takes up the slack in the rod connections so that when admission occurs a knock is avoided. Increased compression can be secured in two ways only: by reduction of the compression space or by securing earlier exhaust closure. As the limitations for applying the latter method are narrow, the possibilities for the former should be exhausted before the latter is tried.

High compression reduces the waste occasioned by excessive clearance. Indicator cards should therefore show a well-rounded compression curve if good results are to be secured.

Clearance may be reduced by making the ports short and direct, as by lengthening the steam chest until the port is straight and directly over the end of the cylinder. The necessity for a reverse curve in the port is thus eliminated and the center distance between steam chest and cylinder materially reduced. The increased space required in the exhaust port can be secured at the upper part of the steam chest.

The necessity for a large opening through the body of the piston valve is believed to be exaggerated. The size of this opening is governed by but one consideration, that is, the cross-sectional area of the space between the outer circumference of the spool and the inner circumference of the steam chest must in no case be less than the net area of the live steam port.

Let us now consider another defect in the piston valve, the consequences of which are of no less importance although the evidences are less apparent. Fig. 1 shows a longitudinal section of a portion of the valve, bushing and ports with the live steam packing ring A just passing off the inlet port onto the land between the ports. The ring is now subjected to radial inward pressure over practically its entire outer circumference. Opposed to this pressure is the more or less feeble resiliency of the ring itself and the possible pressure of steam which may have leaked under the ring. The external pressure is enough, however, to collapse the ring and permit the steam to flow past it between the bushing and the bull ring, which may or may not be a good fit in the bushing. Any steam so escaping passes freely to the exhaust port with little or no evidence of its escape. It is clear that well-fitted rings are more subject to this action than those which are loose in their grooves, as the steam cannot penetrate so freely under them and create a balanced condition.

Refer now to Fig. 2 in which the valve has moved to a position where the exhaust ring *B* is just closing the exhaust port and compression is beginning. Conditions are the same as before except that the exhaust ring is subjected to the lighter back pressure which, however, is still enough to compress the ring. The space through which the steam must escape is shorter than before and more open. Since compression takes place during a small part of the piston travel, it is apparent that the leak here need be but small to effect almost total loss of compression.

It is unquestionably true that a large part of the trouble with piston valve packing rings, particularly breakage, may be traced to the continual compressing and re-expanding of the rings. Lack of compression or the loss of it is also responsible for knocking and wear of rod connections, driving boxes, shoes and wedges.

What are the remedies? First, reduce the clearance to a minimum; second, make the rings so that they cannot collapse. Loss of live steam may be corrected by using three equally spaced rings on each end of the valve. This is only a partial cure, however, for it does not prevent the loss past the exhaust ring which affects the compression.

Thomas E. Stuart.

Very Varied Values. Interesting examples of unusual sources from which scrap can be reclaimed are furnished by the practice of the Southern Pacific at its central reclamation plant. Sealing wax is obtained from worn-out dry cells; tin drinking cups and grease cans are made from coffee cans; scrap boiler tubes are threaded or welded and used for water drain lines, air lines and conduits; old shovel blades are made into washers; parlene, a by-product of Pintsch gas plants, is used for painting the underframes of cars; scrap rope is unwound and used for binding company shipments instead of twine; sediment from acetylene generators is used in place of lime for whitewashing and in the company's steel foundry.

THE QUESTION BOX

Design of Crank-Pin and Crank-Pin Hub

By A. Montangie
Civil Engineer, Belgian State Railways, Ghent, Belgium

This is in answer to the questions published on page 202 of the April issue.

The crank-pin of the overhung type is hydraulically pressed in the hub. This practice entails the following assumptions:

1—The bore of the hub is one or two per cent smaller than diameter of pin, say bore = 99 per cent of diameter of pin.

2—Conicity of bore $= \frac{1}{100}$

a—Fibre stress in hub due to the pressing of the crank-pin.

In Fig. 1, with conicity purposely exaggerated, the force, F, gives on a lateral section, s, a pressure, N, of which

K, the radial component = N cos a

K′, the tangential component = N sin a; a = 35′.

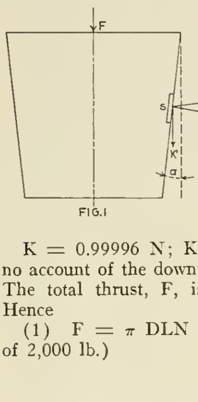


FIG. 1

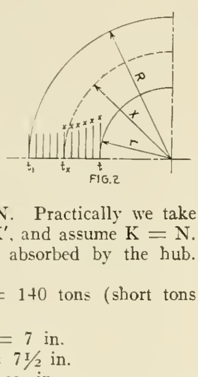


FIG. 2

K = 0.99996 N; K′ = 0.0102 N. Practically we take no account of the downward thrust K′, and assume K = N. The total thrust, F, is frictionally absorbed by the hub. Hence

(1) F = π DLN F = 140 tons (short tons of 2,000 lb.)

D″ = 7 in.
L = 7½ in.
N = 0.85 tons per sq. in.

To determine the fibre stress in the hub, we use Lame's formula giving the tensile stress t_x for layer X (see Fig. 2).

$$(2)\quad t = \frac{(p - p')\,R^2 r^2}{(R^2 - r^2)\,x^2} + \frac{pr^2 - p'R^2}{R^2 - r^2}$$

p = N = 0.85 tons per sq. in.; p′ (outside pressure) = 0

Maximum tensile stress occurs for minimum of X, therefore X = r

$$T = N\,\frac{R^2 + r^2}{R^2 - r^2} = 1.61 \text{ tons per sq. in.}$$

R = 6¾ in., r = 3¾ in.

Minimum tensile stress for x = R; t_1 = 0.76 tons per sq. in.

The t_x curve is a hyperbola (third degree) Marked xx..

b—Maximum allowable pressure.

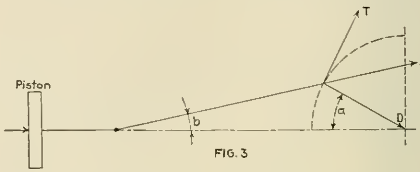
Taking the tensile strength of cast steel, 90,000 lb. = 45 tons the safe working load = 75,000 lb. = 7½ tons.

Formula (2) with t = 7½ gives N = 3.96 tons per sq. in., which is the maximum pressure
3.96 × 165 = 650 tons.

d—Strength of pin to resist load W

(1) Load W Assumptions:
Boiler pressure 180 lb. per sq. in.
Steam chest pressure 160 lb. per sq. in. = p
Back pressure 20 lb. per sq. in. = p′

$$\frac{\text{Throw of crank}}{\text{Length of connecting rod}} = \frac{r}{l} = \frac{1}{5} \text{ (see Fig. 3)}$$



P = pressure on piston

S = thrust on connecting rod = P ÷ cos b

T = tangential pressure or turning moment = S sin (a + b)

D = radial pressure = S cos (a + b)

$$\text{Maximum of S for a} = 90 \text{ deg.} = \frac{P}{\sqrt{1 - \left(\frac{r}{e}\right)^2}} = 1.02\ P = S \max$$

Maximum of T for a + b = 90 deg. Since $\frac{r}{l} = \sin b = \frac{1}{5}$

b = 11 deg. 30′ cos b = 0.980 T_{max} = P ÷ 0.98 = 1.02 P.

Maximum of D for a b = 0° or a = b = 0: P = D

$$\text{The maximum of W is } \frac{\pi D^2}{4}(p - p')\frac{1}{\cos h} = 1.02\ P = 70{,}000 \text{ lb. or 35 tons}$$

2—Strength of pin

$$(3)\quad \text{Bending moment } M = W\frac{l}{2} = \frac{I}{e}K = 0.1d^3K \text{ with } \begin{cases} K = 7\tfrac{1}{2} \text{ tons per sq. in.} \\ l = 7\tfrac{1}{2} \text{ in.} \\ W = 35 \text{ tons} \end{cases}$$

$$d = \sqrt[3]{\frac{W\frac{l}{2}}{0.1\,K}} = 5.59 \text{ in.}$$

To insure efficient lubrication the unit pressure should not exceed a certain value k′, a complex function of the speed in r.p.m., the metal in contact, oil, etc.; k′ is empirical or determined by experiment

W = KLD; for D = 6½ in., L = 7½ in., k′ = 0.74. For hard steel pin running or bronze bearings and a speed of 150 r.p.m. the usual figure is taken between 0.4 and 0.6 tons per sq. in. In the present case lubrication to be efficient shall be abundant, or an oil of high viscosity shall be necessary.

3—Stress in hub due to the load W and pressure of pin.

Maximum bending movement M = W × m = 340 tons
Maximum shearing force T = W = 35 tons } in section AA′

The reaction of the cantilever in the hub may be likened to two compressive forces R_1 and R_2 acting at ¼ and ¾ l from section AA′ in a diametral plane of the pin containing W.

$$\text{We have } \begin{cases} W + R_2 - R_1 = 0 \\ M + \frac{WL}{4} - \frac{L}{2}R_2 = 0 \end{cases} \text{ giving } \begin{cases} R_1 = \frac{M}{0.5\,L} + 1.5\,W = 150 \text{ tons} \\ R_2 = \frac{M}{0.5\,L} + 0.5\,W = 150 \text{ tons} \end{cases}$$

The lower half ring ABo'o is compressed by

$$\frac{R_2}{\frac{1}{4}\pi DL} = 3.64 \text{ tons per sq. in.}$$

Total maximum stress in this ring 3.64 + 1.61 = 5.25 tons per sq. in. In the lower half ring Bo'o" c we have

Compression stress in hub = 1.61 tons per sq. in.

$$\text{Tensile stress } \frac{115}{\frac{1}{4}\pi DL} = 2.8 \text{ tons per sq. in.}$$

$$-1.19$$

or a negative stress, which means that the tension due to W

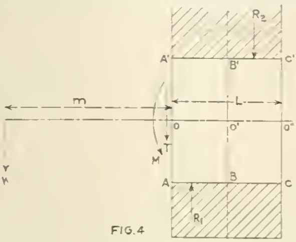


FIG. 4

relieves the hub of the compression stress due to the pin. For the upper half rings we have

A'B'o'o, — 2.03 tons per sq. in. no compression on hub
B'c'o"o' + 4.41 tons per sq. in. compression

The present crank-pin is provided with a sufficient margin of safety. Mention has to be made that figures are according to European practice, the specifications of the A.R.A. not being at hand. If any marked differences occur, corrections are to be made accordingly.

AIR BRAKE CORNER

How Would You Answer These Questions?

Questions.—1. How could a train be handled if the brake pipe was broken behind the connection leading to the automatic brake valve in either A1 or ET equipment?

2. If the automatic brake would not apply but the independent brake functioned properly, where would the trouble be?

3. If the automatic brake would not apply on a long train but operated correctly when the engine was detached from the train, where would you look for the trouble?

4. If, when applying the brake with either brake valve—the engine being equipped with the ET brake—the main reservoir pressure began to fall, where would you look for the trouble and what should be done to avoid stalling?

5. On an engine equipped with the ET brake, if the feed valve pipe was broken between the feed valve and the brake valve, what should be done?

(The questions given above were sent to us by a subscriber in West Grand Forks, British Columbia, Canada. Similar questions have doubtless been asked and have been discussed more than once by enginemen and air brake men in roundhouse gatherings or in instruction cars. They are of the kind that make a man think. Send us your answers. As an additional incentive to do so, we will print the best replies and send the one who wrote them a check for $10.—*(Editor.)*

Hearing on Power Brakes by Interstate Commerce Commission

In conformity to order No. 13528 of the Interstate Commerce Commission, dated February 20, 1922, and supplementary orders in connection therewith, an important hearing in regard to power brakes and appliances for operating power brake systems was started in Washington on Wednesday, May 17. The object of the inquiry and investigation is to determine whether, and to what extent, such brakes and appliances now generally in use on locomotives and cars are adequate and in accordance with requirements of safety, what improved appliances or devices are available for use, and what improvements may or should be made to obtain increased safety in train operation.

The hearing is being held before Examiner Mullen. The air brake manufacturers and the American Railway Association are represented by counsel and on account of the importance of the case the sessions are being attended by from 80 to 100 men, among whom are most of the air brake supervisors of the largest railroad systems.

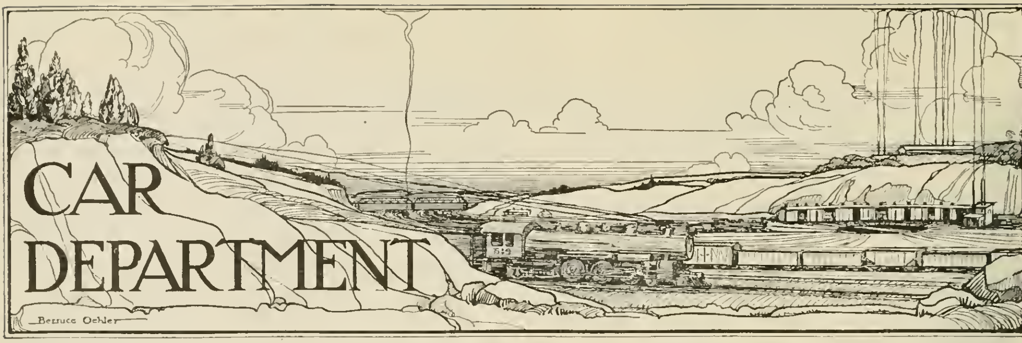
The first subject taken up was the air brake apparatus which has been developed by the Automatic Straight Air Brake Company, New York. In substantiation of their claims for the need of such a system and that it was superior to the Westinghouse air brake system now in general use, Clark and La Roe, counsel for the Automatic Straight Air Brake Company, have called a number of witnesses and submitted many exhibits. The first witness examined was Robert Burgess, southeastern manager of the Westinghouse Air Brake Company. The questions centered around a paper presented by Mr. Burgess before the Southern and Southwestern Railway Club in November, 1919, relative to the empty and load brakes. The next witness examined was S. D. Hutchins of the Westinghouse Air Brake Company, who was questioned in regard to a memorandum relative to the automatic straight air brake which he sent to M. A. Kinney, superintendent of motive power, Hocking Valley. Mr. Hutchins was followed by W. S. Bartholemew, vice-president, Westinghouse Air Brake Company, who was questioned in regard to a similar general memorandum.

The next witness called was M. E. Hamilton, field engineer, Automatic Straight Air Brake Company. His testimony covered the operation of the automatic straight air brake both in solid trains and when mixed with Westinghouse brakes, as observed on the test rack and on various railroads where this system has been applied. Evidence showed that an early design of the brake was tested on the Virginian in 1918 and subsequently removed. The apparatus of this company is now in service on the following equipment: 100 coal cars on the Norfolk & Western; 40 coal cars on the Denver & Salt Lake; 11 passenger cars on the Chicago & Eastern Illinois; 48 passenger cars on the Erie, and 6 passenger cars on the New York Central. Additional orders now on the books include brakes for the New York, Chicago & St. Louis; Pere Marquette; Rock Island; Erie; Norfolk & Western; Missouri, Kansas & Texas; and El Paso & Southwestern.

A number of enginemen and brakemen of various roads who have operated trains on which automatic straight air brakes were in use have been called to testify as to the operative results obtained.

From present indications it appears that the hearing will be thorough and will last for some time, as many additional witnesses are to be called. These will include additional witnesses for the Automatic Straight Air Brake Company, also witnesses for the Westinghouse Air Brake Company and probably others for the railroads or called by the Safety Bureau of the Interstate Commerce Commission.

The above covers the evidence presented during the first week. Further details will be given in the next issue.



The Design of Passenger Car Repair Shops

Requirements for Various Departments Outlined and Typical Layouts Proposed by A.R.E.A. Committee

At the 1922 convention of the American Railway Engineering Association, the Committee on Shops and Locomotive Terminals presented a report on the design of car shops prepared by a sub-committee, of which L. K. Sillcox, general superintendent of motive power of the Chicago, Milwaukee & St. Paul, was chairman, the other members being Walter Goldstraw, E. M. Haas, L. L. Tallyn, and A. M. Zabriskie. This report includes much valuable information not only from the standpoint of new shop layouts, but also suggestions for the operation of existing shops. On account of its general interest, it is reproduced in part below:

So many passenger car repair shops throughout the country today have a fifty-year-old nucleus, with piece-meal additions, in which the shopmen are making the most of what their shops possess, and are struggling along as best they can to keep modern equipment in repair and serviceable, that it seems proper that careful study and consideration be given to the subject of repair shops, with the view of improving facilities and developing plants that are as modern as the equipment to be maintained. If each workman in a shop, where 1,000 men are employed, saved five cents for the railroad company each day, the sum saved in one year, of 300 working days, would amount to $15,000, an amount which is equivalent to five per cent interest on a capital of $300,000. Yet in most, if not all, railroad shops it is indeed conservative to estimate that each man wastes five cents' worth of his time daily due to poor shop layouts, poor arrangement of facilities, antiquated tools and machinery, or old-fashioned methods of handling work, conditions over which neither he nor his immediate supervisors have any control.

Dispatching Repairs

Harrington Emerson in his book, "The Twelve Principles of Efficiency," says "The railroad that dispatches its 'crack' trains with ninety-nine per cent of time accuracy has either no dispatch system or a very crude one for work, either big or small, through its shop; therefore, in some cases it fails to realize an efficiency of even one per cent, and on the big average of all shop work fails to realize either a time or cost efficiency of more than forty per cent. . . .

"It is interesting to note in the matter of repairs the great superiority of marine repair dispatching over locomotive repair dispatching. A vessel will be put in dry dock . . . , and be completely scrapped, repainted, new propeller and rudder fitted, new plates inserted in perhaps three days. . . .

"A fifteen-day schedule for general repairs to a locomotive is considered fast time and the average is nearly thirty, but if the time for each item is separately entered in the summary, it is hard to discover why three days would not be enough."

Considering the importance of these facts, this report is written with an object to obtaining high efficiency fully as much as to gain mechanical excellence. However, the two are co-ordinate, for high efficiency bears with it mechanical perfection.

In laying out a passenger car shop, or any other, no better advice can be given than that offered by Herbert Kaufmann, when he said, "Make your chart before you start. Know what you're after before you start out for it."

Importance of Proper Layout

The committee in submitting this report has endeavored to cover only what seems to be best in layouts and treat the subject so that it will be of most assistance to the greatest number. Most railroad shops of today are operated on the hourly basis, and it is therefore on arrangement, organization and supervision that efficiency, output and workmanship depend. Furthermore, when it is remembered that organization and supervision are in a large measure dependent on layout of plant and facilities the importance of the first factor is appreciated.

The shop, yards, buildings, and machinery should be arranged so that the various operations follow through in a logical sequence; the bad order equipment should pass in at one point, progress by various steps, without hindrance, or delay from congestion or awkward movements, over a predetermined circuit to the point of release and emerge as a finished product. In general repair work, a car will enter the shop, be unwheeled and stripped, after which the car, trucks and trimmings will progress through the shops, each over a different route, and will finally meet at some point for trimming, assembly and release.

The older shops are generally situated within the limits of some city, with the result that now the cities have grown around them, hemming them in and forbidding their further development. It is hopeless to attempt the development of a modern plant in cramped quarters. Therefore, a location must be sought elsewhere even though the shop crews are well established and the labor conditions favorable at the old point, but in the selection of the new site, while it may be true that labor will follow the job, the importance of selecting a location with a suitable labor market must not be neglected.

Local Conditions to Be Considered

Topographic and climatic conditions must not be lost sight of, and in laying out a plant, nature must not be forgotten. A careful study of the forces of nature must be made so as to offset or reduce any hindrance from this source and at the same time secure any benefits that may be derived. Too often, in order to take advantage of cheap real estate, ease and simplicity in providing drainage and other things, shops are located in valleys adjacent to water courses which cannot be controlled, with the consequence of much damage from floods and severe losses from delay and interruptions to operations, the cost of which offsets the savings in first cost many times over.

It is useless to attempt, in an ideal layout, to fix definite dimensions and proportions. These must be left to be determined for each particular case from the policies, practices, and conditions prevailing. It is the policy with some railroads to thoroughly overhaul the trucks of every car passing through the shops; therefore, for them an elaborate truck repair shop is required. At other shops a large portion, or all of the equipment may be steel cars requiring extensive steel working machinery and but small wood mill equipment. Roads not operating their own sleeping cars do not require the space for upholstery work demanded by those that do. Where the climate is mild a great deal of work may be done out of doors, and so there are a great many factors to be considered. It is our object to offer something that can be used as a guide. The committee's submission, therefore, is laid out so that all operations can be taken care of indoors and those using it as a guide need subtract rather than extend.

All buildings should be substantially built, of fireproof construction, well lighted, comfortably heated, and have good ventilation. The last three requirements, together with large sanitary lockers, wash and toilet rooms, go a long way in keeping up the morale of the employees and will produce returns on investment in the form of efficiency, quality and quantity of the work produced.

For the passenger car work, buildings with transverse tracks served by transfer tables undoubtedly give the best operation. Passenger coaches, which are handled singly, can be placed or shifted about much more expeditiously and with better provision in a transverse layout than in any other. Frequently, the transportation department requests that preference be given certain cars after they have been placed in the shops, making it necessary to shift their position. The plant should, therefore, be flexible for the moving of individual cars. On the other hand, the reverse is true of freight car shops. Freight cars are handled in groups; therefore, a better operation is to be had from a longitudinal layout.

The committee makes the following general comments and recommendations for the various subdivisions which make up a large passenger shop layout.

Coach Paint Shop

The paint shop should be of fireproof construction, light, airy, roomy, free from dirt and dust, and should be well heated in cold weather. The most economical operation as to first cost and production is obtained with a building of sufficient width to hold two cars on each transverse track with ample aisle room on either side and in the middle. With more than two cars per track awkward conditions arise in moving the center car. Each track should run through and be served by a transfer table on either side of the building. The tracks should be 25 ft. from center to center. The floor should be concrete and should pitch to floor drains to allow for scrubbings and quick drying after.

Traveling cranes and supply tracks are not needed. Permanent scaffolds should be provided. They should be adjustable and easily operated, preferably suspended from overhead so they can be pushed up out of the way when not in use. Ample space should be allotted for storing and mixing paints. This should be located at the center of the building for so large a plant as this, so as to be equally accessible from the extreme ends of the shop. Ample toilets, wash and locker rooms should be provided.

Some places may require baking ovens, in which case they may be provided for across the transfer table or a few stalls of the paint shop may be converted for this purpose.

Coach Repair Shop

The same width and track arrangement is recommended as for the paint shop. The building should be divided into two main bays, one on either side with a center aisle about twenty feet wide in which should be installed a fifteen-ton traveling crane. This should be operated from the floor so that the operator can hook on his own loads or do other tasks at such times as the crane is not in use.

The floor should be wood block, substantially constructed to withstand the severe wear from the handling of heavy parts. Permanent scaffolds should be provided of the same construction as recommended for the paint shop. The shop should be piped for compressed air, steam, water, and acetylene, and ample electric connections should be provided.

If cars are all placed on dollies before they are taken to the repair shop, pits are not necessary. However, as the probabilities are that not all cars will be unwheeled, a portion of the stalls should be provided with pits.

Some tools and machinery are necessary in connection with this shop, although it may be the intentions to do the greater portion of the work in the main machine and blacksmith shop; therefore, a certain space should be set aside for this purpose. The pipe shop, air room, and tin shop should be annexed to this building, if possible, as the greater portion of that work comes from and goes back to the cars while in this shop.

As with the paint shop, the best operation will develop from this shop being served on both sides by a transfer table.

Wash House

At most shops the cars are washed on the same track on which they are painted, or on tracks in the paint shop especially set aside for this purpose. At some places the washing and stripping is done on the same tracks. In view of the continual dampness resulting and the hindrance which it produces on the paint work, the committee recommends that a separate department be assigned and be properly equipped for this work. Certain stripping such as the removal of air equipment can be advantageously taken off here.

The wash house should be well lighted, heated and ventilated so the cars will dry quickly. It should have a concrete floor, properly pitched, with frequent floor drains to give good drainage. Gutters in the floor between tracks or so located as to catch the drip from the sides of the car will greatly assist in keeping the floor dry. Scaffolds should also be provided and the shop should have water and steam connections. Floor space should be provided in a convenient location for the preparation of soap and acid solutions.

Stripping and Trimming Shop

A very logical and economical grouping of operations can be accomplished by providing a place for stripping cars of sash, doors, upholstery, and fixtures as they pass into the shops and another for trimming them as they go out with space in between where the parts removed can be repaired, finished, and stored ready to be placed back on the car as it goes out. It is the custom at most shops to remove such things either in the yard, paint or repair shop, haul it to the respective departments for repairs, painting, plating, etc., and then haul it back again to paint shop, yard, or some other place where the car is trimmed, all of which involves considerable labor and forms a serious problem in the shop operation. Therefore, the committee recommends the adoption of an arrangement as just described and as indicated in the proposed layout for large plants of this kind, where the trim may be removed, pass through its respective department, while the car is progressing through the shop, be stored, finished, and ready for the car after it has passed the paint shop and has been brought back to the trim shop on its way out.

Unwheeling Hoist

The manner of removing trucks from under the coaches varies greatly with different shops. At some shops the car is taken directly to paint shop where the trucks are removed and the body set on horses. The trucks are then taken to the truck shop or machine shop. In some places the trucks are overhauled at one end of the coach repair shop or paint shop, while at others they are taken to a separate shop. At some shops the cars are jacked up in the yards, the bodies put on dollies and the trucks and bodies wheeled to the respective places for repairs.

A much smoother operation is to be had from the practice of placing the bodies on dollies, providing the course through the shops is smooth and systematic. The unwheeling if done by a permanent or fixed hoist can be accomplished more expeditiously and with less hazard to employees than by the use of the ordinary jacks. With a layout of this size the labor saved will more than justify the expense involved. The use of dollies not only affords an easier and more simple way of handling the bodies but in case of fire offers a chance of saving some cars which would be impossible if resting on horses.

In the layout herewith submitted, two traveling cranes, one located in the stripping shop and the other in the trimming shop, are suggested for this purpose. These cranes should be at least of 80-ton capacity and have two hoisting drums, one for either end of the car body.

Truck Shop

In most shops the trucks are repaired on the same tracks with the cars, or on a few designated tracks in the passenger car repair shop. A separate truck shop gives better supervision, more production and permits a better and more extensive use of the proper tools. A separate shop permits the segregation of material, tools, and facilities such as hoists, lye vats, spring testing machines, truck gauges, and templates. The shop tracks should be transverse with room on each track for two sets of trucks. The building should have two main bays on either side and a narrow bay at the center with a ten-ton traveling crane. A longitudinal track should run the full length of the building to facilitate the handling of mounted wheels and axles.

Over each track in the side bays should be installed a five-ton floor-controlled traveling crane for the handling of truck parts, and the removing and replacing of wheels.

There should be ample track space outside for the storing of trucks, ready for and after leaving the truck shop. The truck shop should be located close to the smith, machine and wheel shops. The shop should be well lighted, heated and ventilated. Concrete or wood block is satisfactory for floor.

Wheel and Axle Shop

This shop should be conveniently located to both the freight and passenger repair shops. Large yard space is necessary in connection with this department for the storage of wheels and axles, both mounted and unmounted. Free movement of this operation is essential to economical production, and great care should be exercised in laying it out. Monorails form the best method for serving this shop. These should extend out into the yard for the handling of the

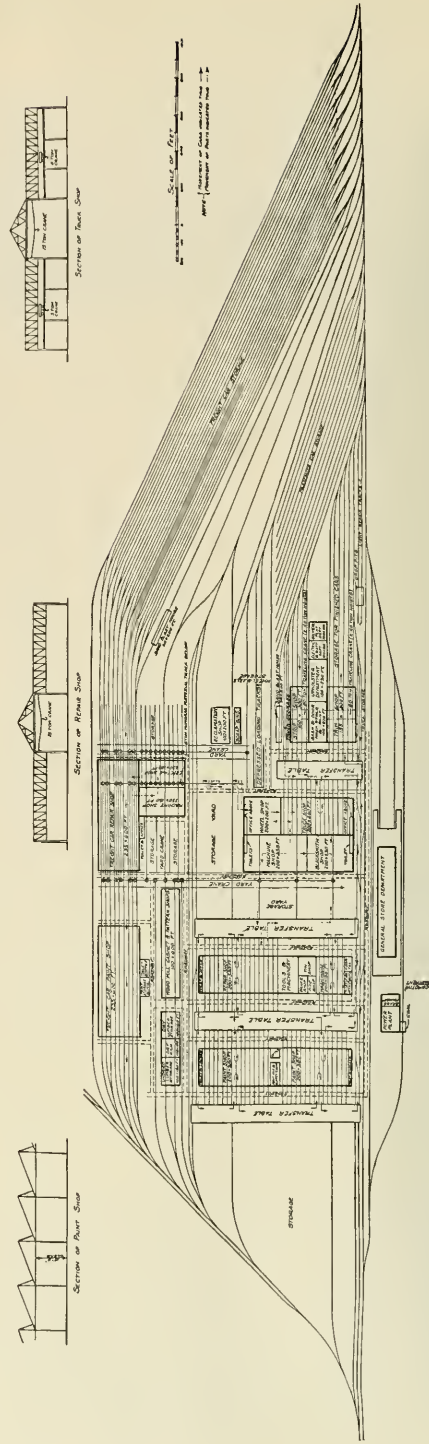


Fig. 1—Proposed Arrangement for a Passenger Car Repair Shop

wheels and axles both into and out of the machine shop.

The building should be well lighted, heated and ventilated, and the floor should be substantially constructed, preferably of wood block.

Blacksmith and Machine Shop

These two shops are treated together because most of the work progresses through the smith shop into the machine shop to be finished. They should be very conveniently located with respect to the truck shop and easily accessible for the coach repair shop, as these two departments furnish practically all the work.

These shops should be well lighted, heated and ventilated. Particular attention should be paid to ventilation in the smith shop. Wood block floor is preferable for the machine shop, while a good solid dirt floor gives best results for the smith shop.

Yard cranes and push cars are necessary for handling material to and from the shops, and monorails, jibs, etc., should be amply provided for handling the work inside the building.

Wood Mill, Pattern and Cabinet Shops

These three sections are closely related. All do wood work, and in the majority of layouts are combined under one roof and it is proper that they are. The mill should be conveniently located with respect to both passenger and freight car repair shops and should be so placed that ample yard and storage space is available for the storing of lumber. It should have as an accessory a dry kiln and large sheds for the storing of dried lumber.

At least two supply tracks, leading from yards and sheds, should be run longitudinally through the mill and the machines so spaced that heavy timbers can be easily handled from cars to machines and progress through the mill in logical sequence, leaving the mill at the opposite end from yard in a finished state.

The building should have good light, heat and ventilation and should be of fireproof construction. Some means of disposing of sawdust and shavings must be provided. The preferable means of disposal is to bale for a commercial trade. There is now a good demand for shavings as a substitute for straw in packing crockery, etc. This is preferable to burning them in boilers as they are not satisfactory fuel and in addition require special boiler settings and provisions for handling.

If many patterns are to be made and stored, a separate fireproof storage should be provided.

Power Plant

This involves a study in itself, for a great deal can be done toward economy in the selection and proper installation of boilers and appurtenances, together with the proper coal and ash handling equipment. The power plant should be made ample for all requirements, spare units should be installed to insure continuity of service and to allow for the making of routine repairs.

The water, steam, air and electric power systems for a layout of this kind are worthy of very careful study and consideration.

Miscellaneous

(a) Foundry—Unless there is to be a separate foundry run independently to serve all departments, it is well to have a small brass foundry in connection with the Car Department.

(b) Sand Blast House—This because of the dust and dirt produced should be isolated somewhat from the other department, but should not be too far away to cause delay in detouring from the main circuit.

(c) Reclamation Department—Should be centrally located with respect to freight and passenger car repair and machine shops and in the vicinity of the scrap yard.

(d) A fire department, hospital, and ambulance is quite essential with a plant of this size.

(e) All transfer tables should be of ample dimensions and capacity to allow for rapid travel and expeditious handling of cars.

(f) Paved roadways and walks of ample width should be provided throughout the plant to afford ease of communication, facilitate trucking and allow unobstructed passage for both the fire-fighting equipment and for the ambulance.

From the standpoint of economy in layout and subsequent operation, the grouping of as many departments as can be consistenly united into one large plant is recommended. Between the locomotive and car departments the storehouse and its supply yards, the power plant, water, heat and light systems, the fire department, hospital and ambulance service, and the general office can be used in common at a lower initial cost outlay than would be necessary to fit up two independent plants. The relation between the passenger car and freight car departments is even closer. The wood mill, the machine, blacksmith, and wheel shops can handle work for either equally well. The supplies, stores, power plant, etc., can serve both and the extra land, buildings, and machinery necessary to fit out two separate plants would more than offset any advantages that may be derived from separate operations.

In preparing the layout submitted with this report (see Fig. 1) it was assumed that the topography was favorable and that ample property was available. It is considered that the plant as shown is to form a part of a complete repair point for the maintenance of both cars and locomotives; therefore, the power house and store department will be common and should form the natural separation between the two departments. In sizes, the intention is that it be sufficiently extensive to take care of most any large point. No provision for extension has been indicated, but the suggestion is that if only a portion be used the remaining space be allotted for this purpose, or if built full size that additional space transversely be provided.

The actual capacity of the plant as laid out will depend to a great extent on the average painting schedule. The paint shop will hold sixty cars, and if worked on an eight-day schedule, should permit of a capacity of eight cars per day. This operation is really the criterion, and if other departments are properly proportioned, will control the output of the entire plant.

Thus unimpaired by cramped quarters, it is the intention to execute a layout which will give freedom to productive movement of cars through the shops, eliminate all unnecessary handling of materials and parts and locate the various operations and groups logically and with due regard to their relation to each other.

The routing through the shop forms a complete circuit. The cars to be repaired are delivered to the receiving yard from which place they are switched, as selected, to the tracks leading into the stripping shop. Inside this building brake rods, etc., are disconnected and removed and the car moved up under the crane where the body is removed from the trucks, set on to dollies, and the trucks switched out. The outside track should be used for the handling of trucks, from which they can either be moved via the transfer table or shifted in the opposite direction and placed on storage tracks. Before leaving the stripping shop all the sash, doors, hardware, upholstery, fixtures, etc., are removed and delivered to the proper quarters for repairs.

From this building the car body is moved via transfer tables and tracks, first to the washing shed, then to the coach repair shop and from thence to the paint shop. After the car has been painted it is brought back via transfer tables and tracks to the trimming shop, trimmed, mounted onto its trucks, leveled, brake rods hooked up, and put onto the outgoing tracks for release.

The trucks are removed from the storage tracks, to which they were shifted after the bodies were taken off, via transfer table to the truck shop for repairs, after which they are placed on the storage tracks adjacent to the trim shop to await the arrival of the bodies.

The wheel shop is at one end of truck shop and the smith and machine shop is alongside of it. As the heaviest work contributed to each of these three shops originates in the truck shop, this forms a logical grouping. The coach repair shop located just across the transfer table from the smith and machine shops with the mill just above it forms another convenient grouping.

Between the stripping and trimming shops are located facilities for handling sash, doors, upholstery, fixtures and hardware. Thus the handling of these parts is reduced to a minimum.

The paint shop which is practically independent from the rest of the layout is at the extreme end.

Between the wash house and repair shop is space allowed for air equipment, pipe work, tin shop, and for tools, and such small machines as will be necessary for this department, it being considered that the heavy smith and machine work will be done in the main building.

At the lower end of the wash house is space for the fire department, ambulance, and hospital. This is a convenient point and gives them a central location.

For such cars as are required to have paint burned off and sand blasted a separate building is provided just above the stripping shed. The dust arising from this prompts its being isolated; this location while taking care of this feature does not break up the free movement, as the car after being stripped can be moved via transfer table to sand blast house and thence to repair or paint shop. The back up movement is not a serious obstacle in this case as a small percentage of the cars are burned and sanded.

There is ample space and track facilities around the wheel shop for the storage of wheels and axles both mounted or unmounted. The wheel shop is conveniently located with relation to the passenger car truck shop and to the freight car repair plant.

The smith and machine shops are primarily to handle passenger car work only. Ample storage space has been provided for material both raw and finished between the building and the transfer table and between the machine shop and freight car department. Yard cranes are indicated which will greatly facilitate the handling. Standard gauge tracks over which push cars can operate will further assist in this respect. The close grouping of machine, smith, truck and wheel shops will provide for easy supervision forming one very economical feature.

It has been the intention throughout to eliminate all small buildings or sheds. Such structures not only form the nucleus for the addition of other sheds as the plant expands, but bring about a bad operation in supervision and produce excess handling of materials and parts.

It is the committee's recommendation that space inside the main buildings be set aside for toilets, locker rooms, and offices, and thus avoid all leantos and unsymmetrical additions. Toilet and locker rooms can be installed on main floors with offices above very advantageously. An elevated office is desirable as it gives isolation and a good means of supervision.

The reclamation shop has beeen located between the machine shop and the freight car repair shop. This is both a logical and convenient point as parts to be reclaimed will be received from both plants. The scrap bin should also be placed in this vicinity.

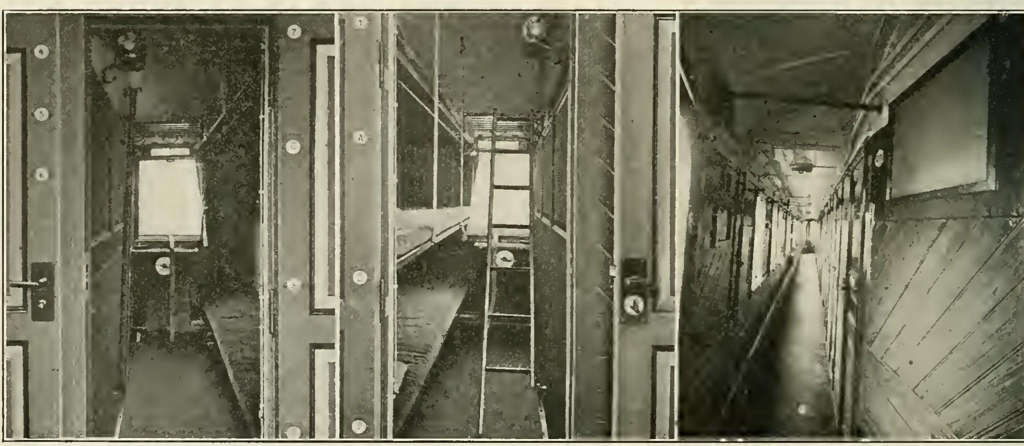
The wood mill, cabinet and pattern shop are logically located between the coach repair and the freight car repair shops, providing free movement for material to either place. The lumber storage is below the coach paint shop and also adjacent to the mill. It is considered that the layout is equally accessible from either end for switching in cars of material.

A "rip" track with drop pit is also suggested, for light work on cars not required to pass through the shop. This has been located near the receiving yard.

Above the passenger car shop a layout has been prepared for a freight car repair plant of considerable size.

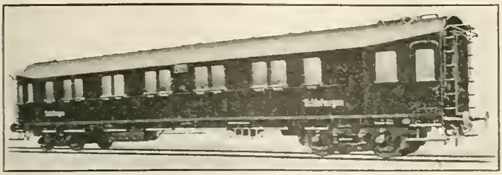
Third Class Sleeping Cars for German State Railways

European travelers in the United States often criticize American Pullman cars because of the lack of privacy accorded the passengers. To Americans, however, the European compartment sleeper, with the berths extending transversely across the car and compartments in which the passenger faces a blank wall, are likewise unsatisfactory. Probably no more striking contrast between American and European equipment could be found than the modern American Pullman car as compared with the third class sleeping cars recently built for the German State Railways by the Linke-Hofmann Works of Breslau, Germany.



Interior of German Sleeping Cars; Compartments Arranged for Sitting and Lying; Looking Down the Side Aisle

In size, the cars are comparable with American rolling stock, the length over the buffers being 70 ft. 4 in. and the width, 9 ft. 5 in. The underframe is of steel and the exterior walls of the body are of steel plate, three millimeters (approximately 1/8 in.) thick. The floor is made of two layers of boards and the interior partitions are of wood.



German Third Class Sleeping Car

The ends of the car are made torpedo-shaped to afford an easy entrance to the car without the use of a vestibule end. The interior is divided into twelve compartments, each having seats and berths for three passengers. There is also a porter's compartment, two toilets and two washrooms. The side passageway is 30 in. wide and extends directly from one end of the car to the other.

Each compartment is 6 ft. 3½ in. by 4 ft. ½ in. There are three berths, 24½ in. wide, placed one above the other. The top and bottom berths are stationary and the center berth is pivoted. During the day the lower berth is used as a seat and the center berth drops to form the back. At night the center berth is held up by fastenings in the wall. Two straps suspended from the ceiling keep the passengers in the upper berths from falling out. The berths have plush upholstery and horsehair stuffing; apparently no springs are provided. Access to the upper berth is gained by a ladder which is swung over against the side of the compartment during the day. The cars are lighted by electricity from a generator mounted on the truck.

The truck construction, as will be noted from the exterior view of the car, is similar to American practice. The trucks have spiral and elliptic springs and equalizers suspended from the journal boxes. Compressed air brakes are used, as is now the standard practice in Germany, with the one brake cylinder for both trucks.

New Features in Service Railway Motor Coach

Unique Type of Truck with Cushioned Wheels—High Seating Capacity Combined with Light Weight

A MOTOR coach especially designed to meet the requirements of railway service has been built by the Service Motor Truck Company, Wabash, Indiana, and is now being operated on demonstration trips over the lines of the Big Four between Wabash, Indiana, and Benton Harbor, Michigan. The power plant and details of the transmission follow regular motor truck practice, but the design of the running gear as well as of the car body is a complete departure from the motor bus type of construction. A seating capacity of 38 passengers is provided in the body the bumpers and 8 ft. 6 in. wide over the posts. The frame is of steel construction throughout and is finished on the outside with steel sheeting. The engine hood, with the exception of the radiator is included in the baggage compartment, which is 8 ft. long back of the hood, and is served by a sliding door on either side. The passenger compartment is entered through a vestibule at the rear end of the car which is fitted with trap and side doors in accordance with steam railroad practice. Each window has two sashes, the lower one of which can be raised, and is fitted with a

The Model 55 Service Coach Drives on All Four Wheels of the Leading Truck

of the car and there are seats for 8 additional passengers in the baggage compartment, which may be folded up against the sides of the car.

Although the total weight of the car does not exceed 13 tons the body is of rugged construction built up on an underframe of four 6-in., 8-lb. channels and it is carried on two four-wheel trucks with power transmitted to both axles of the forward truck. The body is 42 ft. 5 in. long over

Pantasote curtain. Suction ventilators are also provided in the roof. A saloon with a dry hopper and an alcove water cooler is located in the forward left hand corner of the passenger compartment. The car is heated by exhaust gases from the engine carried back through the passenger compartment in thin wall steel tubes, one on either side. The body was built by the J. G. Brill Co., Philadelphia, Pa.

The power plant is a four cylinder, four cycle, valve in head motor with 4½-in. by 6-in. cylinders. This motor has a safe constant operating speed of 1,500 rev. per min. at which it has a rating of 61 hp.; its maximum speed is 1,800 rev. per min. at which it has a power rating of 66 hp. The clutch and transmission are mounted in a unit with the engine and provide three speeds with gear ratios of 4.09 to 1, 1.76 to 1, and 1 to 1. The power plant is mounted between the channel sills at the front of the car and is removable as a unit. The fuel tank has a capacity of 50 gals.

Power is transmitted from the main transmission through an auxiliary transmission mounted in the cast steel swinging bolster of the forward truck, by means of a motor truck type propeller shaft having two universal joints. The auxiliary transmission provides two gear ratios for forward operation, one for 30 miles an hour maximum speed and the other for 40 miles an hour maximum speed. One ratio is provided in reverse, designed to give a maximum speed of 30 miles an hour. This makes a total of six speeds forward and three in reverse. From each end of the auxiliary transmission a motor truck propeller shaft provided with two universal joints transmits the power through a pinion and bevel gear drive to one of the axles of the forward truck.

The most unique feature of this car is the type of truck construction used. The trucks are of the four-wheel type, the axles having inside bearings of the Timken roller type. The truck frames are built up of 6-in. I-beam side rails on which are placed the channel cross members that carry the swing motion bolster. The ends of the side rails are also joined by cross channels with gusset plate connections. The axles are of alloy steel, heat treated and are 3 in. in diameter.

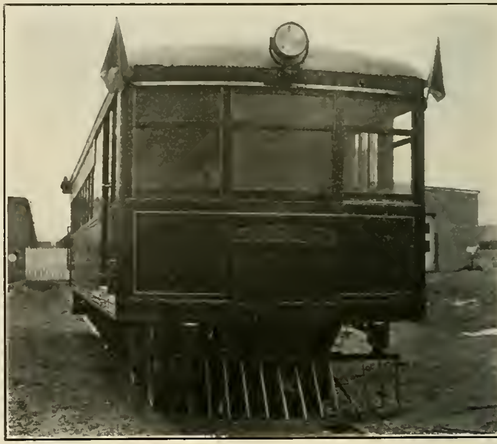

Interior of the Passenger Compartment

The ends are tapered to receive the wheels which are also secured by keys. The axle bearing housings carry the semi-elliptic springs the ends of which are shackled to and support the truck frames.

The wheels on both the driving and trailing truck are of unique construction. The centers are of cast steel with tires of rolled steel 30 in. in diameter over the treads. Between the center and the tire is placed a rubber cushioning element consisting of two rings of rectangular section one on either side of a metal web cast integral with and projecting outward from the middle of the wheel center face. The lateral thrust between the wheel center and the tire is taken by inwardly projecting flanges attached to both sides of the tire, which overlap the wheel center.

Each truck is provided with four brake shoes operated by a link arrangement similar in principle to that formerly employed on the driver brakes of American type locomotives. These brakes are operated by a hand wheel through an irreversible worm and gear, with a pawl for locking the wheel when the car is unoccupied. An independent emergency brake, operating on the propeller shaft drum is also provided. Although not included as regular equipment on the car, Westinghouse traction brake equipment can be installed if desired.

The motorman's seat is located at the left of the engine


The Front End of the Service Coach

hood. The controls consist of a foot operated clutch, a hand operated gear shift, hand operated spark and throttle controls with a foot operated auxiliary throttle, and the hand brake wheel, or brake valve if the car is equipped with air brakes.

On a recent run from Wabash to Elkhart, Indiana, a distance of 68.6 miles the trip was made with an average speed of 28.6 miles an hour and a maximum speed of 45 miles an hour, the total time of the run being 2 hours and 24 minutes. The average fuel consumption was at the rate of 5.3 miles per gallon of gasoline, while the total oil consumption was less than one quart for the round trip of 137 miles. From a standing start the car accelerated to 25 miles an hour in 30 seconds, 29 miles an hour in 1 minute, 35 miles an hour in 2 minutes and 41 miles an hour in 2 minutes and 40 seconds.

The Economic Operation of Superheater Locomotives—Another matter affecting road performance that is too frequently overlooked or ignored is the absolute necessity for employing a pyrometer. In many instances the use of this instrument has been abandoned because of its alleged unreliability. But it is without question that a dependable temperature gage—and there is at least one such on the market—is indispensable to the economic operation of the superheater locomotive. Without it, neither the driver nor the fireman can tell what the degree of superheat is on the road, and consequently the engine cannot consciously be driven and fired in such a way as to produce the best results. It is possible, of course, that the engine may be working economically; but on the other hand, it is far more likely that the reverse will be the case and that no superheat of any value is being obtained. If a superheater is worth fitting at all it is worth being used in an effective manner, and it cannot knowingly be so used unless it is possible at all times to ascertain the steam temperature by means of a pyrometer. The pyrometer is just as essential as the pressure gage and no superheater locomotive can be said to be intelligently handled if it is absent.—F. W. Brewer in The Engineer.

Some Notes on Railway Refrigerator Cars*

Requirements for Efficient Refrigeration; Importance of Air Circulation and Insulation

By W. H. Winterrowd
Chief Mechanical Engineer, Canadian Pacific

THE subject of railway refrigerator cars has been, and is still one of growing importance, a growth that has been contemporaneous and proportional to the development of the United States and Canada and their communities, and to the resultant demand and necessity of transporting increasing quantities of perishable commodities greater and greater distances. When hauls were short and the variety of perishable commodities few, the problem of transporting and protecting the commodities from heat or cold was comparatively simple. Increasing distances and a greater variety of perishables not only made necessary greater numbers of, and more efficient cars, but involved the establishment of railway-divisional and terminal facilities, upon

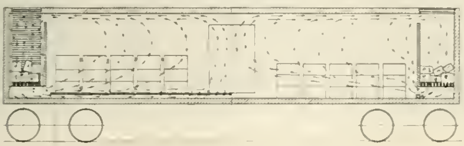


Fig. 1—Diagram of Air Circulation

which the successful operation of this type of equipment is contingent.

Comparatively speaking, literature upon the subject is not vast, although exceedingly valuable. Finding the sources of information to some extent scattered, the writer has attempted to include under one heading some of the most interesting and important facts regarding principles and methods involved, as well as to present some information regarding the type of cars and methods of construction used by various railways and private-car owners.

Refrigeration of Commodities in Transit Involves Many Factors

The prevailing method of obtaining refrigeration is by means of naturally-circulated air, cooled by contact with ice, or ice and salt, placed in suitable receptacles called bunkers located at each end of an insulated car. Some modifications of this system will be touched upon very briefly later.

Circulation is assisted and made most efficient by means of insulated partitions, called bulkheads, placed in front of the containers and so constructed that the relatively warm air must pass over the top of them to reach the ice, or ice containers. The air becoming chilled, and therefore heavier, sinks toward the floor and reaches the body of the car by passing through a space beneath the bulkheads.

These insulated partitions also assist in protecting the lading nearest the ice containers. Without bulkheads, and when salt is used with the ice to hasten and increase refrigeration, that part of the lading nearest the ice frequently freezes, an undesirable and disastrous occurrence with some commodities. At the same time, that portion of the load near the center and top of the car may remain at too high a temperature, an equally undesirable condition.

As a further aid to circulation, particularly in cars where the lading is piled or stacked, a slatted wooden structure known as a floor rack is of very great value. These racks, on the top of which the lading may be placed, consist of longitudinal runners 3 or 4 in. high, with cross slats fastened to the top of them. They are hinged to the side walls of the car and are divided in the middle so that they can be turned up to make the floor accessible. These racks permit the cold air which flows beneath the bulkhead to circulate freely toward the center of the car and up through the lading.

Illustrations of Effect of Design

The *A* end of the car, Fig. 1, shows the relative arrangement of bunkers, bulkheads and floor racks, and the resultant trend of air circulation.

It is highly desirable that there be no obstruction to the flow of cold air where it passes beneath the bulkheads. The *B* end of the car, Fig. 1, shows how an obstruction at that point can act as a dam or deflector of the air currents, and partially or entirely defeat the object of the floor racks, and

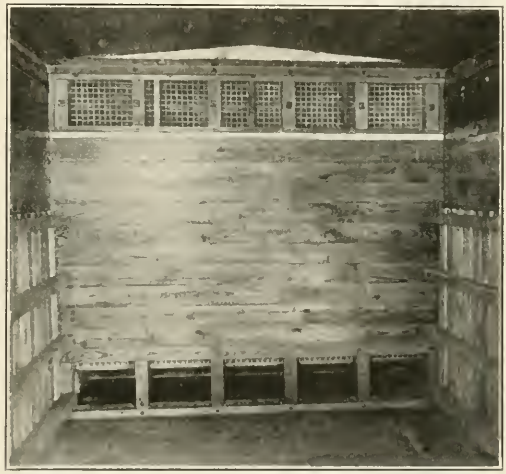


Fig. 2—Car With Fixed Bulkhead and Basket Bunker, Floor Racks Raised

even cause frosting of the lading against the insulated bulkhead. If floor, bunker or splash-board construction necessitates a ledge beneath the bulkhead, it should be kept as low as possible and the floor rack and bulkhead so designed to provide sufficient area for a free flow of air.

At the *B* end the lading is shown piled directly on the floor and the air currents indirectly indicate the advantage of floor racks. Fig. 2 illustrates these racks, showing their appearance when turned up against the side walls.

The method of loading various commodities is an important factor in their proper refrigeration in transit. To obtain the greatest advantage from circulation, the contents of the car should be loaded so that the air can come in contact with a maximum surface with a minimum of restricted circulation. It is easy to understand that boxes or containers, placed

*From a paper presented before the American Society of Mechanical Engineers at New York, May 16, 192?.

closely against each other and against the walls of the car cannot be cooled quickly or properly preserved at as uniform a temperature as when placed so that air can flow between them, or generally speaking, throughout the entire load.

The temperature of the circulating air is affected by the type and size of ice containers or bunkers. The chief considerations in the construction and capacity of the bunkers are the refrigeration required to replace the loss due to transmission and the refrigeration required to cool the car quickly and maintain its contents at the required temperature. The loss in transmission in turn depends upon insulation, car construction and maintenance; factors which will be more fully discussed later.

A basket bunker is shown in the *A* end of the car in Fig. 1, and a box bunker in the *B* end. Brine tanks are shown in Fig. 3.

The sides of the basket bunker are constructed of wire mesh. The bottom consists of a slatted wooden structure. The bunker is placed in position so that air space exists around the outer surfaces, this construction permitting the air behind the bulkhead to come in contact with a maximum ice area, while the open spaces around the bunkers facilitate circulation.

The bottom of the box bunker shown at the *B* end of the car in Fig. 1 is also slatted. The walls are formed by the bulkhead and by the sides and end of the car. In an endeavor to make the refrigerator car more productive and useful for general purposes, some builders have applied collapsible box bunkers. In this design, the bulkhead is swung up, or to one side, and fastened. The slatted rack is swung or folded back against the end of the car. In this

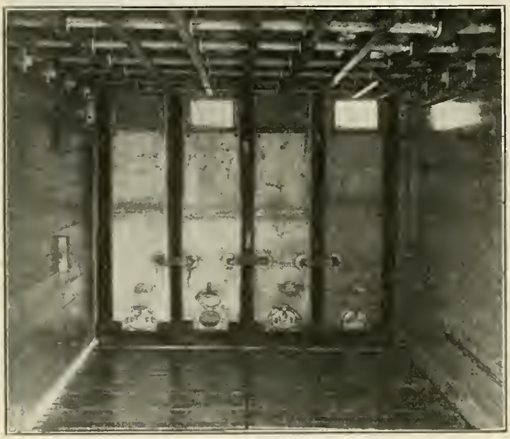


Fig. 3—Brine Tanks in Refrigerator Car, Bulkhead Swung to Side

way the space occupied by the bunker is made available for general lading.

Another very important factor is the size of the car and its proportions, particularly with reference to the distance between the bulkheads. The cold air passing out beneath these insulated partitions flows toward the center of the car. In doing its work it gathers heat and grows warmer. If the distance between bulkheads is too great, the air may not be at a low enough temperature when it reaches the center of the car to properly refrigerate the load at that point, particularly near the top of the car. Under such conditions a portion of the load near the bulkheads may be sufficiently chilled while the upper and center part of the load may be too warm. The chief factors generally considered in this connection are type and capacity of car, type of bunkers, amount of commodities and size of containers, and temperature required for efficient refrigeration.

Importance of Temperature of Entering Load

The temperature of the entering load is a very important factor. If heat is not removed from certain commodities prior to loading it is highly desirable to remove it as quickly as possible after loading. Tests and general experience show that if the heat is not promptly reduced, the commodities either spoil en route or reach their destination in such condition that their market value is greatly reduced. Quick cooling after loading is generally attempted by pre-cooling

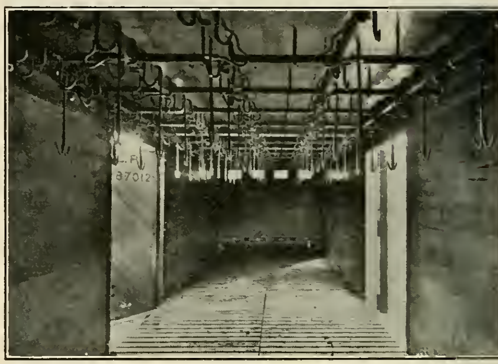


Fig. 4—Meat Rack and Hook Installation

the car, by the use of cars in which maximum and most efficient air circulation can be obtained and by mixing a proper amount of salt with the ice or by placing coarse rock salt on top of the ice.

When salt is mixed with the ice, the greatest amount is used at the first icing, the time when the greatest quantity of heat is in the lading. At the second icing the amount is generally reduced, while at the third and successive icings a stipulated minimum amount is used.

Pre-cooling the car may be accomplished by the use of ice and salt, but at many points where a large tonnage of fruit or meat originate, the cars as well as the lading are often pre-cooled by mechanical means.

Pre-cooling means less ice in transit, a matter of economy to shippers and railways alike. Some commodities can be frozen hard and therefore require little or no icing en route, the lading itself supplying the necessary refrigeration. This not only insures better condition in transit but is an added economy.

Humidity or moisture content of the air in the car is almost as important as temperature. Generally speaking, if refrigeration is effective and a high initial rate of cooling obtained, the air is kept sufficiently dry due to condensation taking place on the surface of the ice, or ice containers. In this way the moisture given off by some classes of lading is also deposited. Excess of humidity, if not fatal, is highly injurious to many commodities.

Insulation Is the Most Important Consideration

Finally we come to the matter of insulation, the most important factor in connection with efficient and economical refrigeration. The function of the insulation is to afford protection to the lading by minimizing heat transmission through the walls, roof, and floor of the car. To do its work properly it must be by nature a poor conductor of heat. Other desirable qualifications are reasonable cost, strength, adaptability, durability, light weight, and imperviousness to moisture.

This subject might well be divided into two parts, insulating materials and insulation, because the general subject involves methods of car construction and maintenance in addition to the consideration of materials and principles of heat transmission.

The whole subject is capable of analysis but that the principles involved are not broadly known is indicated by the fact that in very recent years cars have been built without proper or sufficient insulation. These cars which do not properly protect their lading are huge consumers of ice and, moreover, are expensive to operate and require a great deal of maintenance in order to keep them in service.

Summation of Requirements for Efficient Refrigeration

It is evident that an efficient and economical railway refrigerator car is one which provides adequate air circulation, adequate protection to the lading, adequate quantity and degree of refrigeration, quick initial cooling, uniform temperatures, dry air, space to permit proper methods of loading, and good car construction to minimize maintenance and increase time in service.

(An abstract of the remainder of Mr. Winterrowd's paper will be published in the next issue.—Editor.)

Important Factors in Freight Car Design*

Capacity of Truck Springs and Draft Gear; Size of Center Sills and Location of Center Line of Draft

By Louis E. Endsley

Consulting Engineer and Professor of Railway Mechanical Engineering, University of Pittsburgh

In the design of a freight car, there are two distinct problems to be taken into consideration. One is the direct vertical load and the other is the shock or pressure produced between the cars when they come together at varying speeds. Let us consider first the direct vertical load.

There are some parts that need to be heavy to absorb the shocks of the direct vertical load, but none of the parts above the springs should receive shocks therefrom. What I mean by shock is that force which is produced after the part which is designed to give under varying movements of the car, has gone solid. These parts in the direct vertical design are the springs. I am confident that the springs should be designed with a greater capacity than some designers are now using. Some cars are now designed and put in service with the capacity of the spring only 160 per cent of the normal weight of the car and lading, normal weight being considered as the load on the springs when the car is standing still. In my opinion, this capacity of spring should not be less than 200 per cent and 250 per cent would probably be better. That is, only 40 per cent of the total movement of the spring should be taken out of the spring when the car is loaded and standing still.

Tests of Truck Spring Action

In some tests that I made on the Pennsylvania Railroad in 1914, I used a recording arrangement to determine the movement of the bolster up and down upon the springs, with respect to the side frame. By the use of calibrated springs I was able to determine whether the springs went solid and if they did not go solid, the maximum force upon the side frame. I used for this series of tests two different capacity springs; one set had a capacity of a little more than 200 per cent of the normal load and the other had a little more than 300 per cent of the normal load. In the 200 per cent capacity springs, in trips of the car between Pittsburgh and Alliance, many solid impact blows were delivered between the bolster and side frame, that is, the springs went solid many times.

This solid impact never occurred from one low spot in the rail or crossover, but was an accumulation of vibration up and down on the springs, usually from synchronizing of low spots in the rails or from vibration, up and down, of the car synchronizing with one revolution of the wheel. It usually took 30 up and down vibrations as shown on the recording apparatus, to cause the springs to go solid. The other set of springs, which were 300 per cent of the normal load, never went solid. In fact, there was only one impact recorded that was over 225 per cent of the normal load. This car was run both in local and fast freight. The total movement of the springs, free to solid, was 1¾ in. on the 200 per cent capacity springs and 1⅛ in. for the 300 per cent capacity springs.

This is a point which I wish to emphasize. I am of the opinion that some designers allow too much movement in the car, up and down; that is, allow too much spring travel. I am of the opinion that an inch travel or thereabouts of the spring will give less chance for excessive impact blows than if we used two inches or thereabouts.

The two sets of springs which I referred to before were of the same total height, but the free movement was reduced on the heavy capacity springs due to the increase in capacity. If, as I said before, a designer uses a capacity of 160 per cent of the normal load and the springs are designed for a maximum stress of 80,000 lb. per sq. in., he will have ⅝ of that stress upon the spring when the car is standing still, or 50,000 lb.; while if he uses a 250 per cent capacity spring, he will only have a stress of 32,000 lb. per sq. in. when the car is standing still. This last spring will not be under nearly as heavy strain; the breakage of springs will, in my opinion, be materially reduced, and we will get very few impact blows upon the bolster and side frame of the freight car.

Effect of Shocks on Side Frames

Of course, those parts of the car which are below the springs, namely the side frame, need some extra weight in them, due to those parts coming into contact with any abrupt irregularity of the track and producing an impact blow, due to the side frame's own weight; but on those parts above the springs, if they do not go solid, the design is easy from a direct vertical standpoint. In some tests that I ran some years ago to determine the effect of the impact blow upon the side frame, after the springs went solid, I mounted in the standard M. C. B. drop testing machine a cast steel side frame. This side frame was supported upon blocks of wood to represent in a way the give of the track and was mounted also upon the 17,000 lb. anvil of the standard M. C. B. machine, which in turn is mounted on springs. A 9,000 lb. weight was allowed to drop and strike upon two ends of a short improvised bolster which rested upon the standard set

*Abstract of an address delivered before the Virginia section of the American Society of Mechanical Engineers, at Newport News, Va., April 7, 1922.

of springs that were supported by the side frame. I found that a drop of this 9,000 lb. weight of 12 in. would just put the springs solid. If I raised the hammer another inch, or 13 in., and then dropped it, the side frame, which had an elastic limit of double the spring capacity, would take set. In other words, it only takes a little more energy than that necessary to close the springs to cause some very excessive forces. This is what is occurring in some cars when the bolster springs go solid. so that if you design a car with springs that go solid, you are somewhat in the dark as to the stress being produced in the car. It is perfectly safe to use a stress of 16,000 to 18,000 lb. per sq. in. in the underframe of the car from a direct vertical load standpoint, if you know with certainty the force coming upon the springs, but if the springs are going solid, it may be necessary to use a stress of only 10,000 lb., or in other words, a factor of safety of considerably more than that which would be necessary, if the springs were not going solid.

Design of Underframes

In the detail of the design of the underframe, I am of the opinion that rolled members will give more satisfactory and more uniform results than will pressed sections. This is due to the fact that the corners of the rolled section materially add to the strength of the member, and also pressed sections are not as a rule as straight and uniform as the rolled sections.

With regard to the forces which come upon the car due to their being switched or allowed to run into another car, there are some other problems which have not as yet been solved, but we are here confronted with the same problem that we are confronted with in the bolster springs. If we had a draft gear in each car that would never go solid without a pressure above the coupler and sill strength, when it came into contact with another car, we would have the problem practically solved, but as we have never yet been able to keep our switching speeds below the impact point, we are confronted with the same problem, by reason of the impact, which is indeterminate after the draft gear goes solid. Some years ago we used a wooden underframe for our freight cars, and the line of draft was considerably below the center line of sills due to the fact that the sills were upon the body bolster and raised the center line of sills. Now, when we have steel construction and the sills of the car and the body bolster can be on the same horizontal plane, we are able to get the line of impact almost in the center line of sills in car. We have, though, taken away some of the relieving qualities which allowed the old wooden frame to bend and give, for wood, having a much lower modulus than steel, gives approximately 15 times as much under the same stress as steel, and this mere fact made the underframe of the old wooden car quite a giving medium. Today, the underframe of the car, if strained from end to end, above its elastic limit, will give less than one inch, while the old wooden car would give more than two inches and not overstrain it, and the old wooden car and its lading was much better protected than the new cars with the steel underframe.

Today we are attempting to put in a draft gear that has a travel of two or more inches, most of the draft gears having something like 2¾ in.. some draft gears have been constructed with 3½ in., and a few have been built with 4¾ in. In my opinion, we are now ready for an increase in the travel of the draft gear itself, because if we attempt to absorb in the average travel of say 2¾ in. we are expecting entirely too much of the draft gear. In other words, to get the capacity that is necessary out of the 2¾ in. travel draft gear will require. if the line is a straight line relation, between movement and pressure, a very excessive final pressure, or above that which any designer has yet obtained, while if we should go to 4½ in. or 5 in. travel, we could design a draft gear of almost four times the capacity of the 2¾ in. travel and still have no greater increase in the relation between pressure and travel.

Relative Strength of Center Sill Channels

The weight of the underframe today has been increased for the protection mainly of the impacts between cars. In some tests which I made a few years ago, it was found that two 30-lb. 12-in. channels with a cover plate of 5/16 in. will stand an impact force of over 1,200,000 lb.; while if these channels were of the same weight and 15 in., the web and flanges were thinner and did not give as high an impact force as the 12-in. channel. Some designers have gone to the high channels for the mere purpose of protecting the car from the vertical oscillation, while if they would go to a heavier capacity spring in the truck they could still retain the 12 in. channel of less weight and have as good impact and absorbing medium as if they had the 15 in. channel.

We now have a standard coupler which is a very good coupler. This coupler is of such strength that we will have to design the underframe of the car a little stronger than we have been designing it in order that the underframe will be of greater strength than the coupler, because the underframe should be stronger than the coupler, as it is much cheaper to replace a coupler than to repair the underframe.

Importance of Draft Gear Capacity

I am of the opinion that we should take steps to keep our draft gear capacity up so that we can keep in the service longer the old and medium weight cars. If our old cars have an impact capacity of only 600,000 or 700,000 lb., and we design cars with a new underframe that has a capacity of over 1,000,000 lb. and these cars come in contact, without an adequate draft gear in each of them, there is not much doubt which one of the cars is going out of commission. As long as we keep together two cars of equal strength, they will stand a great many impact blows in the switching, after the draft gear goes solid, but when they come into contact with cars of greater capacity, the old cars will go out of commission very fast; while if we should design the new cars with draft gear and arrangements that would take care of a reasonable switching speed, we would keep in service many cars which are now going out of service. Today we have draft gears which will take care of switching speeds between 3½ and 5 miles an hour when new, but unless they are kept under repairs, this speed at which they will protect the car will be reduced considerably. After the draft gear goes solid, as with the springs, it does not make any difference how strong you make all the parts of the car, you will still be overstraining them if the switching speed is sufficient to close the draft gear.

An important thing to be kept in mind in the design of a car is to get the line of draft as near the center of the channel that makes up the underframe as possible. Some designers have felt that it should be slightly below the center of the channel, but I believe that an inspection of bent underframes will show the weakest point of the car is just behind the bolster on the bottom of the sills. This is due to this point being under compression, due to the direct vertical load, also due to the impact on the end of the car. If the center line of draft cannot be put upon the center line of sills, it would be better to put it a little above than below.

Some designers are attempting to design the draft gear and attachments so that they can be easily taken down and inspected and repaired, but some roads do not seem to appreciate the benefit of keeping the draft gears in repairs. I believe that taking out the slack, which is bound to be produced by bending of parts after the draft gear goes solid, should be practically carried out; in this way we would be able to materially reduce the uncontrolled slack in operation of cars as, in my opinion, there is a marked difference in uncontrolled slack of a long train and draft gear travel.

MACHINE TOOL AND SHOP EQUIPMENT SECTION

Heavy Duty Boring and Turning Mill

MANY improved features have been incorporated in the new line of boring mills, manufactured by the Colburn Machine Tool Company, Cleveland, Ohio, making these machines powerful yet easy to control and therefore well adapted for use in railroad shops. The machines are made in sizes from 36-in. to 84-in. swing inclusive, the following description pertaining to the 42-in. mill which is representative.

The actual swing of the 42-in. mill is 44 in., 36 in. under the cross rail and 41 in. maximum distance between the table and lower face of the turret. The table is 40 in. in diameter cast solid (not cored underneath) and provided with both parallel and radial T-slots. The table spindle has a chilled cast-iron angular bearing of large diameter at the top which makes it self-centering. This, in combination with the large vertical bearings, effectively resists all tool thrusts and strains. Two swivel heads can be provided as shown in Fig. 1, or one swivel and one turret head as shown in Fig. 4.

The drive consists of a primary and secondary speed unit, the secondary unit being located within the bed or base, where three changes are obtained. The primary unit constitutes the feed change gear box and provides four additional changes, thus giving a total of 12 speeds. These speeds range from $2\frac{1}{4}$ to 70 r.p.m. in geometrical progression, being easily available by means of levers within easy reach of the operator when standing at the right-hand side of the machine.

The cross rail is of the narrow guide bearing type being raised and lowered by power independently of the table drive. The heads are entirely independent in their movements both as to direction and amount of feed and each is operated by a Colburn Swastica control through separate feed boxes. Either head can be brought to the center of the table for boring, the exact central position being determined by a positive, hardened center stop.

The turret head is moved horizontally and vertically in the same manner as the swivel head, the turret slide having a vertical travel of 26 in. The five-sided turret is 13 in. in diameter with holes to fit tool holder shanks $2\frac{1}{2}$ in. in diameter. The turret is tilted to an angle of eight degrees

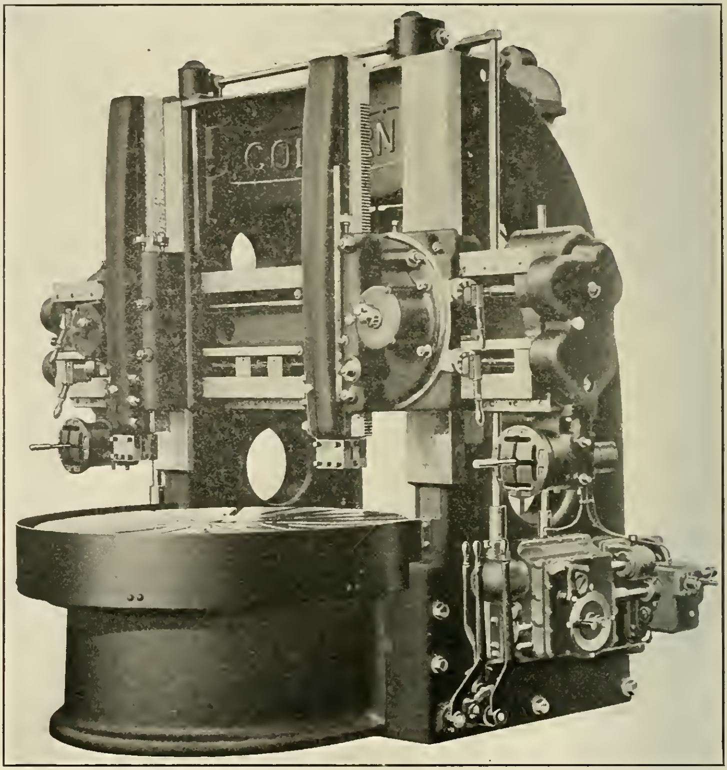


Fig. 1—Colburn Vertical Boring and Turning Mill with Two Swivel Heads

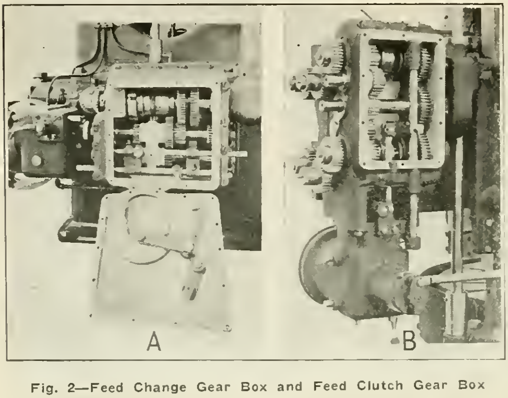


Fig. 2—Feed Change Gear Box and Feed Clutch Gear Box

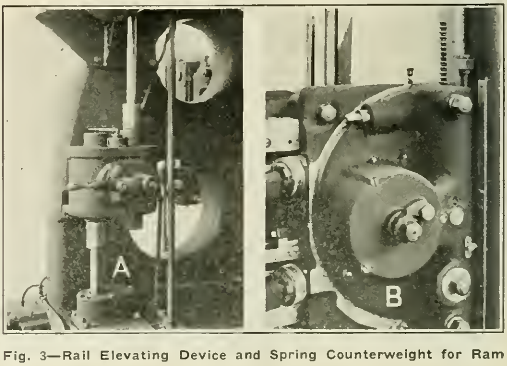


Fig. 3—Rail Elevating Device and Spring Counterweight for Ram

which gives ample clearance for large tools when swung over the slide. Rams on the plain head swivel 45 deg. either side of the vertical position, graduations on the swivel, indicating the angle. The rams have a vertical and angular travel of 30 in. Angular adjustment of the ram is accomplished by means of a worm and segment both wholly enclosed in the head. A rapid and convenient means for

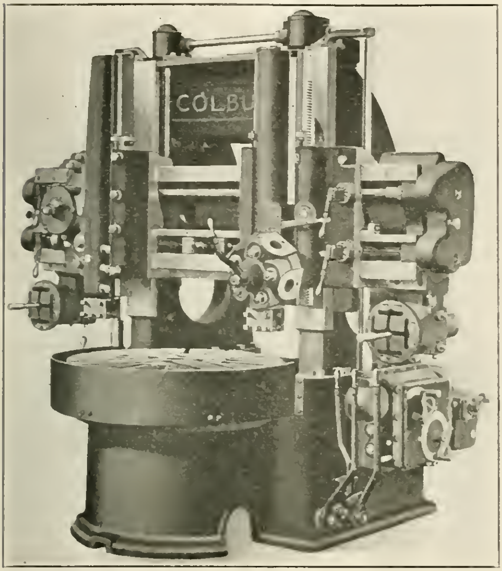


Fig. 4—Colburn Mill with One Turret and One Swivel Head

setting the ram at any desired angle is thus afforded, also acting as a safety lock to prevent tipping when the swivel clamping bolts are loosened.

The complete control for each head and ram for both feed and rapid traverse is obtained by a single lever. The lever is always thrown in the direction of the movement desired, whether it be feed or traverse. This control is so designed that when the rapid traverse is engaged the feed is disengaged and vice versa. Furthermore, the rapid traverse always operates in the opposite direction from the feed in each slot shown on the control plate. Sixteen changes of feed in horizontal, vertical or angular direction are obtained ranging in geometrical progression from .006 to 1 in. per revolution of the table.

The feed change gear box, illustrated at *A* Fig. 2, shows the cam arrangement for shifting the gears. Immediately to the left of the open gear box is the feed multiplying gear which works in conjunction with the first mentioned gear box, the gears of which are controlled by the lever *Z*. The feed clutch gear box is illustrated at *B* Fig. 2 which shows the connection to the single lever control; also the method of engaging clutches through this control.

The rail elevating device is shown in a close-up view at *A* Fig. 3. This device consists of friction clutches and gears contained in one compact unit and controlled by the single lever shown. The spring counter-weight for the ram, illustrated at *B* Fig. 3, is a patented device eliminating the use of weight, cables, sheaves, wheels, etc. The spring is heavy and has been given a thorough try out. The ratchet adjustment is simple, providing a ready means for proper counter-balancing the ram when heavy tools are used.

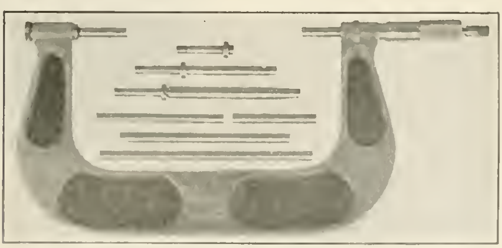
Power rapid traverse permits the heads and rams to be moved horizontally, vertically and in angular directions by power at the rate of approximately 12 ft. per min. The rapid traverse may be operated with the table in motion or at rest. Final adjusting ratchets for vertical and horizontal movements are mounted on the heads and carry adjustable micrometer dials, reading in thousandths of an inch.

Great attention has been given to the proper lubrication of this machine and a large amount of space would be necessary to describe in detail its automatic gravity flow lubricating system. All units not automatically lubricated run in oil baths and require only periodic attention. Single pulley or motor drive by means of a 10-hp. constant speed electric motor running at 1,200 r.p.m. can be provided. The brake is operated by a starting and stopping lever permitting the operator to stop the table instantly at any predetermined point. The brake is on the prime mover, strains resulting from stopping quickly not being transmitted through the gearing. The safety of both operator and mechanism have received careful attention and the table is guarded and gearing enclosed as illustrated. All speed changes are readily made from the regular working position. A starting and stopping lever is located at the front on both sides of the bell and the brake is operated simultaneously with the disengagement of the driving clutch.

Micrometer Calipers With Increased Range

To provide an accurate micrometer caliper for measurements from 2 in. to 6 in., the Brown & Sharpe Manufacturing Company, Providence, R. I., has changed the range of its micrometer caliper No. 55. The increased range of measurement is obtained by four anvils furnished with the micrometer. These anvils are easily and quickly changed, being held positively in place by a knurled nut. One anvil is for measurements from 2 in. to 3 in., another from 3 in. to 4 in., and so on.

The need for a tool of this range has been brought about by the introduction of small pistons in the automobile motor but the tool is by no means limited to that field of usefulness, there being many occasions when micrometer calipers of this range are needed in railway toolrooms. The new tool measures the same range of work as a more expensive set of three or four micrometers. In general construction it is similar to other Brown & Sharpe micrometer calipers, the readings being easily and quickly taken. The shape of the frame is especially well adapted for all around use, enabling it to be conveniently handled.



Brown & Sharpe No. 55 Micrometer with Increased Range

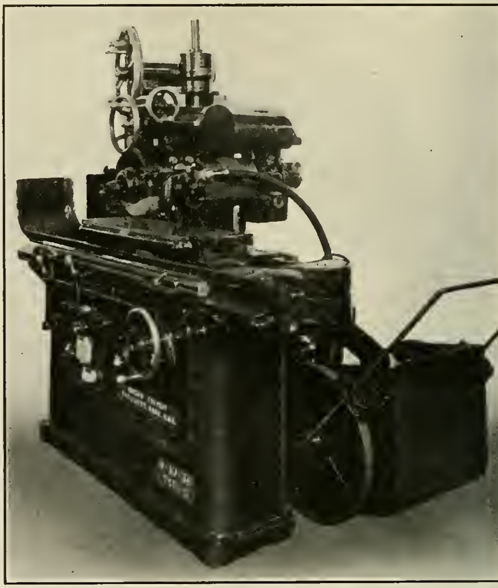
Universal and Openside Surface Grinders

TWO new grinding machines, including a 12-in. by 36-in., type *L* universal multi-purpose grinder and a 6-in. by 10-in. by 36-in., type *G* openside surface grinder have been brought out recently by the Norton Company, Worcester, Mass. These machines embody the latest features of Norton design and are both self-contained. The universal machine is arranged for single pulley drive either from a line or countershaft, or direct from a motor, while the surface grinder is driven by a motor bolted to its base. The simplicity of the set-ups for various grinding operations on the universal machine such as for internal grinding, taper grinding, grinding a bevel collar and face grinding makes this machine desirable for railway toolroom work where many jobs other than straight tool work are sometimes handled.

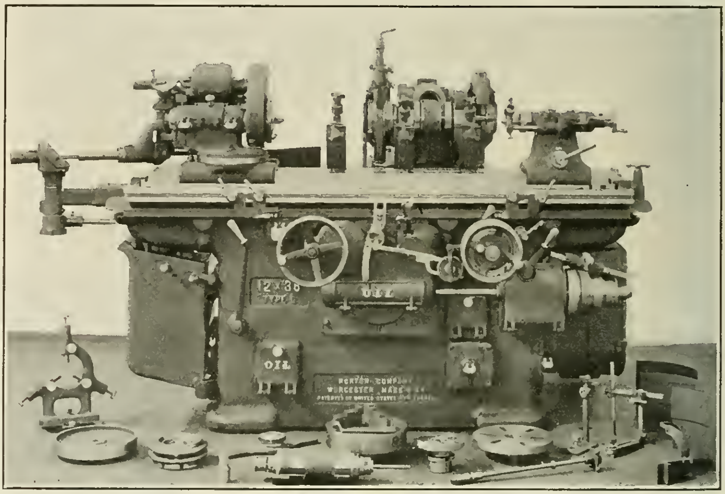
An important feature embodying new ideas of design is the method of transmitting power from the countershaft in the base of the machine to the wheel spindle. This is done in such a manner that the belt passing up over idler pulleys can be twisted to any of the positions to which the wheel head may be set either for regular or internal grinding. This arrangement of the driving belt to the wheel spindle has made it possible to make the wheel head double-ended, carrying the regular wheel spindle at one end and an internal grinding spindle at the other. As will be seen from the illustration the drive to the headstock is through a blind shaft. Six work speeds ranging from 53 to 320 r.p.m. are obtained by a bank of gears and a sliding key contained in the headstock, all work speeds being entirely independent of the table speeds or wheel speeds. The headstock spindle is hollow so that rods up to 3/4 in. in diameter may be passed through. Provision is also made so that the center may be rotated or stopped as required.

The type *G* openside surface grinding machine has been designed for the rapid production of precision work. This is a powerful machine for its size and is adapted to the grinding of many flat faces on motion work and the machine parts of locomotives. Particular attention is called to the improved spindle bearing construction with flood lubrication and thumb screw adjustments. The wheel spindle is designed to eliminate sticking and requires no attention once the thumb screws are adjusted while the wheel is rotating at its normal speed.

Other features which merit special attention are the compactness of design, convenience of operation and high table traverse speeds which assure high production. The latter point is emphasized by the size of the wheel and the diameter and width of the spindle pulleys. These are of ample size to utilize all the power of the 15-hp. motor which is provided to drive the machine. It will also be noted that the grinding lubricant is contained in a portable tank which can be cleaned in a moment without serious interruption of the productive use of the machine. While the capacity of this grinder is to grind flat surfaces 6-in. by 10-in. by 36-in. work 8½-in. wide may be ground. The speed of the table is 80½ ft. per min. The hand table traverse engages automatically when the power traverse is thrown off. The wheel spindle makes 1,342 r. p. m., providing a surface speed on a 10-in. wheel of 3,515 ft. per min. The wheel is 3 in. thick. The spindle end thrust is taken up by a hardened steel flange between bronze washers, thumb screw adjustment being provided. The recommended speed of the main driving shaft is 815 r. p. m., the diameter of the driving pulley being about 14 in.



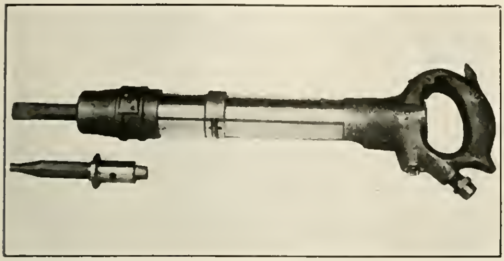
Six-In. by 10-In. by 36-In. Type G Openside Surface Grinder



Norton 12-In. by 36-In. Type L Universal Multi-Purpose Grinder

Pneumatic Tool for Removing Rivets

A PNEUMATIC tool for removing rivets, known as the Thor No. 90-S rivet buster, has just been placed on the market by the Independent Pneumatic Tool Company, Chicago. This is a substantial tool, as shown in the illustration, being similar in design to the Thor riveting hammer. It can be operated by one man instead of three and used in close quarters. The tool is well adapted for cutting off and backing out rivets of all sizes, its greatest value to railroad men being in the dismantling of steel cars.



Easily-Operated Thor Pneumatic Rivet Buster

The operation of this tool by one man instead of three results in a considerable labor saving. Rivets can also be cut in more difficult corners and there is less possibility of damaging the steel plates.

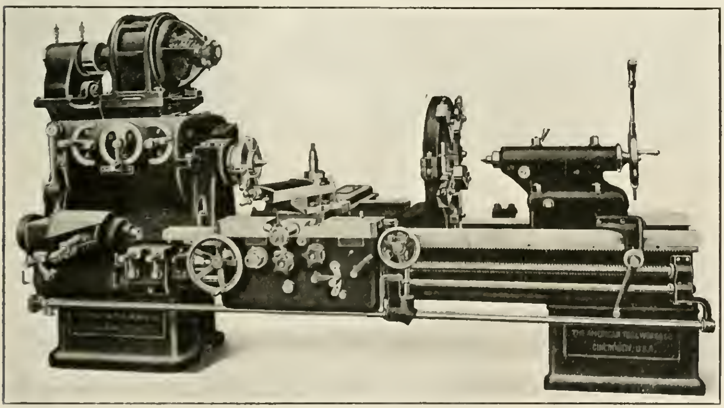
On account of the blows being rapid but not so severe the plates do not buckle at rivet holes, thus wasting expensive material as is often the case with the old style heavy three man buster. The Thor machine is designed to cut the rivet off smoothly at the surface of the sheet without disfiguring or spoiling the material.

The chisels and backing out punches are provided with individual safety retainers and can be quickly changed in the hammer from cutting off to backing out without disassembling the small retainer from the shank.

Engine Lathe with New Head and Motor Drive

A 24-IN. heavy pattern lathe with patented 12-speed gear head arranged for motor drive has been placed on the market by the American Tool Works Company, Cincinnati, Ohio. The interesting feature about this new lathe is the new design of head which now provides 12 speeds instead of 8 speeds, as formerly.

The automatic oiling system employed is also a new development, said to be a decided improvement in the lubrication of geared heads. By means of a geared pump, accessibly located inside the head, the oil is pumped from a reservoir in the bottom of the head to a filtering and distributing tank in the head cover. After the filtration takes place the oil gravitates to the various head bearings through oil pipes leading from the filter reservoir. Since the oil pump supplies considerably more oil to the reservoir than the bearings will consume, the surplus overflows and cascades over the gear teeth, thus keeping them constantly lubricated with clean oil. In order that any impairment of this circulating system may be immediately detected, gage glasses are supplied which indicate the oil levels and show the circulation of the lubricant. This new head is under instant control through either of two levers, one located at the right side of the apron, the other at the left side of the head. These levers operate the powerful friction clutch incorporated in the driving pulley or the driven gear of the motor train if motor driven. A powerful external band brake operates in unison with the friction clutch and is engaged when the friction is released, and vice-versa, consequently the spindle may be instantly stopped or allowed to drift when the driving friction is released, and in addition may be securely locked in its stationary position by means of the brake, thus guarding against the accidental starting of the spindle through possible drag of the friction.



American 24-In. Engine Lathe with New Geared Head and Motor Drive

Another valuable feature of this new head is that by the removal of one gear unit and its operating lever, it can be simplified so as to produce 4 speeds instead of 12, for the satisfactory use of a variable speed 2 to 1 or 3 to 1 motor instead of a constant speed motor.

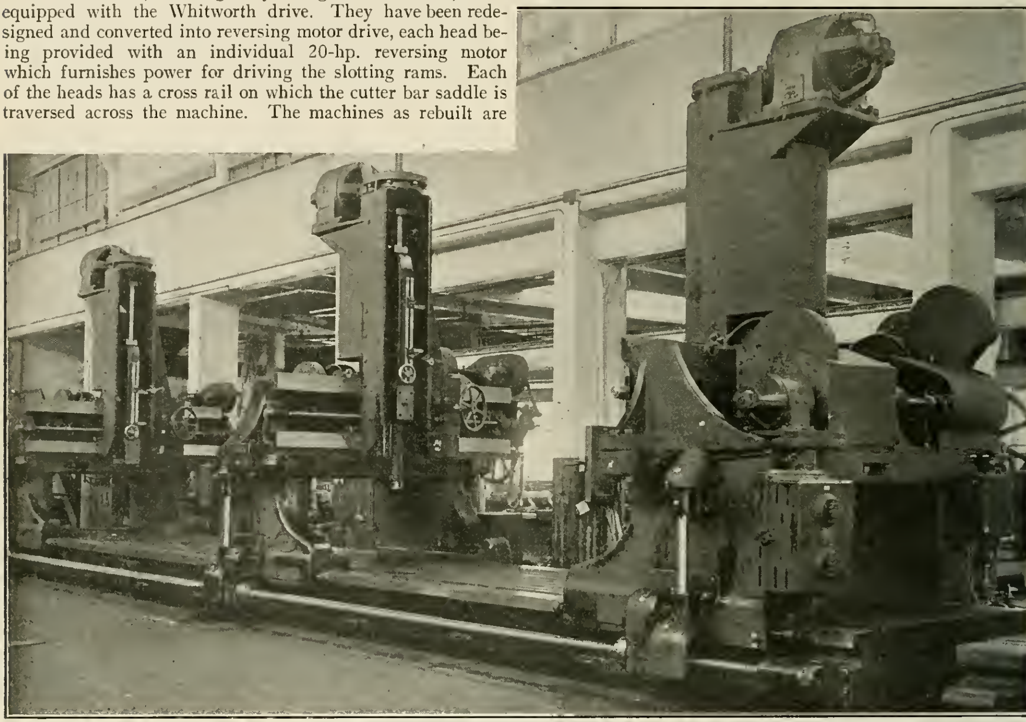
The new motor drive connection adopted is also of interest, consisting of three steel herringbone gears with a patented flexible coupling between the motor shaft and the pinion which permits the motor armature to float without crowding the gear. This construction tends to provide a smooth-running, long-lived mechanism, and inasmuch as the entire unit is completely housed in and operates in an oil bath, it is practically free from noise.

The modern engine lathe, of which this machine is a good example, is used so commonly in railroad shops that there is a tendency to underestimate its importance. Manufacturers are to be commended for developing those refinements in engine lathe design which increase production, thereby decreasing the cost of railway machine shop work.

Heavy Locomotive Frame Slotting Machine

THE illustration shows one of two locomotive frame slotting machines which were recently redesigned and rebuilt for the Dunkirk plant of the American Locomo- Company by the Betts Machine Company, Rochester, N. Y. These machines are used primarily for slotting out frames for new locomotives, and are also used quite extensively in repair shops for various kinds of work in connection with the rebuilding and repair of locomotives.

The machines, as originally designed and built, were equipped with the Whitworth drive. They have been redesigned and converted into reversing motor drive, each head being provided with an individual 20-hp. reversing motor which furnishes power for driving the slotting rams. Each of the heads has a cross rail on which the cutter bar saddle is traversed across the machine. The machines as rebuilt are



Triple Head Locomotive Frame Slotter Redesigned and Rebuilt by the Betts Machine Company

provided with modern electric power feed, each head having its individual $7\frac{1}{2}$-hp. motor which also furnishes power for rapidly traversing the head on the cross rail and the housing on the bed. The bed is 7 ft. wide and 50 ft. long and there are three slotter heads which span its working surface.

One of the important features of this machine as it has been rebuilt is the provision made for slotting at any angle. The saddle can be traversed along the cross rail and the housings traversed along the bed in either direction with both feeds engaged at the same time, having independent adjustment providing for slotting at any angle desired.

By changing the machine over to reversing motor drive with electric feed and modernizing the machine, an increase of at least 25 per cent in output is said to be obtained.

Angle Compound Steam-Driven Air Compressor

THE new air compressor illustrated is made in capacities from 1,000 ft. up by the Sullivan Machinery Company, Chicago, and represents the latest type of compressor developed by this company. It is a single steam cylinder machine of the modern four valve type in which the steam travels in a direct path from inlet to exhaust, and in which initial condensation is said to have been largely eliminated. Some original and peculiar advantages are embodied in the design in conjunction with the angle compound principle which has been so successful in compressors of the belt-driven and direct-connected types during the past ten years.

The steam valve gear side of the machine is illustrated in Fig. 1 which shows the single high duty steam cylinder placed in the rear of and in tandem with the low pressure air cylinder, the high pressure air cylinder being in a vertical plane. A heavy fly wheel, better shown in Fig. 2, is mounted on one end of the crank shaft so as to impart a smooth and even motion to the machine. A single crank pin drives both low pressure and high pressure pistons. All moving parts of the compressor proper are provided with positive automatic lubrication.

The low pressure cylinder is directly attached to the main horizontal frame, the other cylinders being supported and firmly bolted in correct alinement with the main frame.

The main bearings are made in four parts of cast-iron lined with babbitt and arranged for ready adjustment and removal without taking out the main shaft. The steam cylinder is of the Sullivan high duty type. The cylinder casting contains the exhaust ports, placed near the bottom of the bore, and at some distance from the cylinder ends. The cylinder heads contain the steam ports into which the steam valve cages are pressed. The entire head is utilized as a reservoir for the steam so that the head temperature is the same as that of the steam entering the cylinder. The admission ports are placed at the bottom of the heads and extend below the bore of the cylinder to permit any condensation entrapped after the exhaust valves have closed, to escape into the head. The steam cylinder is lined with 85 per cent magnesia and sheet steel.

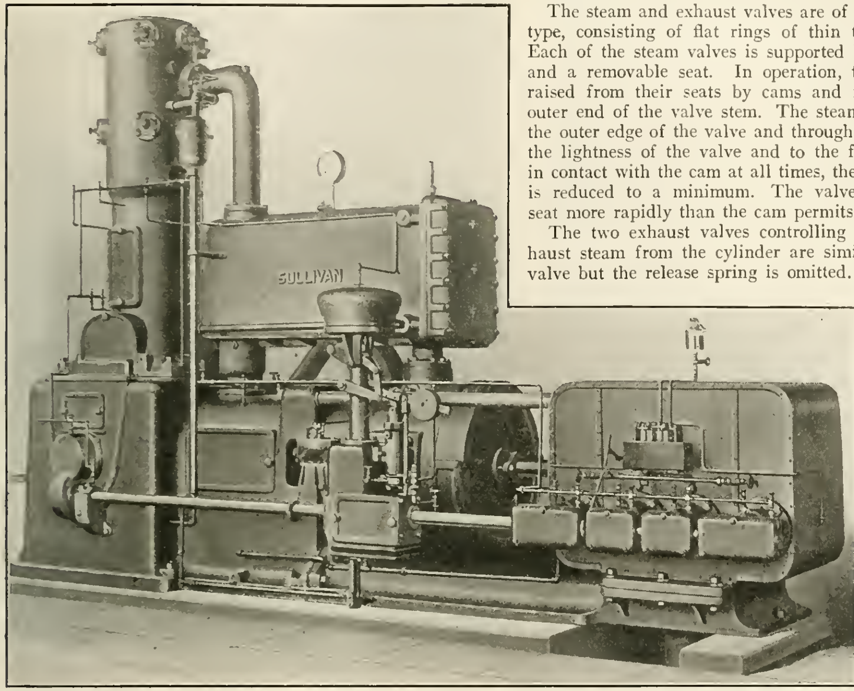


Fig. 1—View Showing Steam Valve Gear Side of Sullivan Air Compressor

The steam and exhaust valves are of the Sullivan "wafer" type, consisting of flat rings of thin tempered alloy steel. Each of the steam valves is supported by a fore-arm spider and a removable seat. In operation, the steam valves are raised from their seats by cams and rollers acting on the outer end of the valve stem. The steam is admitted around the outer edge of the valve and through its center. Owing to the lightness of the valve and to the fact that the roller is in contact with the cam at all times, the tendency to hammer is reduced to a minimum. The valve cannot move to its seat more rapidly than the cam permits.

The two exhaust valves controlling the discharge of exhaust steam from the cylinder are similar to the admission valve but the release spring is omitted. The steam and exhaust valves are operated by cams acting against the rollers mounted on the outer ends of the valve stems. These cams are set on a motion rod running the entire length of the compressor and deriving its motion from the crank-shaft by means of spiral gears. The operation of the valves is controlled through this rod by the speed and pressure governor.

The inlet and discharge valves on both low pressure and high pressure cylinders are of standard wafer design, consisting of plain flat rings of special alloy steel resting on carefully ground seats of the same shape. These valves are fully automatic, being held to their seats by air pressure and returned after opening by the flat helical springs.

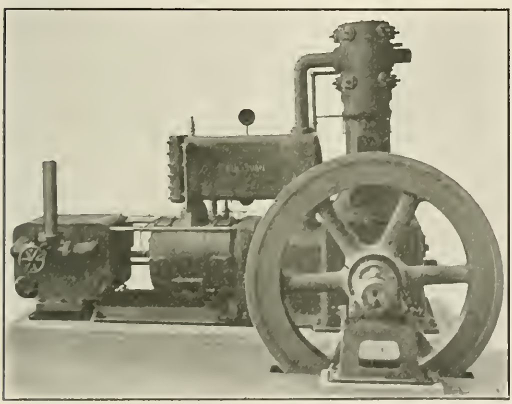


Fig. 2—View from Opposite Side Showing Heavy Fly Wheel

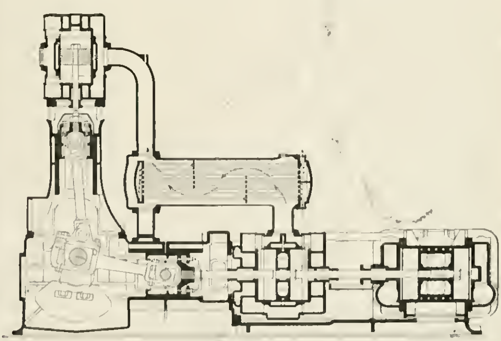


Fig. 3—Section Through Center Line of Compressor

The intercooler for removing the heat of compression in the air discharged from the low pressure cylinder (see Fig. 3) is a substantial cylindrical cast-iron shell designed to contain an amount of cooling surface sufficient to produce thorough cooling of the compressed air. It is located immediately over the low pressure cylinder and frame as shown.

The inner cooling surface consists of a nest of copper or aluminum tubes through which the cooling water circulates entering at one end, traversing one-half of the tubes and returning through the remainder. By removing the bolts securing the outer header the whole nest of tubes with the header may be withdrawn for inspection and repair.

The crank shaft bearings, crank and crosshead pins and crosshead guides of both high and low pressure rear end members are provided with stream lubrication. The air cylinders and steam cylinders are oiled from a two compartment positive oil pump at a fixed speed.

Portable Universal and Triplex Radial Drills

SEVERAL types of radial drilling machines of improved modern design have been developed by William Asquith (1920), Ltd., Halifax, England. These machines include a portable universal radial drill illustrated in Fig. 1, a 7-ft. and an 8-ft. central thrust elevating arm boiler shop radial, and a triplex radial drilling machine illustrated in Fig. 2. The first machine is made in two sizes of 4 ft. 9 in. and 5 ft. 9 in. radius respectively. A traveling bogie is usually provided as shown in the illustration but if required, a special base can be arranged for bolting to the shop floor. The machine is particularly adapted for boiler drilling operations, having ample power for the work and the desired range of feeds and speeds which are easily controlled.

Six changes of speed are available from 41 r.p.m. to 300 r.p.m. through a three-speed gear box and double gear on the drilling head. A special reversing motion enables taps to be withdrawn at approximately three times the speed of insertion, this quick reversal being obtained automatically without changing the speed in the gear box. The radial arm can be traversed across the column easily by means of a hand-wheel; it can also be elevated on the column by either hand or power. Secure locking devices are provided for each of these movements. The column is of strong section, being fitted at the top with a plug carrying the lifting hook. Drive is by means of a 3 hp. self-contained reversible motor mounted on the arm end plate through a single pulley and gear box.

The triplex radial drilling machine, illustrated in Fig. 2, consists of three radial units and is employed to advantage for drilling holes in boiler fireboxes and similar work. A pit is arranged at the front of the bed to accommodate the larger boilers and other deep objects.

The drilling heads have power adjustments along the bed either simultaneously or independently in the same direction so that the work does not need to be moved after the initial setting. On this machine locomotive frames can be drilled

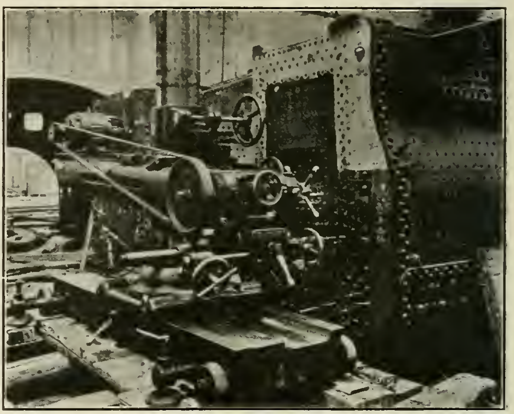


Fig. 1—Asquith Portable Universal Radial Drill

in sets. One or more frame plates are accurately marked out and checked, being then used as jig plates for the remainder of the frames. When work is arranged on both sides of the bed the drilling heads can be kept continuously engaged.

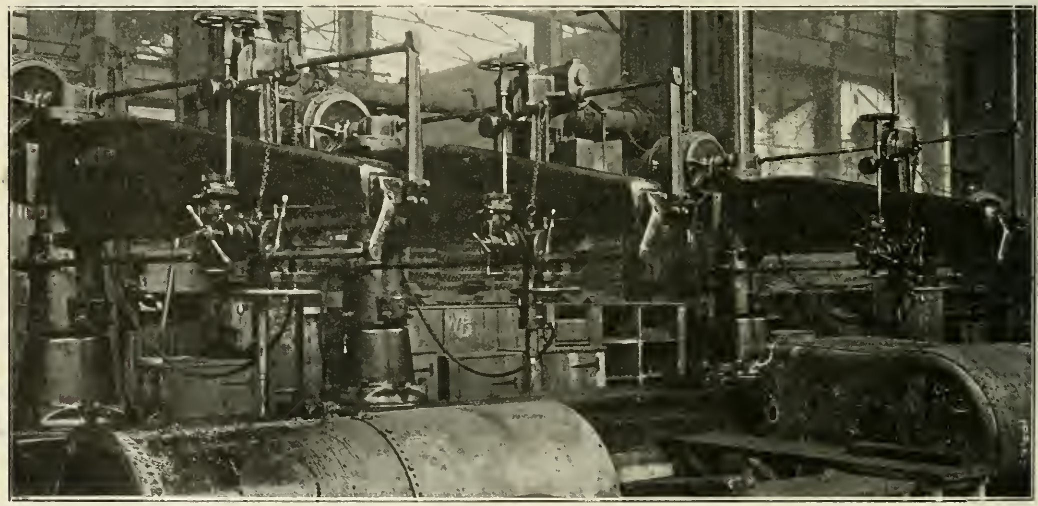
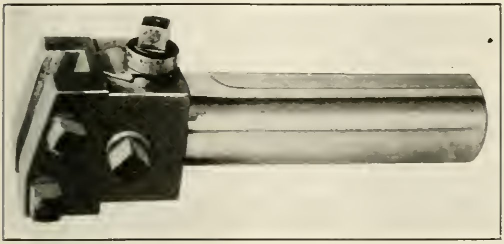


Fig. 2—Asquith Triplex Radial Drills Expedite Boiler Shop Drilling Operations

Accurate Cutter Holder for Turret Lathes

An adjustable angle cutter holder for turret lathes has been designed by the Warner & Swasey Company, Cleveland, Ohio, eliminating guess work when adjusting the cutter to close limits. When turning to accurate size with a cutter head, at least two cuts must be taken over the surface. The roughing cut should be held to a limit of



Warner & Swasey Turret Lathe Cutter Holder

±.004 in. This can easily be done with a common holder by tapping the cutter lightly with a hammer. The finishing cut, however, requires considerable skill and some luck when using the common cutter holder to prevent moving the cutter too far and thereby spoiling the work.

With this new adjustable angle cutter holder guess work and luck are eliminated. A graduated adjusting screw operates a small but rigid cutter slide. The screw adjusts the cutter easily and accurately so that a limit of less than .001 in. can be held. The head is made of hardened steel throughout and a series of severe tests were made to demonstrate its rigidity. After a finishing cut had been taken, the cutter was allowed to bump into the previously rigid shoulder of the work. No variation in the diameter could be detected in the next piece.

When in use the lock screw is drawn up lightly and kept in that position so that adjustment can be made without changing the tension of the screw. An adjustment as small as one half-thousandth of an inch is possible. In addition to obtaining the original setting easily and quickly, the exact size can be maintained as the cutting edge wears and the machine warms up through the day's run. Cutter wear takes place especially on the first few pieces machined immediately after grinding the cutter. By use of this tool production can be increased as it takes much less time to adjust the machine which is, therefore, in actual use a greater length of time. There will also be less chance of turning work under-size where this cutter holder is used.

Flexible Gasoline Power Lift Truck

A gasoline power-elevating platform truck, embodying many unique construction features and known as the Clark Truklift has been placed on the market by the Clark Trucktractor Company, Buchanan, Mich. The new truck conforms in appearance and uses to the electric

Clark Truklift with Power Elevating Platform and Compact Gasoline Motor Drive

elevating lift trucks which have been used in industrial plants for many years. Low initial cost, ease of maintenance, flexibility and continuous twenty-four hour service are distinguishing characteristics claimed for it by the builders.

The loading platform is 26 in. wide by 54 in. long and will elevate its load of 4,000 lb. from a minimum of 11 in. to a maximum of 16 in. from the floor in eight seconds; automatic stops provide for both up and down limits; elevation can be stopped by the hand control lever at any point in the travel.

The lifting mechanism is operated by hydraulic pressure. Power for locomotion and elevating the load is derived from a 15-hp. four-cylinder tractor engine with $3\frac{1}{8}$-in. bore and $4\frac{1}{2}$-in. stroke. The engine is mounted at the rear in a closed compartment containing transmission, governor, vacuum tank, radiator, etc.

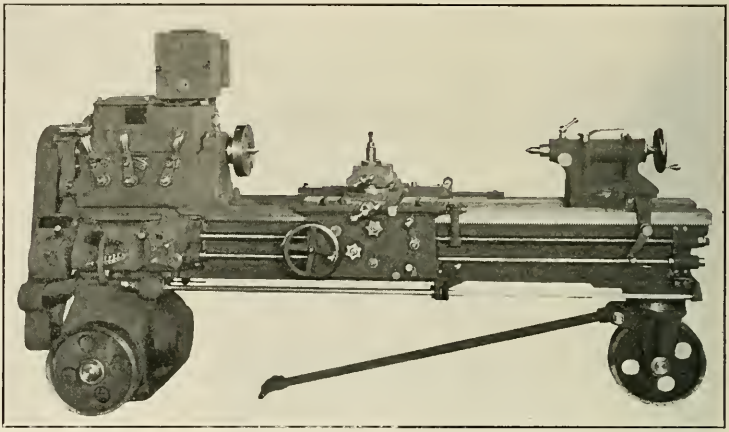
A three-point suspension is used, the steering wheel forks being supported in a steel casting which is pivoted at the center of the frame on a chrome-nickel steel pin 2 in. in diameter. The drive is through a Clark bevel gear axle equipped with ball and roller bearings and located under the loading platform. The driving wheels are of cast steel with pressed-on rubber tires $10\frac{1}{2}$ in. by 5 in. The steering wheels are of cast steel disc type with pressed-on rubber tires 16 in. by $3\frac{1}{2}$ in. Standard automotive construction has been adhered to wherever possible so that the Truklift can be repaired by any good automobile or truck mechanic. A hinged hood renders the engine available for inspection instantly and if necessary the machine can be stripped down to the chassis in less than 20 min., which expedites any repairs that may be needed.

The driving and elevating controls are mounted on the rear of the engine compartment and are operated by the driver who drives standing. The brake lever pedal is under the driver's foot and so arranged that the Truklift stops automatically if for any reason the operator steps off while the machine is running. The machine will climb a 10 per cent grade with a 4,000 lb. load and has two speeds in each direction. The total weight is 2,500 lb.; overall length 107 in.; width $35\frac{1}{2}$ in., and height 51 in.

Portable Geared Head Engine Lathe

THE Lehmann Machine Company, St. Louis, Mo., has just brought out a geared head engine lathe in the portable type, especially adapted for railroad and other shops doing large work where it is necessary to bring the tool to the job. This lathe, which is built in two sizes with 16 in. and 18 in. swing respectively, is direct motor-driven through a belt and idler, an 1,800 r.p.m. motor being used. This motor is light and compact, being mounted in the cabinet of the leg at the head end of the lathe. The pulley and belt and other working parts are fully covered and protected with suitable guards.

The headstock gives 16 spindle speeds in almost geometrical progression with the use of only 10 gears, all of which are heat treated and of a special grade for the purpose. The headstock forms an oil tight case enclosing all running parts. All shafts in this headstock run on ball bearings with the exception of the spindle which is of alloy steel, hardened and runs in phosphor bronze bearings amply lubricated. The spindle nose has two diameters, both hardened and ground, giving two bearings for the face and chuck plate, one in front and one behind the threads on the spindle nose. Forward and reverse revolution of the spindle is obtained through patent friction clutches, running in oil with control handles conveniently located one at the apron and one at the head end of the lathe. The clutches require no adjustment at any time and are designed to pull a little more than the load imposed.

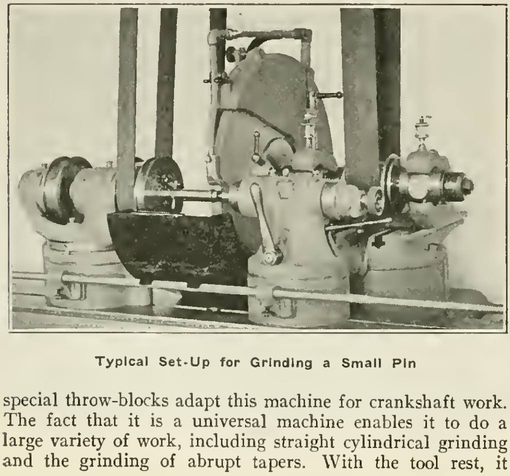


Lehmann Portable Lathe with Compact Motor Drive Arrangement

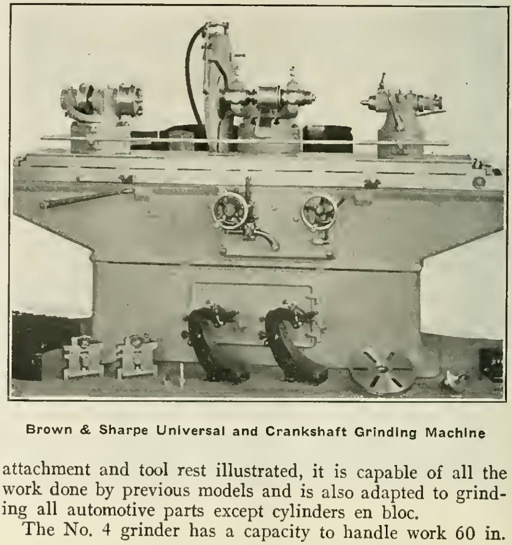
In addition, these lathes include other Lehmann features, such as the patent quick change mechanism, tailstock spindle locking device, rod and screw shift, etc., which have been described at various times in the *Railway Mechanical Engineer.*

Universal and Crankshaft Grinding Machine

A NEW grinder, known as the No. 4 universal and crankshaft grinding machine, has been developed by the Brown & Sharpe Manufacturing Company, Providence, R. I. It is primarily a universal machine, but adapted to the grinding of crankshafts. Raising blocks under the headstock and footstock and a wheel of large diameter, also special throw-blocks adapt this machine for crankshaft work. The fact that it is a universal machine enables it to do a large variety of work, including straight cylindrical grinding and the grinding of abrupt tapers. With the tool rest, it grinds cutters and reamers, boring bars and other tools. The advantages this machine possesses over previous models lie in the wider range of work it will cover. With the internal attachment and tool rest illustrated, it is capable of all the work done by previous models and is also adapted to grinding all automotive parts except cylinders en bloc.



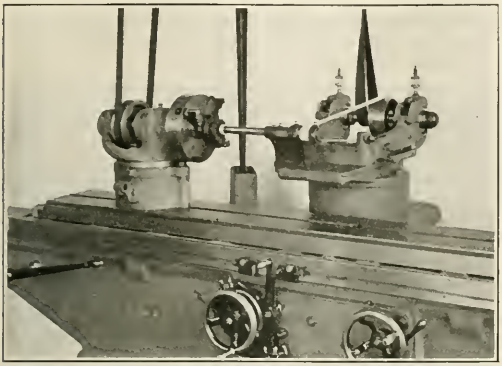
Typical Set-Up for Grinding a Small Pin



Brown & Sharpe Universal and Crankshaft Grinding Machine

The No. 4 grinder has a capacity to handle work 60 in.

in length with a swing of 20¾ in. in diameter and 15½ in. over the water guards. The wheel spindle has hardened



Arrangement for Internal Grinding

bearings ground and lapped, running in self-alining phosphor bronze boxes provided with means of compensation for wear. The automatic cross feed will move the wheel from .00025 to .004 in. at each reversal of the table as desired. It is automatically disengaged when the work is to size. The table travel is automatic, being controlled by easily adjustable dogs. The speeds and feeds of the wheel and work and table feed are entirely independent of each other. A single lever starts and stops the rotation of the work and the feed of the table. The table reversing mechanism is said to be accurate, allowing work to be ground close to shoulders.

The base of this machine rests on the floor at three points, thus maintaining the alinement of the table. The box-like construction of the frame with the ample overhang at each end (not shown in the illustrations) gives firm support for the table, especially at the end of its traverse. The grinding wheel is 24 in. in diameter, 1 in. thick and has a 5-in. hole. It is amply protected by a heavy guard which helps to confine the spray and particles of abrasive. The footstock carries a holder for the carbon point and the wheel can be trued without removing the work from the centers.

Two universal back rests are included for supporting slender work or splined shafts. These rests are universal in all movements, being capable of delicate adjustments and automatically compensating for the decrease in diameter as the work approaches the size. For wet grinding there is an abundant supply of water furnished by a pump. Telescopic water guards included in the equipment effectively protect the operator from spray. The floor space required for this machine is 52 in. at right angles to the spindle and 207 in. parallel to it. The hollow base is fitted as a closet to hold small tools and accessories.

Positive Self-Opening Stud Setter

THE Geometric Tool Company, New Haven, Conn., has developed a self-opening stud setter, made in two styles, positive and friction, and known as the Jarvis self-opening stud setter.

Parts of the positive type stud setter are shown in Fig. 1 and the assembled tool in Fig. 2. The parts consist of shank *A*, body *B*, cap *C*, jaw holder *D* and jaws *E*. The method of assembling these parts will be evident from the illustration.

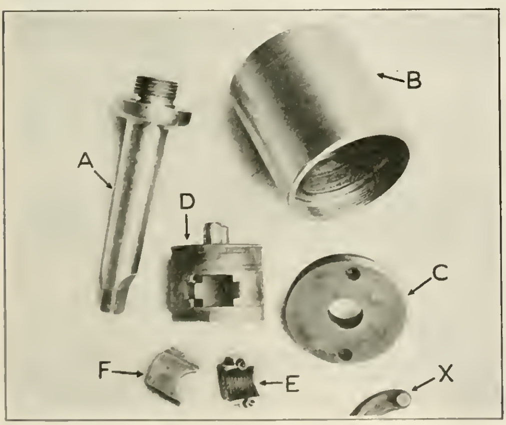


Fig. 1—Parts of the Jarvis Self Opening Stud Setter

Shank *A* is attached to body *B* which drives the jaw holder *D* through two hardened steel pins. The jaws *E* are a sliding fit in jaw holder *D* and are forced together when setting the stud by stops on the inside of *B*. When the direction of rotation is reversed the stud setter releases and may be removed. The stud is not driven by friction on the threads but bottoms against a steel pin in the jaw holder *D*.

The grip on a ½-in. stud is about ½ in., larger sizes being slightly more. The gripping action is substantial. When the positive style stud setter is used it is necessary to have a stop collar around the stud to serve as a stop and release the jaws when the stud reaches the bottom. The stop on the spindle of the drilling machine will serve for this purpose. There is a downward travel of about 1/16 in. in the jaws necessary between the instant when the stop is met and that in which the jaws will release. For this reason, particular care must be taken in the adjustment of the stop collar so that the jaws will release the stud the instant it is at the bottom. Otherwise damage will result.

A friction style stud setter also is provided, the stop collar in this case being unnecessary. With this type of tool a large cone friction on top may be adjusted by manipulation of

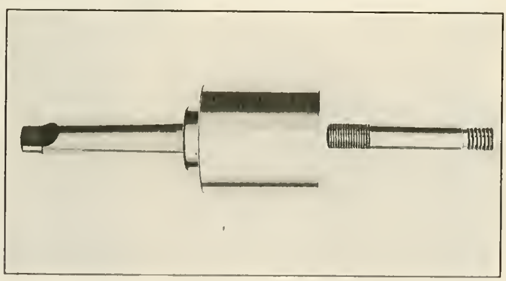


Fig. 2.—View of Assembled Stud Setter and Stud

lock nuts. When the stud being set reaches the bottom the proper adjustment of the friction will allow it to slip, at which time the operator by a quick upward motion of the feed handle releases the jaws and frees the stud. Three sizes of stud setter are regularly listed with capacities from 0 to ½ in., 0 to ⅞ in. and 0 to 1½ in. A fourth size also is now furnished on special order with a capacity from 1 in. to 2 in.

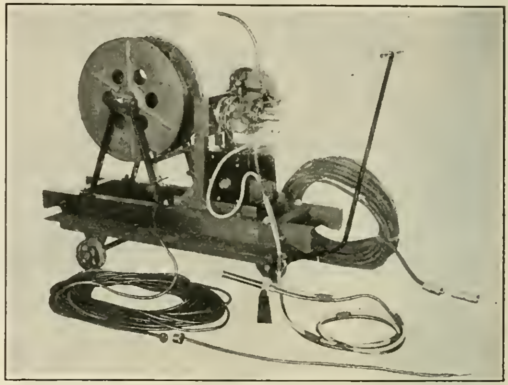
Portable Semi-Automatic Arc Welding Set

IN order to increase the applicability of its semi-automatic arc welding apparatus, and adapt it for use in any place where current for welding is available, the General Electric Company is now building a portable set. This comprises a complete semi-automatic equipment, with support for a wire reel, mounted on a small truck that can be pulled over the shop floor by hand, or lifted by a crane. The complete outfit weighs about 400 lb.

The welding equipment consists of a semi-automatic lead, an automatic welding head, with control, and a standard for holding a reel of electrode wire. Power is supplied to the arc through a flexible cable with a plug for attaching it to the nearest welding circuit. The reel carrier is equipped with a brake and designed to take any size reel up to 2½ ft. in diameter.

The portable outfit should be valuable in repairing parts of machines in place when these parts are too bulky, inconvenient, or otherwise impractical to move, and for doing routine welding of all sorts, such as filling holes in castings, welding seams in pipes or tanks, or other work of a similar nature. Besides the saving in time and trouble due to the portability of the outfit, its use will save both time and material in welding.

The electrode is fed continuously, the number of interruptions are reduced and less skill is required by the operator to make a good weld than is the case with ordinary hand welding. Material is saved by eliminating the waste ends which usually amount to at least ten per cent of the total amount of electrode wire used.



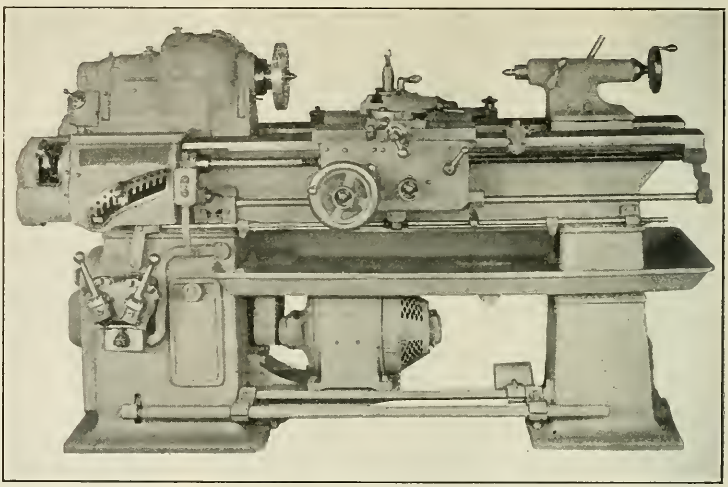
The Set Can Be Used Wherever Welding Current Is Available

Novel Motor Drive for Tool Room Lathe

AN unusually interesting feature of the new 14-in. tool room lathe, developed by the Hendey Machine Company, Torrington, Conn., is the location of the driving motor under the oil pan as shown in the illustration. This is one of the most compact arrangements that it would be possible to devise, the lathe not requiring any additional head room or floor space due to the fact of its being motor driven. The lathe retains the desirable features of the cone type lathe and most of the advantages of the gear-type. Half of the spindle speeds are obtained through belt drives, an arrangement tending to provide flexibility, power and rigidity.

All motive parts of the lathe excepting the lead screw and face plate are enclosed. In construction, the lathe is a combination of readily accessible and generally independent units. The motor is easily reached or moved and does not obstruct light and vision. Reducing gears are placed between the motor and the speed box, which is in the left pedestal. The interior of the head, speed box, and quick change gear box may be conveniently exposed by hand holes or cover plates.

The head stock is equipped with the usual Hendey taper spindle and bearings with several distinctive features added, including the method of taking up end play on the spindle; construction of single pulley and pinion running on a sleeve readily supplied with oil; operation of the intermediate sliding feed gear by conveniently located eccentric levers; oiling of the back gear quill while in motion; enclosing all moving parts of the headstock except the spindle nose, thus protecting the operator and machine from injury.

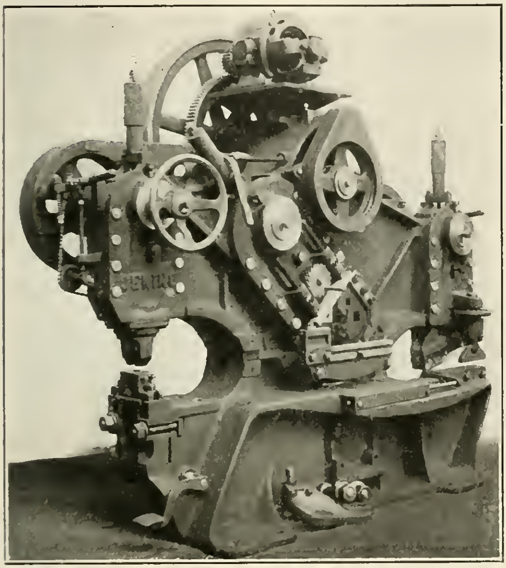


Hendey 14-In. Tool Room Lathe with Driving Motor Under Oil Pan

Eighteen speed changes are obtainable, nine being direct through a belt to the spindle and nine through the customary back gears. The speed change mechanism is contained in an oil tight box. Maximum and minimum belt tension may be instantly obtained by a single screw adjustment. The carriage and compound rests are of new design, providing maximum rigidity and convenience. The tailstock also is improved in the graduation of the spindle and the method of clamping. Motor control is by means of push buttons. By an interlocking method between the shifting levers and starting panels the speed of an a. c. or d. c. motor may be automatically reduced while the gear shifts are made. Supplementary control of the spindle is obtained through a treadle running the full length of the bed, which by foot pressure instantly stops the spindle for examination of or calipering the work.

Triple Combination Punch and Shear

An improved design of triple combination solid steel frame punching and shearing machine, marketed under the trade name Oeking, is being offered by Amplex, Inc., New York. It may be noticed in the accompanying illustration that the operator's side of the machine is clear of all encumbrances such as flywheels and driving gears, all of which are placed on the opposite side. A slanting centering slide to permit mitering cuts to be made without lifting the angle bar to be cut, has been provided. The plate shear knives are 13 in. long for the No. 16 machine and 16 in. long for the No. 20, as against the former lengths of 9 and 11 in. respectively. Ample room is provided behind the knives to avoid binding of the plates when being cut.



Oeking Triple Combination Punching and Shearing Machine

The punch is arranged for punching both the webs and flanges of structural shapes and the height of the throat is designed to accommodate broad-flanged Bethlehem shapes. The punch is provided with a lowering device to locate the center mark before punching and both hand and foot levers are provided for throwing the machine into gear. The springs and gears have safeguards.

The bar and angle cutter is for any shape of structural material, but the standard equipment is for rounds, squares, angles and tees only. Knives can be conveniently changed for cutting beams and channels.

The frame is of cast steel; also the slides, which are adjustable. The covers of the slides are attached to the body by pin bolts ground to fit in position, a feature intended to prevent the covers from working loose. The bearings are designed to have ample surface, are bronze-bushed and provided with ring lubrication. All gears are cut.

The machines are built in sizes from No. 13 to No. 32. The No. 13 will split ½ in. plates, cut 3½ in. angles and punch ⅞ in. holes in ½ in. material. The No. 32 will split ¼ in. plates, cut 8 in. by 8¾ in. angles and punch 1¾ in. holes in 1 in. material. Provision has been made for cranes, gages and other attachments, which are provided if required.

For a machine of its power and range of work the Oeking triple combination punching and shearing machine takes up unusually little floor space. It is motor-driven by means of a self-contained electric motor and consequently the machine can be placed wherever is most convenient in the blacksmith shop, boiler shop or steel car shop, irrespective of position of driving shafts and pulleys.

Rubberstone Car Flooring Stands Tests

A car flooring, sold under the trade name Rubberstone by the Junius H. Stone Corporation, New York, may safely be said to have passed the experimental stage in that a two-year test on a prominent eastern railroad has resulted in an order to equip 50 additional coaches. Rubberstone is a composition of vegetable and mineral rubber, asbestos fibre and cork, particularly designed to withstand the severe service of a flooring used in passenger coaches. This service is particularly severe due to continuous vibration and torsion which tend to cause flooring of hard consistency to crack. If a soft flooring is used on the other hand the wear is excessive which is equally objectionable.

According to the tests referred to Rubberstone is not subject to the objections of either of the above types of flooring as it does not crack under stress of car motion nor does it show localized wear to any appreciable extent under exacting service conditions.

The new flooring is furnished in tile form, 12 in. by 24 in., and 12 in. by 12 in., in two thicknesses, ⅛ in. and 3/16 in. The available colors are brown, terra-cotta, olive green and black. The method of laying is to cover the floor area with a plastic water-proof cement into which the tiles are set. The cement not only holds the tiling down in a permanent grip but seals the joints rigidly. Filling the joints of the tile with plastic composition makes it a continuous one-piece flooring.

The characteristic feature of Rubberstone is said to be its self-healing ability. Abrasions, dents and even deep cuts are ironed out by traffic. When long and continuous traffic has caused wear it may be immediately restored to its original thickness by an application of the plastic composition to the worn parts. Patches of this kind are said to bond perfectly to a feather edge and be invisible.

An important feature is the speed with which Rubberstone sets. Coaches floored with this material may be put into service 24 hrs. after laying the floor. Where patches are applied the composition solidifies in a few hours. Rubberstone is said to be highly fire resistant and matches and lighted cigarettes dropped on it will not cause it to burn. It is also waterproof and can be washed with any cleaning agent and hose without injury. This feature together with its close texture and the absence of open joints render it sanitary to a high degree.

Polyphase Motor With Unique Ventilating System

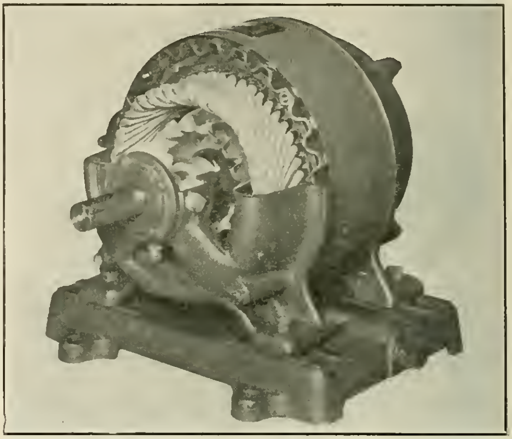
A LINE of polyphase induction motors has been brought out recently by the S. A. Woods Machine Company, Boston, Mass., so designed as to prevent the accumulation of oil on the motor windings and the resulting collection of dirt. The new Woods semi-enclosed 40-deg. induction motor, as it is known, is so built as to screen the ventilating air before it enters the windings and direct this air so that it opposes the entrance of oil into the windings from the waste-packed bearings. The waste-packed oiling method has been adopted also to overcome any tendency toward the spilling of oil when vibration is particularly severe.

While the motors are ventilated, or air-cooled, they are virtually enclosed from a mechanical standpoint. Air enters at the periphery of the machine and is discharged at both ends, the direction of air flow being opposite to that found in most motors. It is claimed that oil leakage caused by the careless filling of bearings cannot occasion bad results, because such oil is expelled from the ends of the motor instead of being driven into it.

The motor frame or casing is made from a single piece of corrugated sheet steeel. The corrugations are equally spaced and in mechanical contact with the stator core, so that much of the heat generated in the core and its winding is conducted to the casing, which therefore forms a large surface for the radiation of heat to the ventilating air.

Air entering at any point along the surface of the screen travels over the outside of the corrugations through holes provided at the center of these corrugations, then through the lateral ducts between the casing and core, then over the windings at the end, and finally is discharged at each end of the motor.

Fans are provided at the ends of the rotor for the purpose of drawing the cooling air through the machine. They are of unique design and it is claimed that a stream of air is drawn directly over the bearing housing and immediately expelled without entering the motor, while another stream is drawn through the machine and expelled at the same points. These fans are made of a single piece of sheet steel welded to the thrust collars. Rotor windings are used which have bars and end rings made of one piece of metal, entirely eliminating mechanical or electrical joints, the windings being molded or cast on the magnetic core. The motors are built in size up to 30 hp. at 1,800 r.p.m. for 60-cycle polyphase circuits with corresponding capacities at other standard speeds and frequencies.



Ventilating Air is Reversed to Keep Oil Out of the Windings

Superspeed Sensitive Drilling Machine

THE latest addition to the line of drilling machines made by the Fosdick Machine Tool Company, Cincinnati, Ohio, is a new superspeed sensitive drill. It is built in two types, bench and pedestal, and in combinations of from one to eight spindles. The capacity is for drills up to 1/4 in. in steel, iron or brass. With the driving pulley operating at 1,750 r.p.m. three spindle speeds of 5,700, 8,000 and 12,000 r.p.m. are available; other speeds to suit conditions may be substituted.

All revolving members are equipped with annular ball bearings, and dust-proof metal oil retainers, the only revolving member exposed being the drill chuck. A spiral gear drive tends to eliminate vibration and noise, and in combination with the flat endless belt reduces the danger of drill breakage at maximum speeds.

The outstanding feature of the new drill is the speed changing arrangement, by which a single turn of a handle automatically releases the belt tension, shifts the belt first from the larger to the next smaller step on one cone pulley, followed by a similar movement from the smaller to the next larger step on the other cone. The belt tension then automatically adjusts to the new position. An aluminum guard which completely encloses the belt and cone pulleys may be lifted off without removing or loosening bolts or nuts, thus enabling the operator to install a new belt quickly.

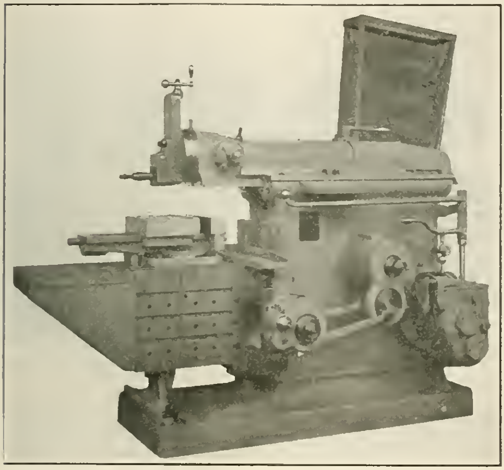
In the pedestal type machine an unusually large floor area is noticeable. The elevating table is of the quick acting, counterbalanced type, with the clamping handle in front. The traverse is 10 in. Both the elevating and the bench tables are surrounded by liberal chip and lubricant channels. The head has a vertical traverse of 6 in., and is counterbalanced to prevent dropping when unclamped. The spindle feeds to a depth of 3 in. with a depth stop adjustable to any point within this range. It has an adjustable gravity counterbalance, devoid of springs, which may be readily set to automatically return the spindle.

The feed lever is adjustable to suit the operator's convenience. Opposite the feed lever is the quick return hand wheel, which enables the operator to position, feed, or return the drill with either hand. The adjustable belt guard and shifter will adjust to receive the belt from any angle. Motor drives are either belted or direct-connected, with a ½-hp. motor mounted on machine.

The regular equipment includes a No. 1A Jacobs improved drill chuck on each spindle. The single spindle type machine weighs 225 lb. and the pedestal type 464 lb.

Crank Shaper Featured by Extended Table

THE latest shaper design of the Hendey Machine Company, Torrington, Conn., is shown in the illustration. The extended table is a valuable feature of this machine which is designed for great durability, simplicity and convenience in operation. The machine has the capacity to handle 24 in. work and may be arranged for either motor or single pulley drive.



Hendey 24-In. Crank Shaper with Extended Table and Long Ram

As indicated in the illustration the machine is decidedly compact and self-contained, occupying a minimum of working space whether motor- or belt-driven. Bearing and rubbing surfaces are liberally proportioned so as to provide long life and accuracy and wherever practicable ball bearings are used to reduce the friction and power required for operation.

The ram is started by a sensitive lever conveniently located at the right of the operator. It can be stopped at any point in the stroke within one-half inch even while taking the heaviest of cuts. The ram is unusually long and well braced and because of its length and the design of the bearings is held in accurate alinement while working at maximum stroke. Wear is taken up by an improved single gib adjustment. The head is liberally proportioned, the head slide having a binder which may be used as a drag. Aside from the usual T-slots, the table of this machine has rows of jig-drilled and reamed plug holes at right angles to the edges of the table providing means for blocking and fastening work to the top or sides.

The cross feed is specially designed giving complete control and setting of feeds on the end of the crosshead, the control lever indicating the direction of table travel. The down feed is also patented and said to provide uniformly smooth and noiseless motion at all speeds. All levers and feed indexes are stationary.

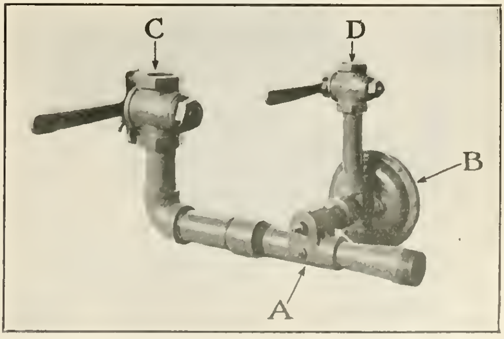
The driving pulley and gear shafts are mounted on interchangeable ball bearings, the gears being of alloyed steel, heat treated. The starting clutch and brakes are located with the pulley at the rear of the machine. Both crankpins and crank-blocks are of hardened steel ground on all wearing surfaces. The take-up of the crank-pin in the bolt gear center is by a single gib. The machine is designed with ample power and structural strength to stand up under the heavy cuts required in modern shop practice. The sturdy design makes it especially adapted for railroad work.

Surface Combustion Low Pressure Inspirator

DESIGNED for use on any make of gas furnace, the surface combustion, low pressure, air gas inspirator illustrated has been developed by the Surface Combustion Company, New York. This device uses the same principle and occupies an equally important position with the gas furnace as the carburetor does with the automobile. It operates on any fuel system in which air is available above ¼ lb. per sq. in. pressure and gas at pressures above one in. of water. The important features of the equipment are: (1) Automatic supply of the exact proportions of air and gas to the furnace needed under all conditions of operation. (2) The thorough and homogeneous mixing of the air and gas immediately prior to entering the furnace. (3) Instantaneous combustion. These features tend to secure the highest combustion efficiency and often effect fuel savings of 20 per cent over the usual two valve control systems.

The complete inspirator equipment consists of inspirator casting *A*, governor *B*, air cock *C* and gas cock *D*. The air line is connected at *C*, the gas at *D*, and the manifold piping from the open end of *A*. A water gage is installed at any convenient location on the manifold line to indicate pressure.

The entire operation of the furnace is controlled through the air cock. An increase or decrease of the air supply auto-



Low Pressure Air Inspirator Designed for Use on Gas Furnace matically increases or decreases the gas so that the mixture proportions remain in a constant fixed ratio. The water gage indicates the rate of consumption, and enables the operator to reproduce accurately each day the most advantageous rate of operation. The gas cock is used only when starting or stopping and is either full on or full off. No adjustment of it is required. It is stated that explosive mixtures are impossible in any part of the distribution mains with this system. The gas and air are mixed only at the point of supply to the burners.

Hand or Power-Operated Differential Chuck

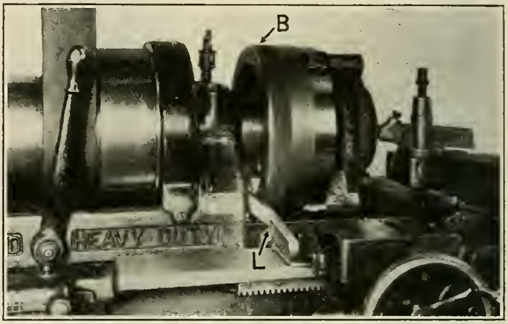
Designed to provide greater holding power and speed of operation, a wrenchless type of differential chuck, as illustrated, has been developed by the E. Horton & Son Company, Windsor Locks, Conn. The advantages claimed for this chuck include a powerful grip obtained by differential gearing, quick and convenient wrenchless operation by hand or power, complete range for all sizes of work and simplicity of design.

To operate this chuck the knurled hand wheel *B* at the back is revolved until the jaws close to the work when the grip is tightened either by a quick push on the hand wheel or by starting the machine and exerting pressure on the lever *L*. To open the jaws, one quick pull on the hand wheel will release the grip and the jaws can then be run out to clear the work by a spin of the wheel.

The principle of operation is that of differential pinions operating with internal gears. The hand wheel carries five double pinions meshing with the backing gear and an internal gear of different pitch diameter than the backing gear. When the hand wheel is revolved the scroll rotates in the chuck with a powerful gear multiplication on account of the differential action due to this difference in pitch diameters. With the gear ratio as regularly furnished, one revolution of the hand wheel causes the jaws to move 1/32 in. radially, opening the chuck approximately 1/16 in. diameter.

An important feature is the device for locking and releasing the chuck. By allowing the backing gear a slight rotation on the pins which hold it to the body, a lost motion is imparted to the hand wheel. This lost motion furnishes a hammer action multiplying many times on the scroll the actual pressure applied to the hand wheel.

The lever *L* which is bolted to the machine, carries a friction shoe acting on the inside of the hand wheel. This is used, when power operation is desired, to hold the hand wheel stationary while the chuck revolves, thus affording great gripping power.



Horton Differential Chuck Designed to Speed Up Lathe and Other Chucking Work

Ball-Bearing Hanger Box and Pillow Block

Recent additions to the line of ball bearing hanger boxes and pillow blocks, made by the Fafnir Bearing Company, New Britain, Conn., are the single ball bearing hanger box and self-alining, double ball bearing pillow block, illustrated. The former is similar in construction to the double ball bearing hanger box described in detail on page 325 of the May, 1921, *Railway Mechanical Engineer* except that only a single set of balls is utilized. This hanger box is a comparatively recent development designed for use on line shafts, light drives and machine applications. The box is said to be easy to install with no dangerous projections, bolts or screws. It is designed to give long service owing to the ball bearings running in hardened alloy steel races.

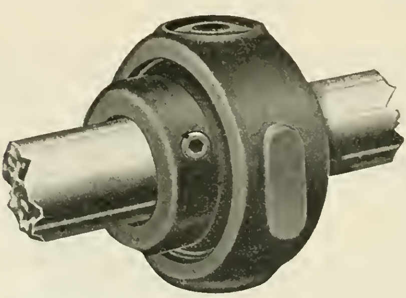


Fig. 1.—Fafnir Single Ball Bearing Hanger Box

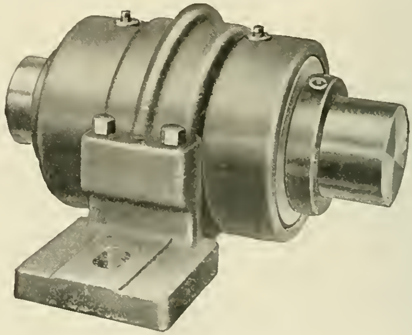


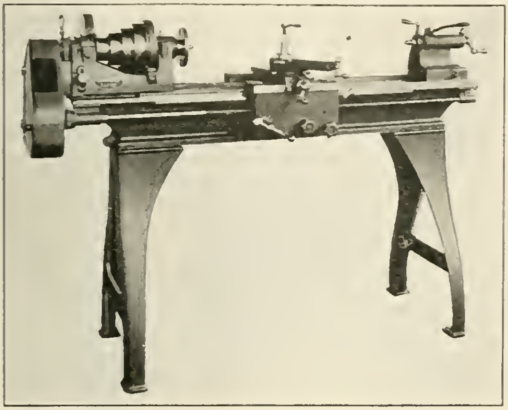
Fig. 2.—Self-Aligning Double Ball Bearing Pillow Block

The pillow block is also provided with Fafnir transmission-type ball bearings, made from thoroughly treated alloy steel. Two ball bearings are provided. The inner ring of each bearing is made an inch wide in order to give the bearing a firm seat on the shaft and afford the shaft extra support. A driving collar is mounted on the shaft at each end of the box and has lugs which engage corresponding slots cut in the wide inner ring. Consequently the shaft, collar and inner ring revolve as a unit and all end thrust is transmitted to the balls.

The driving collar and wide inner rings are exclusive Fafnir features. By this method, adaptor wedges and delicate adjustments are eliminated; the shaft is given ample support; and the bearing axis is held in accurate alinement with the shaft axis. It is also possible to mount each pillow block in an assembled unit containing no bolts or set screws in the housing. A special point of interest is the self-alining feature of the pillow block by means of which the bearing axis is held in accurate alignment with the shaft axis.

Small Screw-Cutting Engine Lathe

The Seneca Falls Manufacturing Company, Inc., Seneca Falls, N. Y., has recently placed on the market a new screw-cutting engine lathe ranging in size from 9 in. to 13 in. swing and of the usual bed lengths. This machine is known as the "Handy" lathe, being a general purpose machine, arranged for either motor or belt drive. All the regular Star lathe attachments may be used in connection with it.



Handy Screw-Cutting Engine Lathe

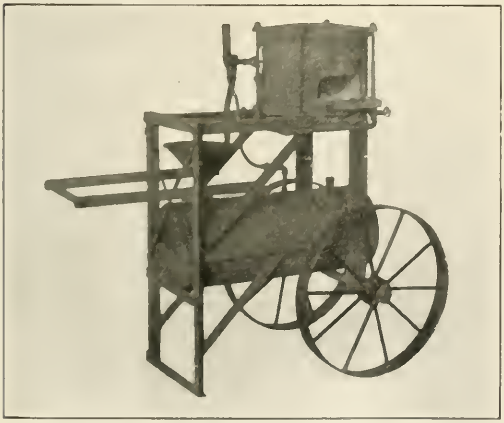
The Handy lathe is of heavy ribbed construction, equipped with either bench or floor legs. It is provided with back gears, power longitudinal and cross feeds, a large hollow spindle adapted to draw-in chucks, graduated cross feed screw, set-over tailstock, plain or compound rest, double friction countershaft with a cone belt shifter on the countershaft and self-oiling bearings. The lathe is said to be accurate, well designed and built of the latest construction to meet satisfactorily the exacting demands of modern machine shop practice.

This company is also placing on the market a plain turning lathe, having a 10 in. swing, 3 ft. bed, and taking 12 in. between centers. This lathe is equipped with a plain rest and feeds from .002 to .040 in. per revolution of the spindle are obtainable. A set-over tailstock, open belt, three-step cone and self-oiling spindle are provided. The countershaft is of the tight and loose pulley type with roller bearings in the loose pulley. This machine is brought out to meet the demand for a small sturdy plain turning lathe without the screw-cutting feature.

Rivet Forge and Oil Heater for Car Work

The illustrations show a rivet forge of the suction type and an oil heater for steel car work manufactured by the MacLeod Company, Cincinnati, Ohio. The forge is built with a heating chamber made of special tile, the chamber being 11 in. by 7½ in. The oil is supplied from a 20-gal. tank and the outfit is mounted on a two-wheel truck that can be easily handled and moved from place to place. The rivet forge is built to endure rough usage and to support the heating chamber at the top. The opening is fitted with a blast pipe to keep the flame inside and protect the operator.

The forge operates with oil and compressed air. There is no pressure on the tank, the oil being sucked from the tank and sent to the burner in a steady, even flow by the vacuum



MacLeod Portable Suction-Type Rivet Forge

Oil Heater for Steel Car Work

tube, shown on the left side of the forge, to the back of the burner.

The burner shoots the flame into the forge on an angle, in such a manner as to cause a reverberatory action in the forge. In this manner the flame is prevented from touching the material to be heated and thus oxidizing the rivets.

The burner with the oil heater is supplied with four casings or nozzles, three of different sizes and one for work at right angles. The heater has a 17 gal. tank fitted with pressure gage and necessary fittings and is mounted on a two-wheel truck. The burner is supplied with two 12½-ft. lengths of air and oil hose.

The heater operates with compressed air and oil, either crude, fuel, kerosene or distillate oils. Operation is instantaneous; the outfit is attached to the compressed air line and the burner started. The mixing of the air and oil takes place in the mixing or combustion chamber which is just back of the nozzle or casing, the nozzle being simply to confine and direct the flame. The burner will give an intense, hot flame from 3 in. to 48 in. in length, making it suitable for a wide range of work.

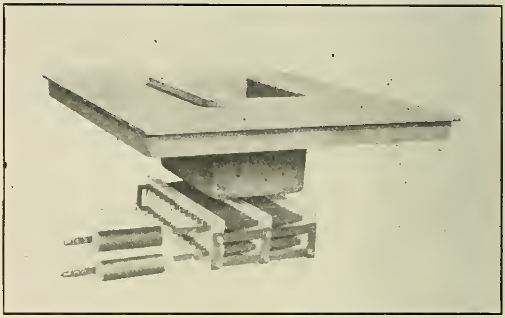
The shipping weight of the heater complete is 150 lb. and the light truck enables the outfit to be used either in the repair shops or in the yards.

Electrically Heated Babbitt Pots

TWO large size, high temperature, automatic melting pots have been developed by the General Electric Company for melting large quantities of babbitt, solder and similar alloys or metals. The two devices are similar in appearance and construction and consist of a pot, supporting plate, heating unit, insulators and an automatic control panel with a temperature control instrument.

The pot and supporting plate are made of gray cast iron. The heating unit consists of a nickel-chromium alloy ribbon, which is formed, equipped with terminals, and assembled on the insulators, which are made of a special compound.

One of the pots will operate at temperatures up to 800 deg. F. in the metal to be melted, requires 10 k. w. of energy for operation, and is controlled by a Tycos mercury thermostat. The other pot will operate at temperatures up to 1,100 deg. F., and is controlled by a Leeds & Northrup single point potentiometer. The thermostat may be set for any desired temperature and will cut off the current at 5 deg. above the temperature and will close the connection again at 5 deg. below. Both of the pots have a capacity of 1,000 lb. of lead, 668 lb. of tin, or 920 lb. of babbitt consisting of 80 parts lead and 20 parts antimony. These pots are designed for use where larger quantities of material are needed at one time, when the temperatures involved are higher or a quicker rate of heating is desired than is possible

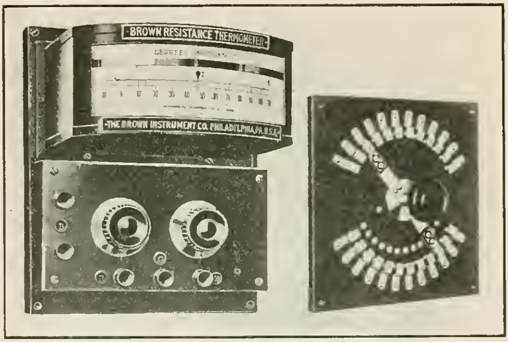


Electric Melting Pot Without Brick Housing

with the smaller self-regulated pot manufactured by this company.

A Direct-Reading Resistance Thermometer

THE fundamental principle of the resistance thermometer, recently developed by the Brown Instrument Company, Philadelphia, Pa., is the well-known physical property of metals, except special resistance alloys, of change in re-



Brown Resistance Thermometer and Rotary Switch

sistance with change in temperature. This change in resistance can be accurately measured and a scale calibrated in temperature degrees.

The bulb or coil of wire which changes in resistance is usually of nickel for temperatures up to 300 deg. F. and of platinum for higher temperatures to 1,800 deg. F. Three wires lead from the bulb to the instrument, eliminating any effect on the indications of the instrument due to changes in temperature along the wiring connecting the bulb to the instrument. The length of wiring is immaterial in the Brown three wire system and bulbs can be placed up to 1,000 ft. distant from the instrument using No. 14 gage copper wire or up to 2,500 ft. distant (half a mile) with No. 10 gage copper wire.

A recent development has been the perfection of a direct-reading resistance thermometer. For years resistance thermometers have been built on what is known as the zero or null basis. In this type of instrument a galvanometer pointer must be brought to zero and a reading then taken on a scale mounted in front of a rheostat. While quite accurate this method has the disadvantages of not being direct reading and the operator must obtain a balance by adjusting the slide arm of the rheostat so that the galvanometer indicates zero before the temperature reading is secured.

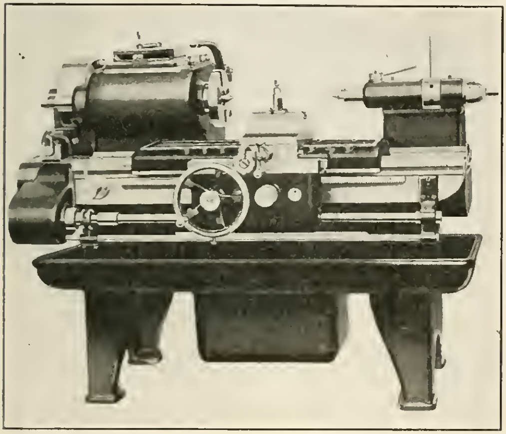
The Brown direct-reading resistance thermometer has a scale graduated directly in temperature degrees as illustrated. To check the instrument for zero reading, the left hand knob is turned to Z and then to S to check the instrument with a standard resistance at the top graduation on the scale, and in the third position the instrument is operated directly off the temperature bulb. The rheostat is the right hand knob on the instrument for adjusting the voltage. This check of the instrument while recommended daily need only be made every few days even where dry cells are used to operate the instrument since the current required is infinitesimal, and dry cells last four months without replacement. Where storage batteries are used a less frequent check is satisfactory.

By means of a switch the instrument can be connected to any number of resistance thermometer bulbs installed in different locations. Where used in dry kilns the instrument can be used to measure both temperature and humidity.

Applications where the Brown direct reading resistance thermometer can be used to advantage are in power plants for many temperature measurements, for the temperature of coal piles and numerous other applications.

Sundstrand Twelve-Inch Manufacturing Lathe

In the 12-in. Sundstrand manufacturing lathe, developed by the Rockford Tool Company, Rockford, Ill., especial attention has been given to securing a compact, rigid machine, capable of standing up to the demands of specialized



Front View of Sundstrand 12-in. Manufacturing Lathe

production and yet suited to a variety of work owing to the incorporation of the cross-feed, quick change feed, carriage reverse and a lead screw for thread cutting.

An idea of the compactness and rigidity of the machine may be obtained from the illustration. Separate ways are provided for the tool carriage, head and tail stock so that the carriage can travel to the end of the bed in front of the tail stock. This is an uncommon arrangement, eliminating overhang of the tail stock spindle on short length work and assuring great rigidity under heavy cuts.

The head stock is provided with single pulley drive equipped with a powerful friction clutch to the driving pulley. An outer bearing support relieves the belt strain on the driving pulley. It will be noted that the carriage has lugs on top, drilled and tapped to permit the mounting of extra cross slides, special tool holder blocks, etc. A special feature is the multiple stop collar which makes a positive stop for the cross slide when turning shafts with shoulders.

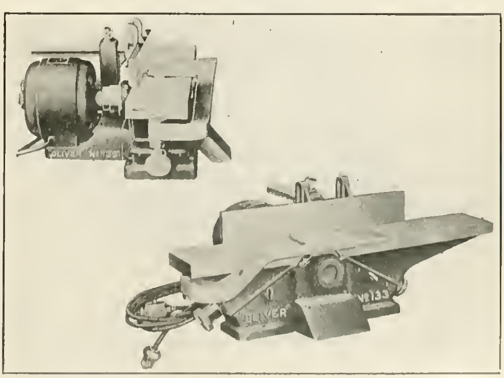
The apron is of the improved double wall type with a minimum of working parts and gears. A quick acting tail stock is regularly supplied and is a time saver in turning duplicate parts for the reason that it facilitates the work of operating the center. The lever is conveniently located and a slight turn will move the spindle to or from the work quickly. The rear tool is placed on the rear ways of the bed between the head and tail stock and can be located in different positions best suited for the work. It works simultaneously with the carriage and is driven by means of a rack fastened to the rear of the carriage.

The swing over the carriage of this lathe is 12 in. and over the cross slide 10 in., the distance between centers being 18 in. The diameter of the driving pulley is 12 in., a driving belt 4 in. wide being used. Twenty-nine feeds are provided ranging from .005 to .043 in. per rev. of the spindle. Nine spindle speeds are provided ranging from 36 to 251 r. p. m. In case of motor drive a 3-h. p. motor running at 1200 r. p. m. is recommended.

Portable Hand Planer and Jointer

Two views of the portable hand planer and jointer recently placed on the market by the Oliver Machinery Company, Grand Rapids, Mich., are shown in the illustration. This machine has been designed to meet the demand for a portable, compact, motor-driven hand planer and jointer to replace the hand plane for jointing and fitting almost all classes of small work in wood construction. The machine is said to be thoroughly accurate and efficient, being fitted with ball bearings and arranged to run from any electric light socket or power circuit. The arrangement for safe-guarding are plainly shown in the illustration. The machine has a capacity to plane work 6¼ in. wide on the 6 in. machine and 4¼ in. wide on the 4 in. machine. Both sizes rabbet up to ½ in.

The tables are mounted on inclined dove-tailed ways, being raised and lowered by means of a hand-wheel and screw and being easily locked firmly in any position. Each table has a steel lip next to the throat opening. The fence can be quickly adjusted anywhere across the tables, also tilted and locked to any position up to 45 deg. It is 16 in. long, 2½ in. high and when not in use may be shoved back out of the way of the knife jointing and setting attachment.



Oliver Portable Hand Planer and Jointer

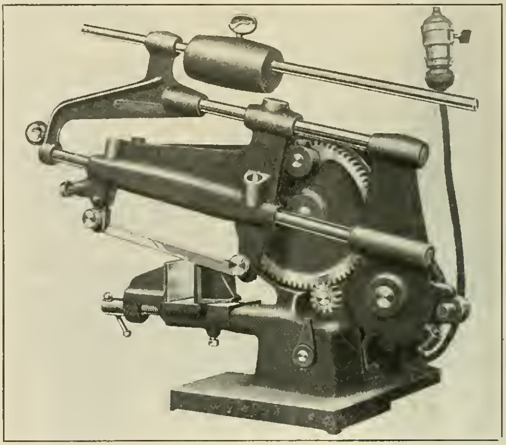
The cutter head is the three knife, circular, safety type, fitted with three tungsten-chromium thin steel knives which are 1/8 in. thick and 1 in. wide. The cutting diameter is 3½ in.

The motor is direct-connected by means of a universal flexible coupling. It is fully enclosed, well ventilated, and fitted with ball bearings, being designed to run at 3600 r. p. m. A ¼-hp. motor for the 4-in. machine and a ⅓-hp. motor for the 6-in. machine are required. The knife setting attachment is furnished when desired. It consists of a right angle way with a slide block, jointing stone and aluminum guard. It serves as a guide for setting the knives and by sliding the jointing stone back and forth while the cutter head revolves it will sharpen and join the knives so that all three knives will cut equally and produce much better work.

Motor-Driven Portable Bench Hack Saw

It is a serious question whether the modern railroad shop man has as much patience and steadiness in using a hack saw or file as was common in former years. Fortunately, however, this is the age of machinery and comparatively few hand operations are now required. For example, the small motor-driven bench hack saw illustrated can be set up wherever convenient on the bench adjacent to an electric light cord and it will saw off any piece of iron within its capacity far more quickly, smoothly and with less damage to the saw blade than could be done by hand. Time is saved; physical effort is saved; saw blades last longer; and workmen can do something else while the machine is working. Another advantage is that this small hack saw can handle a large share of the work usually done on much heavier machines. It is designed for long life and ease of operation and all parts subject to wear are easily replaced. Both tool and machine steel can be cut efficiently and the machine is well adapted for use in toolrooms and machine shops, particularly those having considerable hack saw work formerly done by hand.

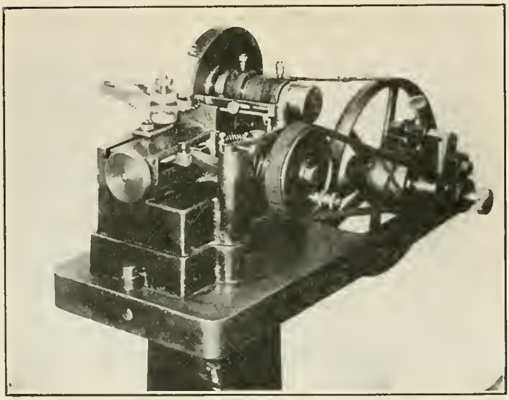
Power is supplied by a small motor direct-connected, the power being transmitted through cut gears. The machine is portable and can be attached to any electric light socket. It will be observed that cutting is done on the backward stroke, the saw blade being automatically relieved on the forward stroke which diminishes the wear and greatly prolongs the life of the blade. This portable bench hack saw is made by the Edlund Machinery Company, Inc., Cortland, N. Y.



Edlund Portable Power Hack Saw

Entirely Automatic Saw-Sharpening Machine

The latest addition to the line of automatic saw-sharpening machines, made by George Scherr, New York, is the No. 2 machine illustrated. This saw sharpener is similar in construction to earlier models except that it has an increased capacity to sharpen and recondition saws, screw slotting cutters, fitting saws, etc., up to 8 in. in diameter. The machine is entirely self-contained being mounted on a cast-iron column. Its principal advantage is that the indexing is done by means of the saw to be sharpened so that differences in the thickness from tooth to tooth present no difficulty. The machine will feed without any trouble saws with one or more teeth broken out. The proper adjustment for feeding saws with teeth broken out is provided. The machine is easily operated and adjustments for different kinds and sizes of saws can be made easily and quickly, thereby saving time and enabling a large number of saws to be kept in condition by one machine.



Scherr Automatic Saw-Sharpening Machine

This saw sharpener is a precision machine without unduly complicated parts and arranged so that the setting and resetting for work of one size or kind to the other requires but a few minutes time. It is especially valuable owing to the fact that it enables small saws under 6 in. in diameter and previously sharpened by hand tooth for tooth to be sharpened automatically. Not only is a tiresome hand operation now performed by the machine but the quality of the work is considerably better. More uniform cutting edges are secured resulting in better work. The specifications for the new No. 2 automatic saw sharpeners are as follows: It will sharpen saws from 1½ in. to 8 in. in diameter with thicknesses up to 5/32 in. The holes in the saws may vary from ⅜ to 1 in. The distances from tooth to tooth may be accommodated up to ⅜ in. Grinding wheels 4½ in. by ⅜ in. by ½ in. are used, 650 r.p.m. being recommended. The saw sharpener is mounted on a column 30 in. high. The net weight of the machine is 134 lb.

Vertical Miller Designed for High Speed

The Becker Milling Machine Company, Worcester, Mass., has recently made changes in its No. 2 vertical miller which permit at least 50 per cent higher speeds than were formerly obtainable. This machine is now equipped with a ball auxiliary bearing to take the belt pull and hardened steel thrust washers are provided on the spindle. The main spindle bearing is bronze with a babbitt lining which has been found well adapted for high speeds. The spindle is made of crucible machine steel ground all over and carefully balanced. The pulley and all rotating collars and nuts are also balanced, and every effort has been made in the design to minimize vibration.

Becker No. 2 High Speed Vertical Miller

Two sizes of spindle pulleys are now furnished. On the No. 2 machine in addition to the usual 5-in. pulley, a 3-in. pulley is supplied for securing higher speeds. The operation of changing pulleys is simple, it being only necessary to lift one pulley by hand from the sleeve on which it rests and substitute the other. The belt slack is then taken up by means of the idler pulley bracket, which is adjustable.

It is now entirely practical to run the No. 2 machine at 6,000 r.p.m. and factory tests are said to have been run at considerably higher speeds, the proper attention being paid to oiling when running at these speeds. With a maximum speed of 6,000 r.p.m., two other speeds of 3,240 and 1,800 are obtainable using the 3-in. pulley, and by using the 5-in. pulley the following speeds are obtained: 3,540, 1,920 and 1,060. The necessary counter shaft speed is 540 r.p.m.

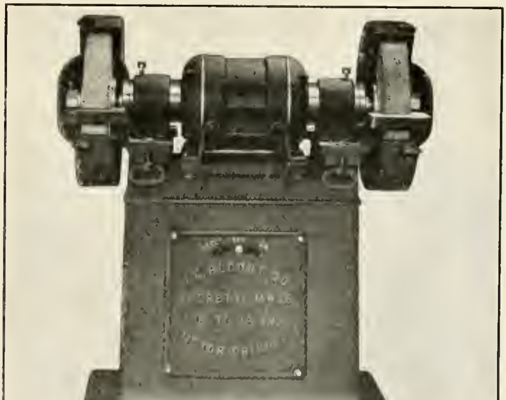
Other recent improvements in the No. 2 Becker miller are the new full box form knee, which is more rigid, and a steel chip guard in the knee in front of the carriage to protect the cross feed screw. A special canvas belt is furnished in the regular equipment which is particularly suited to high speeds. In case slower speeds with larger cutters are desired, it may be found advisable to change to a leather belt.

Heavy Duty Alternating Current Motor Grinder

Motor grinders of the heavy duty type and designed for operation on alternating current circuits have been developed by the J. G. Blount Company, Everett, Mass. Three-inch wheels, either 16 or 18 in. in diameter, are provided with this type of machine. The end shields are of cast-iron, turned and bolted directly to the motor frame. They are further secured in position by additional supports clamping around the end shield hub and then bolted to either side of the head casting. The end shield flanges are turned and threaded and screw into the ends of the shields.

Bearings for this grinder are of the S. K. F. double roll, heavy series type, being secured to the spindle by lock nuts. It is recommended that a high grade grease be used on the bearings. The spindles are turned from 45 carbon open hearth steel, being carefully ground and threaded. The rests are cast in one piece, being unusually rigid and adjustable to wear of the wheels. The flanges are machined all over and recessed on the inside, being heavy and conforming to the safety standards. Wheel guards are furnished of either the plain or exhaust types. Guards for 16-in. wheels may be supplied if desired. The starting switch furnished is a safety switch, mounted within the column on a separate panel and easily removable from the rear of the machine without disconnecting the switch. The switch is designed to protect both man and equipment against unexpected restarting and accidental starting of the motor. A 5-hp. motor designed to operate on 220 or 440 volts, two or three phase current, or 550 volts, 60 cycles, three phase can be provided.

It is highly essential that advantage be taken of every opportunity to secure an adequate number of modern grinders for railway shops and engine houses. The machines must be powerful enough to do miscellaneous grinding rapidly; they must be dependable and kept in good working condition;



Blount Heavy Duty Grinder Driven by A. C. Motor

they should be provided in sufficient number to reduce unnecessary steps taken by shop men whenever they have a little grinding job to do.

Pinch Bug Riveter With Wide Range

UNUSUALLY wide range is one of the features of the new Shepard pinch bug riveter recently developed by the Hanna Engineering Works, Chicago. This riveter has a reach of 20 in. and the gap is 11½ in. or 18 in. depending on whether the short (channel jaw) or long (girder jaw) is used. The capacity of the riveter is 50 tons on the dies at 100 lb. air pressure and its weight is 1490 lb. which is relatively low in proportion to its capacity.

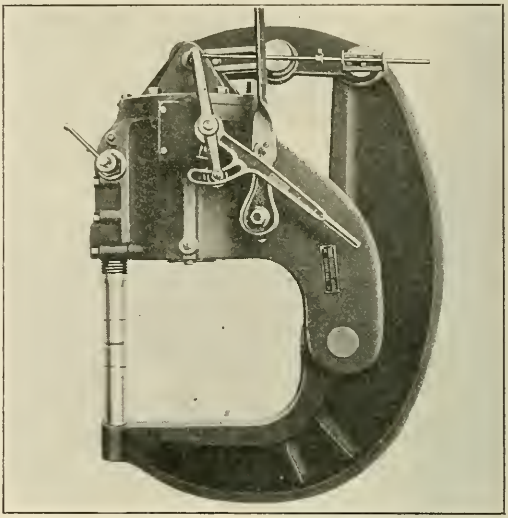
The angular movement is small due to the small radius from the hinge pin to the die axis. This allows greater variation in the length of the lower die. The die stroke of the Shapard riveter is 3⅝ in. The machine is equipped with a removable valve plate and an extra plate and valve allow maintenance of the valve without shut down.

In the Shepard pinch bug riveter, the upper die does not move as the rivet is driven when the machine is suspended with the die vertical. Rivets are placed from the top and driven from below and may be inserted far in advance of the machine itself. It is thus possible for the "rivet sticker" to devote some of his time to drift pins and stitching bolts without interrupting the continuous operation of the machine.

The suspension pin about which the machine is free to revolve is so located with relation to the center of gravity of the machine that the riveter when suspended naturally assumes a position resulting in the upper die screw being exactly vertical. The upper die screw remains vertical whether the unit is open or closed as the center of gravity shifts but lightly during movements.

The proper working suspension is easily obtained by merely hoisting the machine to the point where the upper die just rests on the work.

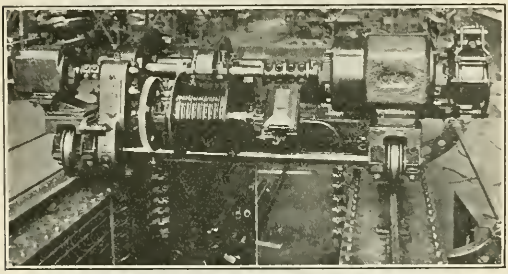
The Shepard pinch bug riveter is particularly adapted to light and medium weight structural riveting such as roof trusses, plate girders, beam box girders, crane girders, plate and channel columns, small plate and angle columns, lighter channel columns, steel car stills, etc. The unusual reach of the machine makes it an exceptionally flexible unit.



Shepard Pinch Bug Riveting Machine

Special Retriever Keeps Cable Always Taut

THE feeder cable retriever illustrated has been developed by the Pawling & Harnischfeger Company, Milwaukee, Wis., on the principle of keeping the crane cable taut at all times with a fixed but moderate tension constantly maintained, thus causing the cable to wind up and pay out without slack or undue strains. The retriever is designed to provide the fool proof construction needed in this type of equipment, more or less subject to abuse, and constantly exposed to the elements in all kinds of weather. It is of liberal proportions, the drum being provided with large flanges on both sides, and all bearings being bronze bushed.



Pawling & Harnischfeger Feeder Cable Retriever

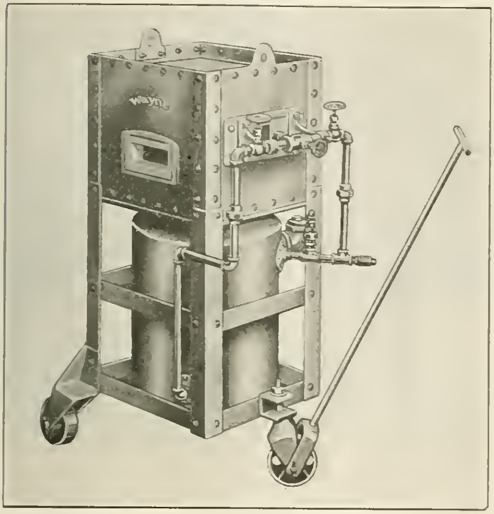
The magnet cable leads attached to the collector rings are passed through a hole in the center axis of the shaft to a point even with the arms of the cable drum. The cable here passes through an opening in the shaft along the drum arm to which it is securely attached. After passing the cable through the hole in the rim it is coiled in the outside of the drum, thus making a secure attachment and leaving no exposed electrical contacts.

The improved cable drum is driven only in the hoisting direction. The drive consists of gearing from one of the shafts of the hoisting mechanism, the final drive to the cable drum being by friction. The gearing is so proportioned as to tend to drive the drum at a peripheral speed greater than the magnet being hoisted. This arrangement causes the friction drive to slip, producing a moderate tension in the magnet cable. Should there be several feet of slack in the cable when the magnet is hooked on the crane this slack will be taken up in the first hoisting operation.

The cable drum is not driven in the lowering direction. A pawl engages in a ratchet wheel attached to the driving friction, preventing it from revolving. The cable drum is then unwound, due to the pull of the cable while the magnet is lowered. A raveling or too rapid unwinding of the cable is prevented, however, by the resistance of the stationary friction against the cable drum which produces the same tension or pull on the cable in the lowering as in the hoisting direction.

Portable Forging and Rivet-Heating Furnace

THE portable oil-burning forging and welding furnace shown in the illustration has recently been developed by the Wayne Oil Tank & Pump Company, Ft. Wayne, Ind. It is especially adapted for shops where the forging or rivet-heating equipment must be readily moved about in order that the work may be more speedily and easily accomplished. The furnace is substantially but lightly made.



Wayne Portable Oil-Burning Furnace

The furnace is approximately 51 in. high overall, 25 in. from the front to the back, and 31 in. wide. The handle is 40 in. long and attached to the guiding castor. The furnace body is made of 14 gage black iron, held by heavy angles, and is 16 in. high, 18 in. wide and 16½ in. from the front to the back. The work opening is 6 in. wide, 3 in. high at the edges and 4 in. high in the center. The working space is 9 in. wide and 7 in. deep, exclusive of the tile opening, which is 5¾ in. from front to back.

The supporting frame which surrounds the tank is made of heavy angles. The tank itself, which is flame welded, is constructed of black iron with a 3/16-in. shell and ¼-in. heads. The tank is designed to withstand a working pressure of 100 lb. per sq. in. It is 17 in. in diameter and 22 in. long and has a capacity for 14 gal. of fuel, sufficient for 10 hours of normal operation. The tank is fitted with a safety valve. The 2-in. air-tight filling opening is conveniently located.

This machine is particularly valuable for rivet heating work in railway shops, especially the boiler shop, tank shop and steel car shop. In these places its flexibility and ready movement from place to place are important advantages.

As shown in the illustration, the Wayne portable forging and rivet heating furnace is supported on three substantial castors of large diameter. The two in the rear run on bearings in brackets firmly riveted to the main furnace and frame work. The third guiding castor, as it is called, is arranged to swivel, being guided by the long handle previously referred to. By means of this handle one man can readily move the furnace to the most convenient location with respect to the work. Two ears are provided on the upper part of the furnace for the insertion of small hooks and a chain or some other arrangement, enabling the furnace to be lifted by a crane from one department to another. A safety valve protects the tank from excess pressure.

Power-Driven Tube-Shearing Machine

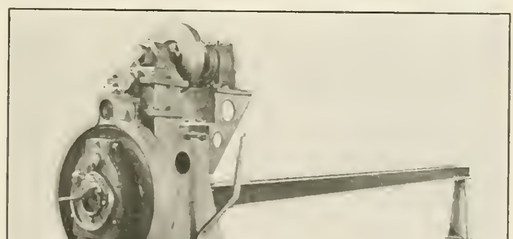
WITH the object of providing a machine for shearing pipes and tubes rapidly, without loss of material, with a square cut free of fins and without revolving the pipe or tube, the Laughlin-Barney Machinery Company, Pittsburgh, Pa., has developed the tube shearing machine illustrated.

In general design this machine is compact, rugged and simple thus meeting the fundamental requirements of machine tools used in railroad shops. All gears are fully covered for the protection of the operator. The shearing principle employed is quite novel and consists of an internal arbor and two shear knives in the form of two hardened steel rings which are placed close together, and through which the pipe or tube passes (these shear knives do not revolve). One knife is held concentric and the other carried in the shear head which follows an eccentric path, thus causing the pipe or tube to be sheared off in one revolution of the machine.

This method of shearing is said to have little wearing effect on the cutting edges of the knives and owing to their simple design they can be quickly removed and easily sharpened by grinding the sides of the knives.

The machine is under entire control by the operator at all times, this being accomplished through a positive clutch operated by a foot treadle which permits either intermittent or continuous operation as desired. These machines can be furnished either belt or motor driven and for shearing practically any size or kind of tubing.

The tube shearing machine, illustrated, is motor driven by a motor mounted on a bracket attached to the upper machine frame work. The two shear knives are driven through reduction gearing, all of which is carefully guarded. The machine is operated by means of the levers, conveniently placed. A support for long tubing is provided as shown at the right.



Laughlin-Barney Tube-Shearing Machine

Rotary Pump Has Five Movable Parts

THE Curtis rotary pump, manufactured by the Pittsburgh Machine Tool Company, Braddock, Pa., has been improved lately and developed to a point where it can handle water up to 400-ft. heads. The entire construction has been changed so as to make a pump suitable for unusually severe service. These pumps are made in capacities from 15 up to 300-gal. per min., having only five moving parts and buckets or impellors which are made of bakelite, being about 40 per cent the strength of cast-iron and nearly frictionless. The buckets as shown in Fig. 1 are held out against the liner by pressure in the pump itself. The bearings are of lignum vitæ which is the same material as used on stern bearings in steamships where it is impossible to oil, and if through negligence these bearings do not get lubricated they work very well with water as a lubricant.

The new pump is said to have a high efficiency and low maintenance cost. The water in the pump is carried around through the part shown in the end plate and underneath the buckets which holds them out against the liner. The pumps are designed to be self-priming and develop a vacuum of 27 in. They are compact and light in weight. They are strictly rotary pumps as distinguished from centrifugal or gear pumps. The solid rotor revolves in the eccentric body with blades or buckets which create suction and discharge.

When installing a Curtis rotary pump, it is advisable to get the pump as close to the supply as possible. Long suction lines are undesirable as they are liable to be leaky and also it takes some time to exhaust the air before the pump will prime. In places where long suction lines cannot be avoided, it is sometimes advisable to put a standpipe on the discharge line with a valve close to the discharge line. This standpipe can be filled when the pump is discharging and used as a primer when restarting the pump.

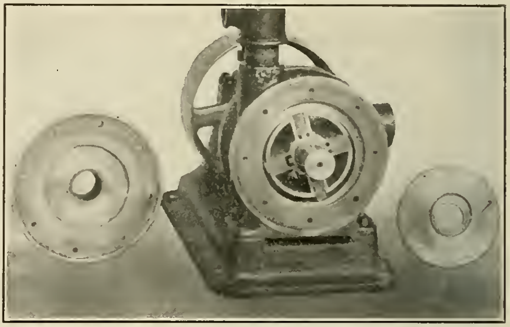
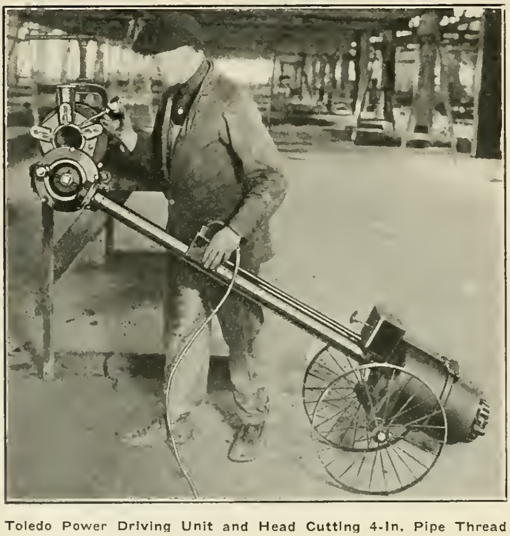


Fig. 1—Interior View of Curtis Rotary Pump

Power Drive for Hand Threading Parts

ANYONE who has ever tried to cut a 2-in. pipe thread by hand can testify to the amount of physical effort involved and will probably be an ardent advocate of any effective method of doing the work by power. The machine illustrated has been developed recently by the Toledo Pipe Threading Machine Company, Toledo, Ohio, for this purpose, namely to provide power drive for the hand pipe-threading devices which are made by that company.



Toledo Power Driving Unit and Head Cutting 4-In. Pipe Thread

Tests indicate that this device has great time- and labor-saving possibilities, it being possible to cut a 2-in. thread in 18 seconds, a 4-in. thread in 2 min., a 6-in. thread in 3 min. or a 12 in. thread (including the time necessary to run over the pipe with a set of blank dies to true up the surface) in less than 15 min. These are said to be actual working figures which can be reproduced regularly on any pipe-threading job.

The device consists of an especially designed electric motor mounted in a housing that also encloses transmission gearing, communicating to a driving shaft, extending to the operating end of the shaft housing, the whole mechanism being mounted on wheels thus providing for easy movement from place to place. Mounted on the shaft housing just above the motor is a fuse box containing two especially designed fuse plugs which will permit of normal loads but blow should any overload become dangerous to the life of the motor. Mounted midway on the shaft housing is a switch box to which the flexible cable is connected by a two pole plug.

The driving head is furnished with two bushings, one containing a cored hole 15/16 in. square and the other containing a cored hole 1 1/16 in. square, these holes being supplied to fit the two sizes of pinions used on the various Toledo tools. At slow speed the driving head rotates at 38 r.p.m. and on high speeds at 57 r.p.m. While designed primarily for the operation of pipe cutting and threading tools, this machine has also been utilized for the operation of a hand winch and in another case for operating bending rolls in a sheet metal shop. This type of tool is to be recommended for shops having an occasional heavy thread cutting job which does not occur frequently enough to warrant the installation of a large power threading machine.

Alternating Current Motor Headstock Speed Lathe

The latest lathe development of the J. G. Blount Company, Everett, Mass., is a 12-in. alternating current motor-headstock speed lathe designed to meet the requirements of any pattern shop. This machine, which is provided with S. K. F. ball bearings, can be mounted on a bench as shown in the illustration. The headblock, consisting of a rotor and outside frame together with necessary windings, is supplied by the Westinghouse Electric & Manufacturing Company. The motor frame is a cylindrical iron casting with openings at the bottom to bring out the leads to the controller, which is directly beneath and totally enclosed. The end brackets are solid, thus making a fully enclosed motor. The feet are cast integral with the brackets, giving strength and rigidity to the motor. The bearings are mounted in dust-proof housings and secured to the spindle by suitable lock-nuts. The bearings are of larger size than regularly furnished on these headblocks, and take end thrust in either direction.

Blount Direct Motor-Driven Speed Lathe

The spindle is made of 45 carbon steel, carefully turned, threaded and ground, with a 5/8 in. hole bored the entire length. The nose end of the spindle is 1 1/8 in. outside diameter, threaded on the end with 10 V threads per inch to receive a face-plate, chucks, or other equipment.

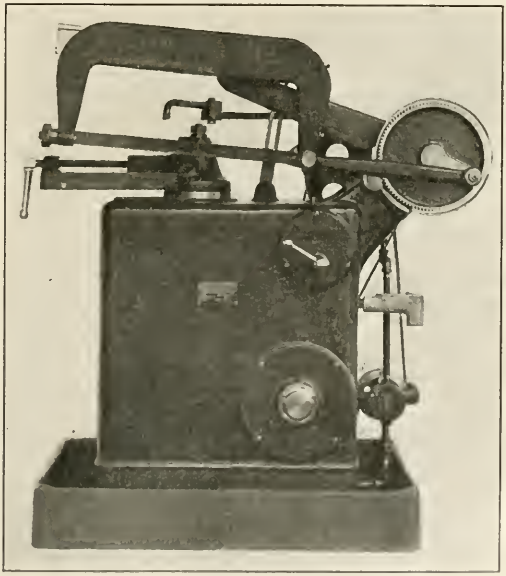
A Morse No. 2 large taper is used for the live center, and by using this particular size of taper, a much larger hole can be bored in the spindle than otherwise. The rear end of the spindle has the same size of thread as the nose end. An outside face-plate and pulley combined, 8 in. in diameter, completes this unit.

The distance between centers is 25, 37 and 49 in. on the 4-ft., 5-ft. and 6-ft. beds respectively. The portion of the bed under the headstock is widened out to allow for the controller thus fully enclosing it. A hand wheel gives four spindle speeds of 575, 1160, 1750 and 3450 r.p.m. respectively. Each lathe is provided with one spur and cup center, three T-rests, a 5 1/2-in. faceplate, a 3-in. screw chuck and a 2 1/2-in. by 4-in. right angled rest.

Self-Contained Motor-Driven Hack Saw

The electrically driven hack saw outfit shown in the illustration is unique in that the motor is housed in the base, thus making a compact self-contained unit which can be mounted on wheels if desired and used as a portable machine. This motor and its control switches are built into the machine in such a manner as to be out of the way and at the same time protected from injury. The 1/2-hp. ball bearing motor used with the equipment may be had for any commercial voltage desired. The length of the saw used is 16 in. and the length of the stroke is adjustable between 5 and 7 in. The saw can be operated at either 45 or 90 strokes per minute so that hard or free cutting stock can be cut with best results. The saw can be raised and held in any position. The feed is by gravity and an automatic stop is arranged to stop the motor when the work is cut off. The saw slide is above the blade where cuttings and grit will not fall on the sliding surfaces. An oil pump may be used if desired. The vise swivels are graduated for cutting angles.

There are many places in railroad repair shops where power hack saws are used, including the machine shop, tool-room, blacksmith shop and even in the stores department where bar stock must be cut to required lengths on orders from the various shop departments. It is essential that the tool be of ample power, easily operated and require little attention aside from the setting up and removal of the work. The fact that the new machine illustrated is driven by a self-contained electric motor makes it a flexible unit and one which can always be located in the position most convenient for the work and irrespective of the location of line shafts and driving pulleys as would be the case with belt-driven machines. Compactness is also an important feature of this machine which has a height of 36 in., occupies a floor space of 18 in. by 30 in., and weighs 450 lb. This hack saw outfit is being marketed by the Louisville Electric Manufacturing Company, Louisville, Ky.



Portable Self-Contained Power Hack Saw

Turret Tool Post for Wheel Lathes

For the benefit of those who prefer a turret to a pneumatic tool post the Niles-Bement-Pond Company, N. Y., has developed a rugged, two-position tool post, revolving in a vertical plane, as shown in Figs, 1 and 2, for use on car and driving wheel lathes. Features of special merit are the location of the roughing tool in the solid part of the tool post and the provision of a wide taper key, making the turret practically solid after adjustment. The turret *A* is a massive piece of forged, oil-hardened die steel ground and polished, designed to withstand shock and dissipate the heat from the cutting tools without distortion or annealing. Spindle *B* is of a large diameter, made from high-carbon steel. The turret is pressed on and bolted to the spindle which makes it equivalent to one solid unit.

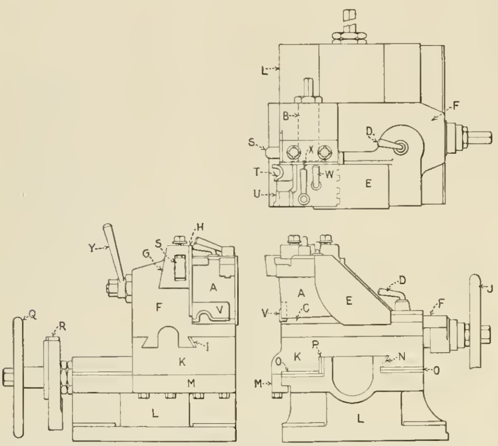


Fig. 1—Details of Turret Tool Post, Revolving in Vertical Plane, Designed for Use on Niles-Bement-Pond Wheel Lathes

Key *C* is tapered on the top side only and holds the turret firmly when forced underneath, forming a rigid lock which prevents the turret from turning. It presents a large flat surface which sustains the heavy downward pressure from the tools, thus relieving the spindle of the turret from undue torsional or shearing strains. This key is made of oil-hardened die steel ground to insure easy manipulation, which is accomplished through a rack and pinion actuated by lever *D*. The key and turret are carefully guarded from chips and dust by chip guard *E* which is hinged on the turret.

The top cross slide *F* is a right angled support for the tool block, the vertical part forming a bearing for the turret, also carrying the round nose roughing tool. On the face presented to the wheel a hardened steel plate *G* is securely fastened to prevent cutting from chips. A hardened steel plate *H* is bolted to the face adjacent to the turret so that when indexing two hardened steel surfaces are in contact. This is done to prevent wear, eliminate cutting and insure easy manipulation. The top slide is mounted on the intermediate slide by an inverted dovetail gibbed by means of a tapered packing *I* which in turn is backed up by a large section of metal to withstand the side pressure from the roughing tool. The cross adjustment is through an 18-in. hand wheel *J*, mounted on a screw having large double ball thrust bearings taking the thrust for either inward or outward adjustment. On the screw is located a collar graduated to 1/64 in. so that the operator can feed in the tool to any desired amount.

Intermediate slide *K* is made of semi-steel mounted on carriage base *L* by a combination of square locks *M* and tapered surface *N*. The components of force from the cutting tool (downward and backward) are taken on hardened steel plate *O* and *P*. These plates are to prevent cutting from chips and dust, also for easy manipulation. This member has lateral adjustment by means of an 18-in. hand wheel. The thrust from this screw is taken in both directions on a large double ball thrust bearing. Power feed to this screw is through ratchet *R*.

The round nose roughing tool *S* is 1½ in. wide by 3 in. deep. It is subject to the heaviest cutting load and is, therefore, carried on a hardened serrated steel plate, and clamped by two large hardened steel screws. The other tools are carried on two faces of the turret, thus requiring only two indexings for the complete turning of the wheel. The flange roughing tool *T* and tread chamfering tool *U* are carried on one face and the flange finishing tool *V* is carried on the other face. Tools *T* and *V* are bolted to the turret, whereas tool *U* is carried on a slide, brought into action through a cam actuated by lever *W* and clamped by lever *X*.

Operation of Turret Tool Post

All levers and hand wheels are within easy reach so that the operator can stand between the rests and see the cutting tool in operation and from this position manipulate

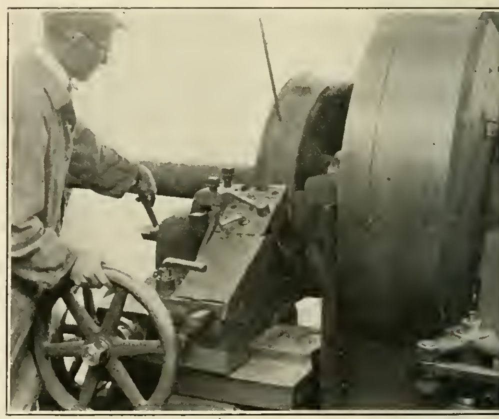


Fig. 2—Turret Tool Post Just Being Turned to Bring the Finishing Tools Into Play

the turrets. With the turret in the position shown in Fig. 1, the tread and top of the flange is turned off by tool *F*, by means of power feed. With a slight additional movement in the same direction through hand wheel *Q* tool *T* is brought into action. Without any lateral movement the turret is indexed, bringing into action tool *V*.

The indexing is done by withdrawing key *C* by lever *D* and revolving the turret through 90 deg. by lever *Y*. The turret is locked by bringing the key forward. It only requires four turns of the hand wheel *G* to withdraw the top slide sufficiently for indexing the turret. The indexing time is a fraction of a minute. The turret is again indexed back, bringing tool *U* into action. This completes the cycle of operation and leaves the turret in position to begin the next wheel. A complete set of tools is regularly furnished with each turret.

GENERAL NEWS

Weights for Car Billing Purposes

The Arbitration Committee of the Mechanical Division of the American Railway Association has issued an approved table of weights to be used in preparing and checking bills for freight car repairs. This includes the weights of bolts, including one nut; the weights of nuts; wrought iron washers; journal bearing wedges; coupler yoke rivets; flat rolled iron bars, and round iron bars.

Unit Cost of Train Operation

The average cost per freight train mile, for the selected accounts which the Interstate Commerce Commission uses to indicate unit costs of train service, for the year 1921 was $1,799, according to the commission's monthly bulletin for December and 12 months, as compared with $2,054 in 1920, a reduction of 12 per cent. Reductions were shown for each of the accounts used. The cost of coal per net ton, including freight, was $4.10 as compared with $4.20 in 1920, a reduction of 11 per cent, and the cost per passenger train mile was $.993 as compared with $1.098, a reduction of about 10 per cent. The selected accounts are locomotive repairs, engine house expenses, enginemen, trainmen, fuel and other locomotive and train supplies.

Freight Car Surplus

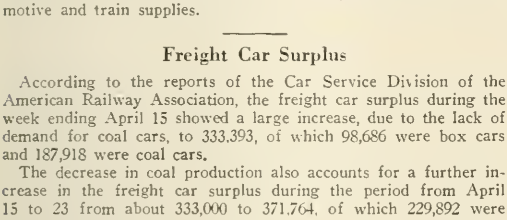
According to the reports of the Car Service Division of the American Railway Association, the freight car surplus during the week ending April 15 showed a large increase, due to the lack of demand for coal cars, to 333,393, of which 98,686 were box cars and 187,918 were coal cars.

The decrease in coal production also accounts for a further increase in the freight car surplus during the period from April 15 to 23 from about 333,000 to 371,764, of which 229,892 were coal cars and 98,406 were box cars.

The number of surplus freight cars during the week ending April 30 showed a decrease of 126 to 371,538. This included 235,077 surplus coal cars, an increase of 5,185 within the week and 94,653 surplus box cars, a decrease of 3,753.

Meter Gage Mallets for Burma

The accompanying photograph depicts a locomotive recently built by the North British Locomotive Company, Ltd., Glasgow, Scotland, for the Burma Railways (meter gage). This locomotive is a Mallet articulated compound and develops 22,170 lb. tractive effort at 50 per cent of its working pressure, which is 180 lb. The wheels are 3 ft. 3 in. in



Mallet With Tractive Effort of 22,170 Pounds

diameter. High pressure cylinders are 15½ in. in diameter and low pressure cylinders 24¼ in. Saturated steam is used and is generated by a grate area of 33 sq. ft. The engine weighs 133,000 lb. and is equipped with a Pyle National electric headlight. These locomotives are the sixth lot of North British locomotives delivered to India and Burma. They were built in accordance with the instructions of Messrs. Rendel, Palmer and Tritton, consulting engineers for the Burma Railways. The photograph and the data presented here were taken from Modern Transport (London).

Freight Car Loadings

In spite of a decrease in coal loading of 71,195 cars as compared with the corresponding week of last year, the total number of cars loaded with revenue freight in the week ending April 15 and reported by the Car Service Division of the American Railway Association was still somewhat greater than it was last year, 706,713 as compared with 702,116. It was also much greater than it was for the corresponding week of 1920, when, due to the switchmen's strike, the loading dropped to 601,695.

The number of cars loaded with revenue freight during the week ended April 22 showed increases both as compared with the previous week and with the corresponding week of last year, in spite of the light coal loading on account of the strike. The total was 714,088 as compared with 704,632 in 1921 and 717,772 in 1920.

A large increase was reported for the week ended April 29 both as compared with the week before and as compared with the corresponding week of the previous year, in spite of the light loading of coal. The total was 758,286 as compared with 721,084 in 1921 and 800,960 in 1920.

During the week ended May 6 a slight reduction was shown as compared with the week before, to 755,749 from 758,286. This represented an increase as compared with the corresponding week of last year, when the loading was 721,722, in spite of the continuance of the coal strike, but was far below the loading for the corresponding week of 1920, which was 843,184.

A. R. A. Recommends New Interchange Practice

The recommendation of the Joint Committee on Interchange of Equipment of the American Railway Association relative to joint interchange inspection of equipment, which was submitted to a letter ballot of the Association, has been approved by a vote of 303 to 14, with 81 not voting.

The recommendation, which follows, has been adopted by the A. R. A. as recommended practice.

It is the opinion of the Joint Committee that special rules of general application covering joint inspection of equipment in interchange cannot be formulated for the reason that local conditions must govern; that existing A. R. A. rules will enable interested roads to agree on inspection of equipment.

It is, therefore, suggested in the interest of economy in operation and to facilitate the movement of cars, that where inspection of equipment is involved at any point of interchange, that the interested roads arrange for conference to study conditions at that point. The following principles to govern any arrangements which may be adopted: 1.—Observance of A. R. A. rules. 2.—No backward movement of cars. 3.—No duplicate interchange inspection of cars. 4.—No delay to cars due to inspection in order to fix responsibility for damage to cars, adjustment or transfer of lading.

There are various forms of interchange inspection which can be adapted to these principles, some of which are outlined below:

A.—Joint Inspection—Where all of the inspectors are joint men under a chief joint inspector.

B.—Inspection Under the Jurisdiction of an Arbitrator—Where inspectors are in the employ of various railroads under the jurisdiction of an arbitrator, whose duty it is to harmonize and unify inspections and settle any disputes which may arise without holding cars or lading for this purpose.

C.—Delivering Line Inspection—Where interested roads accept the delivering line inspection.

D.—Receiving Line Inspection—Where interested roads accept the receiving line inspection and handle each other's defect cards.

E.—Inspection by Receiving Line's Inspectors in Delivering Line's Yard—Where receiving line inspectors make inspection in delivering line's yard.

F.—Joint Inspection and Repairs—Where a single organization in a joint terminal makes all inspections and repairs for the interested roads.

Special Train from Chicago for June Convention

For the convenience of persons going to Atlantic City to attend the convention of the Mechanical Division of the American Railway Association, which meets from June 14 to 21, inclusive, the Pennsylvania System will run a special train leaving Chicago at 1 p. m., central time, on June 12 and arriving at Atlantic City at 10:45 a. m., eastern time, on the following day. The train will consist of club, open section, drawing room and compartment cars, and a dining car.

The International Locomotive Association

The International Locomotive Association is now being promoted, having for its object the study of the history and development of the locomotive; and the preservation of records pertaining thereto. In carrying out these aims the co-operation of all interested will be welcomed.

Information in regard to the activities of the association will be made available to the members through the agency of a bulletin, in which articles of a suitable nature will also appear.

The Organization Committee consists of Arthur Curran, 16 Ballard street, Newton Center, Mass.; Charles B. Chaney, 97 Lafayette avenue, Brooklyn, N. Y., and Norman Thompson, 340 Spence street, Winnipeg, Manitoba.

Supplement to 1921 Rules of Interchange

A supplement to the 1921 Rules of Interchange has been prepared by the Arbitration Committee and the Committee on Prices for Labor and Materials of the Mechanical Division of the American Railway Association. This supplement includes several interpretations of the Rules of Interchange as rendered by the Arbitration Committee and the following modifications of the rules relative to prices for labor and materials:

Rule 101.—Entirely revised on account of present market prices and labor per hour revised to $1.10 per hour. Revision effective May 1, 1922.

Rule 107.—Several items revised on account of revision of labor rate, effective May 1, 1922.

Rule 112.—Reproduction cost per pound prices for settlement for cars destroyed reduced 30 per cent, effective May 1, 1922.

Passenger Car Rule 22.—Material allowances revised on account of present market conditions.

Wage Statistics for Last Half of 1921

The Interstate Commerce Commission has issued a consolidated statement of its wage statistics of American railroads for the six months July-December, 1921, during which its new classification of railroad employees was in effect, as well as the reduction of wages ordered by the Railroad Labor Board effective on July 1. The average number of persons in the employ of the railroads for this period shows a decrease of 416,384, or 19.7 per cent, as compared with the same period of 1920. Compensation decreased $690,829,775 or 33.9 per cent. The average number employed at the middle of the month was 1,692,794 and the average number of full-time positions was 1,592,755, while the total compensation for the six months was $1,343,886,463, of which $70,478,076 represented overtime and $55,487,464 "other compensation." In the next column a table is shown giving a recapitulation, to which has been added a column showing the average earnings per employee per month.

Carefulness Among P. R. R. Employees

The Pennsylvania Railroad reports a reduction of 55 per cent in fatalities and 37 per cent in injuries among employees during 1921 as compared with 1920. After making allowance for a decrease of 25 per cent in the average number of employees in the service during 1921, the net reduction in the accident frequency was 40 per cent in fatalities and 15 per cent in injuries.

Nine operating divisions and five shops, with a total of 19,000 employees, passed through the year without a fatal accident to an employee. The divisions are Cresson, Delaware, Norfolk, Schuylkill, Wheeling, Logansport, Richmond, Zanesville and Peoria, and the shops are Trenton, Hoboken, Altoona Car Shop, South Altoona Foundry, and Juniata. The reduction was primarily due to dull times, a light labor turnover, and few inexperienced men in the service, and to the effect of the safety movement. Many dangerous conditions have been removed, safeguards for machines installed, and working conditions generally improved.

Federal Trade Commission Investigates Proposed Steel Merger

Upon receipt of the resolution adopted by the Senate on May 12, introduced by Senator La Follette, directing the Federal Trade Commission and the attorney general to inform the Senate as soon as possible what steps have been taken or what steps will be taken to ascertain the purposes and probable effects of the proposed merger of seven of the largest iron and steel corporations, the Federal Trade Commission, on May 13, sent a demand in a telegram to the presidents of the Midvale Steel & Ordnance Company, Republic Iron & Steel Company, Lackawanna Steel Company, Inland Steel Company, Youngstown Sheet & Tube Company, Steel & Tube Company of America, Brier Hill Steel Company, and the Bethlehem Steel Corporation, asking them to submit to the Federal Trade Commission full and specific information as to the plan of the proposed merger before the plan is consummated or actual transfers made.

In this connection the commission states that the proposed merger was called formally to its attention on December 27, 1921, and that the matter has been under investigation since that time.

The Labor Board's New Quarters

The Railroad Labor Board is now located in the Transportation building, 608 South Dearborn street, Chicago, and all communications intended for the Board should be addressed accordingly. Unless otherwise advised, all hearings will be conducted in the new hearing room on the twenty-second floor of the above-mentioned building.

Labor Board Decisions

Composite Mechanics and Signal Maintainers.—A controversy arose on the Chicago & Alton with regard to the application of the minimum rate of composite mechanics to signal maintainers with less than four years' experience who were considered composite mechanics because of the ruling of the United States Railroad Administration. The carrier contended that the employees were men of less than four years' service prior to the date of issuance of Supplement No. 4, to General Order No. 27. The employees claimed that no distinction was made in this supplement between electrical workers and signal maintainers and in view of the fact that the men involved in this dispute received the minimum rate of their craft prior to the date of issuance of the supplement, they should have been paid the minimum rate for composite mechanics with four years' experience. The Labor Board decided that employees receiving an amount equal to or in excess of the minimum rate paid prior to the issuance of Supplement No. 4 should be paid the minimum rate of the highest rate of craft represented in such composite service and that such employees receiving a lower rate than that paid any of the craft of which they were the composites should receive the step rate in accordance with their experience.—*Decision No.* 795.

Two Years' Work of the Labor Board

During the first two years of its existence the United States Railroad Labor Board passed upon 632 questions, according to a report which it has just prepared. In the calendar year 1920 it issued 42 decisions, 14 interpretations and 6 addenda, while in 1921 it prepared 539 decisions, 17 interpretations and 14 addenda. During the latter year the board issued two major decisions applicable to rules governing the working conditions of employees, Nos. 222 and 501, the first covering shop craft employees and the latter maintenance of way workers. Since the first of the present year the board has rendered additional decisions governing the working conditions of clerical workers, signalmen, train dispatchers, express employees, trainmen and oilers, supervisors of mechanics and telegraphers.

Decision No. 2 of the board, which was issued on July 20, 1920, and was retroactive to May 1 of that year, covered 140 parent companies and their subsidiaries, and several terminal companies, the exact number not being known. Decision No. 33 (electric lines decision) affected 11 companies, while Decision No. 108 (short line decision) was applied to 67 companies, the three decisions enumerated above totaling 235 companies in all. It is estimated by the board that the annual increase in payrolls due to Decision No. 2 amounted to $558,180.134.56, this figure covering straight time earnings for all employees except those engaged in train and engine service for whom all time was taken into consideration. The estimated annual decrease in the payrolls due to Decision No. 147 amounted to $378,004,675.80, this figure also covering straight time earnings for all employees with the exception of those in train and engine service as mentioned above.

The number of employees in the service of the companies has fluctuated widely. The compensation report compiled by the Interstate Commerce Commission for the month of December, 1921, shows that there were then 1,637,151 men in service, while the report for August, 1920, gives the number as 2,197,784, these figures indicating the minimum and maximum employment. The decisions rendered by the board during 1920 and 1921 involved 45 employees' organizations.

London & North Western Adopts Council System for Dealing With Labor Matters

The London & North Western has announced its plan for the establishment of councils of employees and officers to bring about closer contact with the management, according to Modern Transport (London). This is in accordance with the Railways Act of 1921.

The plan provides for the formation of a council composed of not more than four members representing the employees and an equal number representing the management at every shop or station where 75 or more persons are employed. At places where fewer men are employed, a council of four representing the employees will confer with local officers. The purpose of these councils is to provide a recognized method of communicating with the employees and to give them a wider interest in the conditions under which their work is performed. The matters to be considered by the local committees are:

(1) Suggestions for the satisfactory arrangement of working hours, etc.

(2) Questions of physical welfare (safety appliances, first aid, accommodations for comfort, etc.)

(3) Holiday arrangements.

(4) Publicity regarding rules.

(5) Suggestions as to improving efficiency.

(6) Investigation of conditions tending to reduce efficiency.

(7) Correct loading of freight.

Employee representatives are to be elected from among their number, each employee over 18 years of age being privileged to vote. Representatives must have been in service at least a year. Complaints by employees must be made directly to the company as heretofore and will then be referred to the council.

Matters relating to the local application of the national agreements as to wages, working conditions, etc.; suggestions as to improved operation; points in which employees and management are mutually interested, such as increasing business and promoting economy; and subjects submitted by the local council—all these matters will be handled by sectional councils (likewise representing both employees and management), of which there are five, each covering the entire railway. These councils may not propose any changes inconsistent with rulings of the Wages Board.

The employee representation, Sectional Council No. 1, will be made up of stationmasters, agents, yard masters and traffic controllers (2 representatives); clerks (7 representatives); operating and freight traffic inspectors and foremen and dock supervisory staff (2 representatives); and inspectors and foremen in the locomotive car engineering, signal, telegraph and tugboat departments (1 representative). Sectional Council No. 2 will be made up of enginemen and motormen (12 representatives); No. 3 of signalmen, trainmen, porters, switchmen, car cleaners and car inspectors (12 representatives); No. 4 of freight house, delivery and dock forces (12 representatives); and No. 5 of maintenance of way and signal department employees and linemen (10 representatives).

The company will choose its representatives on each council from among its various officers. The plan provides for a railway council for the whole railway to deal with any matters which can properly come before a sectional council but which affect employees belonging to two or more sectional groups.

When agreements are arrived at by councils they are to be posted for the information of employees. Disagreements are referred to the trade unions, who confer with the railway managements, and if agreement is not reached, to the Central Board.

British Ordnance Works Built 100 Locomotives as Yet Unsold

British ordnance works built 100 locomotives following the armistice in order to prevent a complete shutdown and the sudden discharge of thousands of men, according to the Times (London). These locomotives are as yet unsold and until they can be disposed of represent an investment of some $2,500,000 of the government's money on which there is no return.

Railway Labor Disputes and the Federal Power

A discussion of the "use of federal power in railway labor disputes," by Clyde O. Fisher, assistant professor of economics at Wesleyan University, has been issued by the United States Department of Labor as Bulletin No. 303. It discusses the experience of this country in the development of governmental authority in the settlement of railway disputes. The law of 1888, providing for voluntary arbitration, the Erdman Act, the Newlands Act, the Adamson law, and the Esch-Cummins law are set forth, with the reactions of the different factions, that is, the unions, the railroad operators, and the public.

Meetings and Conventions

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

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City. Annual convention June 19-21, Haddon Hall, Atlantic City, N. J.

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

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Next annual convention June 14 to 21, Atlantic City, N. J.

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

Division V.—Purchase and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio. Meeting June 19, 20 and 21, Atlantic City.

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

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, A. F. Stuebing, 2201 Woolworth Building, New York.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Annual meeting, June 26-30, 1922, Chalfonte-Haddon Hall, Atlantic City, N. J.

American Society for Steel Treating.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention and exposition postponed until October 2-7, 1922, Detroit, Mich.

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

Canadian Railway Club.—W. A. Booth, 53 Rushbrook St., Montreal, Que. Regular meeting second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal.

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

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo.

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Meeting second Thursday in January, March, May, September and November, Hotel Iroquois, Buffalo, N. Y.

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

Cincinnati Railway Club.—W. C. Cooder, Union Central building, Cincinnati, Ohio. Regular meetings second Tuesday, February, May, September and November.

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

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich. Convention Hotel Sherman, Chicago, August 15, 16 and 17.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn. Annual convention September 5-8, 1922.

Master Boilermakers' Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Regular meetings second Tuesday each month except June, July, August and September, Copley Plaza Hotel.

New York Railroad Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Regular meetings third Friday of each month, except June, July and August, at 29 West Thirty-ninth street, New York.

Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Regular meetings second Thursday of each month in San Francisco and Oakland, Cal., alternate.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Regular meetings fourth Thursday in each month, except June, July and August, at Fort Pitt Hotel, Pittsburgh, Pa.

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

Traveling Engineers' Association.—W. O. Thompson, 1177 East Ninety-eighth street, Cleveland, Ohio.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Regular meetings third Monday of each month, except June, July and August.

Austria Builds 300 Locomotives in 1921

The locomotive works of Austria were well employed during 1921, chiefly on foreign orders, according to Commerce Reports. About 300 locomotives were built and delivered, as against 211 and 144 in the two preceding years. In order to keep up with the increased demand the leading firms have undertaken large additions and improvements of their plants. On account of the light demand within the country the railway car establishments were obliged to undertake foreign orders. They also had a great deal of repair work to do for foreign countries. It is difficult to obtain orders for cars from the Succession States because they are trying to get their cars from Germany by way of reparations payments.

Locomotive Orders

The Patagonian Railway has ordered 25 Mikado type locomotives from the Baldwin Locomotive Works.

The Atlantic Coast Line has ordered 80 Pacific type locomotives from the Baldwin Locomotive Works.

The Erie has ordered 15 Decapod locomotives from the United States Government. These are part of the locomotives originally built for the Russian government.

The New York, New Haven & Hartford, reported in the May issue of the *Railway Mechanical Engineer* as having ordered 15, 0-8-0 type locomotives from the American Locomotive Company, has ordered 5 additional 0-8-0 type locomotives from the same company. These locomotives will be used in the joint service of the Central New England and the New Haven.

The Chicago & North Western has ordered 20 Mikado type locomotives, 20 6-wheel switching locomotives and 10 Pacific type locomotives from the American Locomotive Company. The Mikado locomotives will have 27 in. by 32 in. cylinders and a total weight in working order of 304,000 lb. The switching locomotives will have 21 in. by 28 in. cylinders and a total weight in working order of 171,000 lb. The Pacific locomotives will have 25 in. by 28 in. cylinders and a total weight in working order of 269,000 lb All these locomotives will be equipped with superheaters.

Locomotive Repairs

The Western Maryland is having repairs made at the shops of the Baldwin Locomotive Works to about 20 locomotives, including Pacific, Mallet and Consolidation types, and is having 8 locomotives repaired at the shops of the American Locomotive Company, Richmond, Va.

The Lehigh Valley is having repairs made and superheaters installed on 14 ten-wheel locomotives at the Dunkirk shops of the American Locomotive Company. This is the beginning of a well defined program for modernizing the small motive power on this road.

Freight Car Orders

The Chicago, North Shore & Milwaukee has ordered 15 merchandise cars from the Cincinnati Car Company.

The Cuban-American Sugar Company has ordered 50 cane cars of 15 tons' capacity from the Magor Car Company.

The Chicago, St. Paul, Minneapolis & Omaha has purchased 100 ballast cars from the Rodger Ballast Car Company.

The Northern Pacific will purchase 1,000 box cars, 250 convertible work and coal cars, 250 steel coal cars and 250 stock cars.

The Chicago & North Western, in addition to its recent car order, has purchased 20 box cars and 10 flat cars from the Western Steel Car & Foundry Company.

The Chesapeake & Ohio has ordered 1,500 hopper cars from the Newport News Shipbuilding & Dry Dock Company, and 1,500 gondola cars from the Pullman Company.

The American Refrigerator Transit Company, noted in the Railway Age of April 8 as inquiring for 2,000 refrigerator cars, has ordered this equipment from the American Car & Foundry Company.

The Missouri, Kansas & Texas has ordered 300 flat cars of 40 tons capacity from the General American Car Company and 1,500 box cars from the American Car & Foundry Company. The same company also ordered 500 automobile cars from the Mt. Vernon Car Manufacturing Company.

The New York Central will have 1,000 refrigerator cars of 35 tons' capacity for its own lines and 500 for the Michigan Central built in the shops of the Merchants Dispatch at East Rochester, N. Y. Mention was made in the May issue of the *Railway Mechanical Engineer* that these cars would be built by the Merchants Despatch.

The Southern Railway has divided an order for 6,140 box cars as follows: American Car & Foundry Company, 3,000, with an option on 1,000 cars additional; Mt. Vernon Car Manufacturing Company, 1,390; Standard Steel Car Company, 1,000, and 500 40-ton automobile box cars from the Standard Steel Car Company and 250 caboose cars from the Lenoir Car Works.

Freight Car Repairs

The St. Louis-San Francisco will repair 1,800 or more freight cars in its own shops.

The Empire Refineries, Inc., have awarded a contract to the North American Car Company for repairs to 600 steel tank cars

The Chesapeake & Ohio has given a contract to the Newport News Shipbuilding & Dry Dock Company for repairing 100 freight cars.

The Cleveland, Cincinnati, Chicago & St. Louis has ordered 200 sets of underframes and superstructures from the Pullman Company.

The Elgin, Joliet & Eastern has ordered 200 car bodies for 50-ton structural steel side dump cars and 300 car underframes from the J. W. Heggie Company, Joliet, Ill.

The Bangor & Aroostook is rebuilding 250 freight cars in its shops at Derby, Me., which work was authorized last year, and is contemplating the rebuilding of 250 more. The company has recently purchased two Russel snow-plows.

Passenger Car Orders

The Chesapeake & Ohio has ordered 22 undivided coaches, 8 divided coaches, 8 combination passenger and baggage, 5 express with automobile doors and 20 straight express cars, from the Pressed Steel Car Company.

The Southern Railway has ordered 75 cars from the Pullman Company and 25 cars from the American Car & Foundry Company. These include 40 steel passenger coaches, 10 steel combination passenger and baggage cars and 25 steel baggage express cars to be built by the Pullman Company and 25 steel postal cars to be built by the American Car & Foundry Company.

Machinery and Tools

The Cuba Railroad has ordered a number of heavy machine tools for use in its new shops at Camaguey, Cuba.

The Western Maryland has placed orders for the following machines: 36 in. and 48 in. lathes; 6 in. pipe threading machine; 2 in. bolt cutting machine; two 28 in. vertical drilling machines; 5 ft. radial drill; 84 in. boring and turning mill; 36 in. and 42 in. planers; 6 in. car hack saw; 300-ton wheel press and a bushing press.

Shop Construction

Atchison, Topeka & Santa Fe.—This company has awarded a contract to Joseph E. Nelson & Sons, Chicago, for additions to its machine shop at Topeka, Kan., to cost approximately $60,000.

Cisco & Northeastern.—This company has awarded a contract to J. H. Latson, Cisco, Tex., for the construction of a 40-ft. by 200-ft. brick locomotive repair shop in that city, to cost $12,500.

Great Northern.—This road has awarded a contract to the National Boiler Washing Company, Chicago, for the construction of a hot water washout and refill system at Wenatchee, Wash., and to the F. W. Miller Heating Company, Chicago, for a similar system at Minneapolis Junction, Minn.

PERSONAL MENTION

GENERAL

H. E. Smith has been appointed engineer of tests of the New York Central Lines with headquarters at New York.

J. McKenzie has been appointed general car inspector of the Pere Marquette with headquarters at Grand Rapids, Mich., succeeding W. F. Crowder, who has been promoted to shop efficiency engineer.

Robert Quayle, general superintendent of motive power and machinery of the Chicago & North Western, has retired after 54 years of service with this road. Mr. Quayle was born on the Isle of Man November 23, 1853, and entered railway service in 1868, as a machinist apprentice on the Chicago & North Western in its Chicago Avenue shops. In 1872 he was transferred to the shops at Fortieth street, Chicago, where in October, 1877, he was promoted to assistant foreman. Three years later he was made foreman of the car and machine shops. On June 15, 1885, he was promoted to master mechanic with jurisdiction over all lines in Iowa. On April 1, 1891, he was promoted to general master mechanic of the Milwaukee, Lake Shore & Western, where he remained until December 1, 1894, when, following the absorption of this road by the Chicago & North Western, he was promoted to superintendent of motive power and machinery, with headquarters at Chicago. On November 1, 1913, he was promoted to general superintendent, motive power and car department and on March 1, 1920, he became general superintendent, motive power and machinery.

Robert Quayle

Elred Byron Hall has been promoted to superintendent of motive power and machinery of the Chicago & North Western, succeeding H. T. Bentley, promoted. Mr. Hall was born at Parkersburg, Iowa, December 31, 1870, and entered railway service on September 23, 1889, as an engine caretaker for the Chicago & North Western at Eagle Grove, Iowa. He served in that capacity and later as a machinist helper until 1892, when he became a shopman at Hawarden, Iowa, where he served until 1898, when he became a locomotive fireman. After nine years' service as a locomotive fireman and three years' service as a locomotive engineman on the Sioux City and the Northern Iowa divisions he became road foreman of engines of the Sioux City division, in which capacity he continued until 1912, when he was promoted to master mechanic of the Wisconsin division, being transferred to the Sioux City and Northern Iowa divisions in 1914. In 1917 he became assistant to the general superintendent of motive power at Chicago, the duties of which office had to do chiefly with labor matters. In 1917 he was appointed assistant superintendent of the Wisconsin division, with headquarters at Milwaukee, Wis., and in 1919 he was promoted to assistant superintendent of motive power at Chicago, with jurisdiction over lines west of the Missouri river. A year later he was promoted to principal assistant superintendent of motive power and machinery with jurisdiction over the entire system.

E. B. Hall

Harry T. Bentley has been promoted to general superintendent of motive power and machinery of the Chicago & North Western, succeeding Robert Quayle, retired. Mr. Bentley was born in London, England, on June 4, 1862, and was educated at Dulwich College in that country. He entered railway service in 1877 as a machinist apprentice on the London & Northwestern (England). After 10 years' service he became foreman of the enginehouse of the same road at Chester, England, where he remained until 1892, when he came to America and entered the service of the Chicago & North Western as a machinist in its Chicago shops. Shortly thereafter he was promoted to foreman in the shops at Boone, Iowa, and in 1895 he was transferred to Belle Plaine, Iowa, where he remained until 1898 when he became general foreman of the shops at Clinton, Iowa. Seven months later he was promoted to master mechanic of the Madison division and on December 30, 1899, he was transferred to the Iowa division. On August 31, 1902, he was promoted to assistant superintendent of motive power and machinery, with headquarters at Chicago and on October 31, 1913, he was promoted to superintendent of motive power and machinery, with the same headquarters, in which capacity he served continuously to the time of his promotion to general superintendent, except for the period from February 2, 1918, to June 19, 1918, when he was assistant director of transportation of the United States Railroad Administration, in charge of mechanical matters, with headquarters at Washington, D. C., in which capacity he served as chairman of the committee organized to prepare plans and specifications for standard locomotives and cars. Mr. Bentley was president of the American Railway Master Mechanics' Association in 1911-1912; and president of the International Railway Fuel Association the following year.

H. T. Bentley

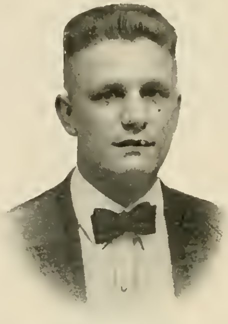
MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

James E. Goodwin has returned to the Northern Pacific as master mechanic at Duluth, Minn., after a five months' leave of absence and John A. Marshall, acting master mechanic, has been appointed road foreman of engines at Duluth.

PURCHASING AND STORES

R. M. Nelson has been appointed purchasing agent of the Chesapeake & Ohio. Mr. Nelson was born in Hanover county, Virginia, on November 6, 1873, and was educated at McGuire's University School, Richmond, Va. After having completed schooling in 1890, he entered the service of the Chesapeake & Ohio (then the Newport News & Mississippi Valley) as a clerk in the store department at Lexington, Ky. During the following year, he served in the same capacity in the freight office and then in the auditor's office at Lexington. In 1892 he went to Ashland, Ky., as a clerk in the freight office and during the same year was transferred to Lexington in the same capacity. In 1901 he was promoted to traveling auditor and, in 1904, was appointed chief clerk in the freight office at Newport News, Va. In January, 1912, he became chief clerk to the purchasing agent at Richmond, Va., and in January, 1916, was promoted to assistant purchasing agent. He was appointed assistant to the director of purchases and stores in April, 1921, and was serving in that position at the time of his recent promotion.

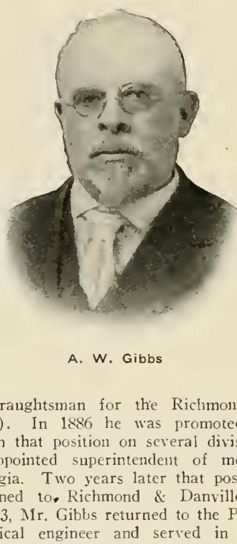
A. W. Hix has been appointed assistant to the director of purchases of the Chesapeake & Ohio. Mr. Hix was born at Bramwell, W. Va., on December 10, 1892, and was educated in the public schools and at Massey's Business College at Richmond, Va. On November 24, 1908, he entered the service of the Chesapeake & Ohio in the office of the storekeeper at Richmond. Two years later he was transferred to the purchasing department as stenographer to the assistant chief clerk. From that time on he worked in various positions including those of file clerk, invoice clerk, trace clerk, tabulation clerk and order clerk, in which position he was serving at the time of his recent promotion as noted above.



A. W. Hix

OBITUARY

Alfred W. Gibbs, chief mechanical engineer of the Pennsylvania, with headquarters at Philadelphia, died suddenly from heart failure on May 19 at his home in Wayne, Pa. Mr. Gibbs was born at Fort Filmore, N. M., on October 27, 1856. He attended Rutgers College Grammar School, New Brunswick, N. J., and Rutgers College (the latter institution in 1873 and 1874) and then entered Stevens Institute of Technology, Hoboken, N. J., from which institution he was graduated in 1878. In March of the following year Mr. Gibbs entered the service of the Pennsylvania as a special apprentice in the Altoona shops and continued as such until June 1, 1881, when he became a draughtsman. Four months later he left the Pennsylvania to become a draughtsman for the Richmond & Danville (now the Southern). In 1886 he was promoted to master mechanic and served in that position on several divisions until 1890, when he was appointed superintendent of motive power of the Central of Georgia. Two years later that position was abolished and he returned to Richmond & Danville as master mechanic. In July, 1893, Mr. Gibbs returned to the Pennsylvania as assistant mechanical engineer and served in that position until September, 1902, when he was appointed superintendent of motive power of the Philadelphia, Wilmington & Baltimore (a subsidiary of the Pennsylvania). On January 1, 1903, he was promoted to general superintendent of motive power of the Pennsylvania Railroad and on July 1, 1911, was appointed to the newly created position of chief mechanical engineer, in which capacity he was serving at the time of his death. Mr. Gibbs was one of the managers of the Franklin Institute, Philadelphia. He served for many years as chairman of the Committee on Tank Cars of the Mechanical Division of the American Railway Association. He was a member of the advisory committee of the Locomotive Cyclopedia for each edition of that volume excepting that of 1912 and at the time of his death was chairman of this committee. Mr. Gibbs played a prominent part in the mechanical design of the electric locomotives built for the Pennsylvania Railroad's electrification at New York.



A. W. Gibbs

SUPPLY TRADE NOTES

The Foamite Firefoam Company has removed its office from 200 Fifth avenue to 151 Fifth avenue, New York City.

C. K. Lassiter, vice-president in charge of manufacturing of the American Locomotive Company, New York, has resigned.

The Sharon Pressed Steel Company has removed its office from 66 Broadway to its new warehouse at 47 West Broadway, New York City.

The Chicago-Cleveland Car Roofing Company has moved its general offices from the Railway Exchange building, Chicago, to the Kimball building.

Leslie G. Lamborn has been appointed manager of the Sheet Metal and Wire Works division of the Parker Rust-Proof Company, Detroit, Mich.

The Davis Brake Beam Company, Johnstown, Pa., has removed its sales office from the Frick Annex to 1619 Oliver building, Pittsburgh, Pa.

The McClellan Products Company, Chicago, has recently been organized to handle the McClellan refrigerating machine for installation on railroad cars.

W. E. Mathews has joined the sales organization of the Lima Locomotive Works, Inc., Lima, Ohio. He will devote his entire time to the sale of Shay geared locomotives.

The Metal & Thermit Corporation, New York, has removed its Pittsburgh branch office from 1427 Western avenue to 801-807 Hillsboro street, Corliss Station, Pittsburgh, Pa.

Howard Yeomans has been elected president of the Bishop & Babcock Company, Cleveland, Ohio, succeeding E. S. Griffiths, who has resigned due to ill health. F. R. Pleasanton has been elected vice-president and general manager.

C. E. Allen, manager of the central station division of the Westinghouse Electric & Manufacturing Company, with headquarters at Chicago, has been promoted to manager of the St. Louis, Mo., office, with headquarters in the latter city.

J. Martin Duncan, follow-up engineer of the Detroit Steel Casting Company, Detroit, Mich., has been promoted to general sales manager and E. R. Young has been appointed follow-up engineer to succeed Mr. Duncan.

W. H. Saunders, district sales representative of the National Cast Iron Pipe Company, with headquarters at Dallas, Tex., has been transferred to Kansas City, Mo. He will be succeeded at Dallas by B. L. Hendershot.

Louis F. Vonier, formerly sales engineer of the Federal Bridge & Structural Company, with headquarters at Waukesha, Wis., has been appointed district representative of the Lyon Metallic Manufacturing Company, Aurora, Ill., with headquarters at Milwaukee, Wis.

E. A. Langenbach has been elected president of the Alloy Steel Corporation, Canton, Ohio, succeeding H. R. Jones, resigned; Mr. Langenbach also has been re-elected chairman of the board of directors. John McConnel, who recently returned to the company, and Elton Hoyt, of Pickands, Mather & Co., Cleveland, Ohio, have been elected directors, succeeding E. L. Hang and J. A. Buell, while George H. Clark has been elected vice-president and general manager, and C. W. Kreig, vice-president, secretary and treasurer, succeeding Mr. Hang as treasurer. Mr. McConnel has been elected vice-president in charge of operations.

The Bucyrus Company, South Milwaukee, Wis., has under way extensive enlargements to its plants at South Milwaukee and at Evansville, Ind. In the South Milwaukee plant, where all the larger machinery is built, a new gray iron foundry is now under construction, 276 ft. in length. The old gray iron foundry is being converted into a cleaning room with annealing ovens, sand blast rooms and a welding room. A large addition is also being made to the steel foundry molding floor, and an electric furnace is being installed. At the Evansville plant, which specializes in the manufacture of small revolving shovels, the machine and erecting shops are being considerably enlarged.

I. L. AuWerter, sales representative of the Carnegie Steel Company in the Michigan territory, has been appointed Michigan district sales manager of the Apollo Steel Company, with headquarters at Detroit, Mich.

E. P. Waller, assistant manager of the railway department of the General Electric Company, Schenectady, N. Y., has been appointed manager of the railway department. J. G. Barry, who has heretofore held the positions of general sales manager of the company and manager of the railway department, will in the future devote his entire time and attention to the work of the sales managership. Mr. Waller was born in Martinsville, Va., and was graduated from the Virginia Polytechnic Institute in the class of 1900. Following his graduation he entered the testing department of the General Electric Company at its Schenectady Works. After two years in that department he joined the staff of its publication bureau and later served as associate editor of the General Electric Review. In the fall of 1903 Mr. Waller took up commercial railway work under Mr. Barry and in 1912 he was appointed assistant manager of the railway department, which position he held at the time of his recent appointment as manager of that department.

E. P. Waller

W. T. Tyler has been elected director, vice-president and general manager of the National Safety Appliance Company, San Francisco, with temporary headquarters in the Peoples Gas building, Chicago. Mr. Tyler was born in Janesville, Wis., on July 20, 1870. He entered railway service in June, 1883, as a messenger on the Wisconsin Central and was later an operator and dispatcher on the same road. In 1889 he was employed as a brakeman on the Milwaukee, Lake Shore & Western, now a part of the Chicago & North Western. From that time until 1891 he was a brakeman and conductor on the Northern Pacific, and from 1891 to 1900 he was consecutively, yardmaster, trainmaster and a superintendent of the Great Northern. He was appointed a superintendent of the St. Louis, Iron Mountain & Southern in 1900, and was promoted to general superintendent the following year. He was later successively general superintendent and general manager of the St. Louis-San Francisco. In 1915 he became a superintendent of the Northern Pacific, with headquarters at Pasco, Wash., and on February 1, 1917, was appointed general manager of the St. Louis-Southwestern. On May 15, 1917, he was elected first vice-president of this road, and on November 1, 1917, he resigned to become assistant to the vice-president in charge of operation of the Northern Pacific. On January 22, 1918, Mr. Tyler was appointed assistant to the director of the Division of Operation, with headquarters at Washington, D. C., and he was appointed senior assistant director on July 1, 1918. He was appointed director of the division of operation on January 15, 1919, in which capacity he served until March 1, 1920, when he became vice-president in charge of operation of the Northern Pacific. He later resigned and, as mentioned above, has now entered the railway supply field.

W. T. Tyler

S. F. Bowser, founder and president of S. F. Bowser & Co., Fort Wayne, Ind., has retired from the presidency of the company to become chairman of the board. Mr. Bowser served for 37 years as the head of the business which was started by him in March, 1885. A change of organization was effected so that he could transfer to others some of the responsibilities he had carried for such a long time and he was made chairman of the board of directors and S. B. Bechtel was elected president. The company has its home plant at Fort Wayne, Ind., a Canadian plant at Toronto, Ont. and a third plant at Milwaukee, with tank assembly plants at Albany, N. Y., and Sydney, Australia. The company makes oil and gasoline tanks and pumps and other allied products, including a high grade system of oil filtration. S. B. Bechtel, the new president, entered the employ of the company in 1899, in the collection department; two years later he was appointed assistant superintendent of salesmen and, the following year, manager of the mail order sales and advertising departments. In 1906 he was appointed assistant to the general manager and subsequently served consecutively as secretary, assistant general manager, general manager and, since 1920, as vice-president and general manager until his election as president.

S. F. Bowser

S. B. Bechtel

A. W. Preikschat has been appointed western manager of the car hardware department of the National Lock Washer Company, Chicago. After graduating from high school, Mr. Preikschat received his technical training at Armour Institute of Technology. He then served with the Pullman Company for four years, in the drafting and template departments, and then for five years as assistant to the engineer of tests in charge of physical inspecting and testing with the same company. He was with the Steel & Tube Company of America for one year and a half, as mechanical representative in the purchasing department and then for two years with the Liberty Steel Products Company, Inc., as assistant mechanical engineer. He later served for one year and a half with Templeton, Kenly & Company, Ltd., Chicago, as special engineer in its railway sales department.

A. W. Preikschat

Louis W. Sipley, formerly sales engineer with the Electric Storage Battery Company, Philadelphia, Pa., has been appointed sales engineer for the Safety Car Heating & Lighting Company, New York. Mr. Sipley's headquarters are in the Commercial Trust building, Philadelphia. He is a graduate of Bucknell University, holding degrees in both mechanical and electrical engineering. While with the Electric Storage Battery Company, his duties included handling the power plant and railway sales.

"No Pullman Merger," Carry Says

E. F. Carry, president of the Pullman Company, has declared that there is no foundation for various rumors connecting the Pullman Company with mergers with other concerns. "There has been no official talk or thought of buying any concern excepting our purchase of Haskell & Barker," he said. "With regard to the reported plan to segregate the operating and building functions of the company through separate organizations, I am told that such a suggestion has been made to the Pullman board of directors at least once annually for the past 10 or 12 years, and at intervals the directors have discussed it to some extent, but with no result. This year is no exception, and the matter will again be duly discussed, but whether anything will be done about it remains to be seen."

OBITUARY

William A. Greaves, a retired machine tool manufacturer, Cincinnati, Ohio, died in that city on April 18. He was the organizer of Greaves-Klusman & Company, lathe manufacturers.

Robert H. Illingworth, whose service as a director and vice-president of the Crucible Steel Company of America, prior to April 1, when he resigned, died on April 23 at his home in Newark, N. J., at the age of 61.

Laroy S. Starrett, president of the L. S. Starrett Company, Athol, Mass., died April 23, at St. Petersburg, Fla. Mr. Starrett, who was born April 25, 1836, at China, Me., was educated in country schools and worked on a farm until he reached the age of 17 when, because of his keen interest in the mechanical line, he went to Newburyport, Mass., to work in a machine shop. Work was slack there, however, and he was soon obliged to go back to farming and in 1862, or during the Civil War, he had a well-stocked dairy farm of 600 acres. Later he again abandoned farming and busied himself rainy days working out mechanical problems in a small work room in his barn. In 1866 he took out three patents and leased a shop with power in Newburyport, put in machinery and hired mechanics to manufacture Starrett's patent meat chopper, later called the American chopper. In 1868 he sold out to the Athol Machine Company, a company incorporated to manufacture his inventions, among which was a line of vises; also a shoe hook fastener. He was later forced out of the company by fellow officials who thought they could push things faster and make more money. Mr. Starrett took this set-back with patience and good nature, starting anew in the same line of activity in a little shop connected with the former Richardson machine shop and later in a part of a cotton factory. Soon afterwards he began to manufacture the Starrett line of tools and mechanical appliances which he had been for years industriously perfecting and for which he is probably best known.

L. S. Starrett

Knox Taylor, since 1910 president of the Taylor-Wharton Iron & Steel Company, High Bridge, N. J., died at his home in High Bridge on April 4. He was born at High Bridge on October 19, 1873, and was graduated from Princeton University with the degree of bachelor of science in 1895. In January, 1902, he entered the service of the Taylor Iron & Steel Company and worked up through various departments in the foundry and the old wheel shop until he became general manager in October, 1905. The High Bridge plant had been engaged in the production of manganese steel since 1892, under license of the Hadfield patents. In 1912 the company purchased all the interests of William Wharton, Jr., & Co., Inc., of Philadelphia, and its subsidiary, the Philadelphia Roll & Machine Company. The Wharton Company had originated the application of manganese steel in track work in co-operation with the old Taylor Iron & Steel Company, and the new combination became known as the Taylor-Wharton Iron & Steel Company. In 1913 the company also bought out the interests of the Tioga Iron & Steel Company, Philadelphia. During the war, Mr. Taylor, in additio nto the work of his company's own contracts for gun forgings, helped supply railway track material for the American Expeditionary Forces. Mr. Taylor was a vice-president of the Railway Business Association and a member of many clubs.

TRADE PUBLICATIONS

Pneumatic Drills.—Pigmy pneumatic drills for light work are described and illustrated in a four-page leaflet recently issued by the Independent Pneumatic Tool Co., Chicago, Ill.

Reducing Valves.—A 28-page reference book of rules, tables, curves, data and formulas to determine the correct size and capacities of reducing valves; also for determining the capacity and flow of steam in pipes of different diameters and different losses in pressure, has recently been issued by the Atlas Valve Company, Newark, N. J.

Aluminum Roofing.—Aluminum roofing is the title of a 15-page booklet issued by the American Aluminum Architecture Company, Aurora, Ill., on aluminum as a roofing material. This booklet discusses the adaptability of aluminum for building purposes, and describes in detail the Ridgdown aluminum shingles and other roofing products which this company manufactures.

Evaporators for Boiler Feed Water.—The application of evaporators to the purification of boiler feed water by distillation is covered in a general and non-technical manner in bulletin No. 360 recently issued by the Griscom-Russell Company, New York. This booklet is so written that the application of Reilly self-scaling evaporators to the power plant may be readily understood by executives.

Spindle Specifications.—"The Spindle Book" is the title of an unusual 59-page booklet recently issued by the Jacobs Manufacturing Company, Hartford, Conn. Spindle specifications of various machine tools for which either taper shank drills, taps or drill chucks may be used, have been compiled and printed in this booklet under the names of the respective manufacturers of the products listed.

Hand Cut Files.—Murcott & Campbell, Brooklyn, N. Y., has just issued a finely illustrated catalogue of 43, 9 in. by 12 in. pages showing the various kinds and sizes of hand cut files made by this company. Enameled paper is used in the catalogue and the illustrations are so clear cut as to give an accurate idea of the actual appearance of the files. Forty-three different kinds of files are illustrated and the catalogue will be of great assistance in showing file users just which type of file will best serve their individual needs. Price lists of files and rasps are included.

Welding Rods and Electrodes.—A 40-page handbook known as Catalogue No. 500 has recently been issued by the Page Steel & Wire Company, Bridgeport, Conn., which gives a variety of information concerning Page-Armco welding rods and electrodes for oxy-acetylene and electric welding. The catalogue is well illustrated and in addition to the welding rod data, it contains a fund of miscellaneous information useful to the welder concerning the metallurgy of iron and steel, amount of welding material required per lineal foot of weld, definitions of electrical units, mensuration factors, wire gage table, etc.

Railway Mechanical Engineer

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Some Defects of Coaling Stations

The coaling station is often a source of considerable trouble in the operation of a locomotive terminal. This is one of the most important terminal facilities and the men in the mechanical department are directly concerned with its operation but they usually give little attention to the design of such plants and when new coaling stations are built, have little voice in the matter. An examination of typical terminals often shows defects in the coaling arrangement that could have been avoided if the requirements of operation had been more carefully considered. Some coaling stations are designed for unloading only one type of car. In emergencies other types must sometimes be used, causing embarrassing delays that might have been avoided by a slight change in the receiving pit. Another cause of trouble is the inadequate provision for spotting cars. Oftentimes the tracks are placed on a grade so that the cars can be moved with pinch bars. This is unsatisfactory, especially when snow blocks the track. A winch with sufficient power to move a loaded car under any ordinary conditions would avoid laboriously pinching the cars along the track, which is both inconvenient and costly.

Aside from a matter of economical handling, the design of coaling station may have a considerable effect on fuel economy. If much breakage takes place in the chute, the coal may be too small to burn efficiently or if the lumps and the fine coal separate, some locomotives may get all lumps and others mostly slack, neither of which will give as good results as a uniform mixture.

Increased Life for Wood in Car Construction

One of the most fruitful sources of deterioration of freight cars, irrespective of the material of construction, is corrosion or decay, which continuously exerts its destructive influence whether the equipment is in service or not. In the case of wood parts there are very few renewals which are not directly caused or at least greatly hastened by decay. Indeed, a close analysis of failures which appear to be purely mechanical will generally disclose the gradual destruction of the piece by decay as the original source of weakness.

The use of paint, to which preservative treatment is now generally confined, has no power to prevent the destruction of the material, by chemical action in the case of steel and by the propagation and growth of the destroying fungi in the case of wood, except by the mechanical exclusion of the offending elements. The preservative treatment of timber by impregnation with a solution (generally creosote or zinc chloride) which prevents the growth of decay, not by mechanical exclusion but by toxic action, has been extensively applied with excellent results in the case of ties and offers possibilities for increasing the life of the wood parts of freight cars the development of which is likely to increase very materially the economic advantages of wood construction in freight car superstructures. It has already been applied to certain parts of refrigerator, stock and gondola cars by several railroads and although none of these applications have yet been in service long enough to determine the full effect of the treatment in prolonging the life of the equipment, it has already been demonstrated that this life will be much longer than can be obtained without such treatment.

No doubt considerable study will be needed before the full possibilities and limitations of the several processes of preservative treatment as applied to freight car material can be fully determined. Their application to such parts as sills, underframe, nailing strips, stock car decking, sheathing, posts and braces, roofing, running board saddles, gondola decking and sides, refrigerator car sub-flooring, and other parts, has demonstrated that the possibilities are extensive. The subject is worthy of much more serious consideration by car department officers than it has received in the past.

Radical Innovations in Locomotives

No one who follows the development of the locomotive can fail to be impressed with the many designs embodying new and radical features that are now being built. For years turbine locomotives have been discussed in the technical press but the designs have not progressed beyond the drafting room. At present two turbine locomotives are in service and still more are being designed and will probably be built. Internal combustion locomotives likewise have been proposed many times but except for Diesel's experimental engine, no important locomotives of this type have been constructed. Hydraulic transmissions are now being tried and may overcome the difficulty of starting trains, which has been the stumbling block for the internal combustion locomotive. Apparently many of the unique designs which have been discussed pro and con for years will soon have an opportunity to prove whether they have advantages over the reciprocating steam locomotive that will justify their use.

It is still too early to judge the worth of the new types of motive power which are now being tested, in fact the experimental locomotives will not settle the question. In regular service a locomotive never gets the close attention that a new design receives on its trial trips and the fact that a turbine or internal combustion locomotive shows a considerable saving in fuel as compared with an ordinary superheated steam locomotive, does not by any means prove that it is superior for every-day operation. The relative economy of the different types depends also on the first cost, the cost of maintenance, the maximum sustained power output and the yearly mileage that can be obtained.

Whatever the outcome of the tests of these radical locomotive designs may be, they will probably lead to the development of equipment that will be useful for certain classes of service, although the reciprocating steam locomotive will no doubt hold its place for some time to come. It is to be hoped that at least one of the new locomotives will be a success, for this would spur all who are interested in the present type of locomotive to increased efforts. Recent years have been notable for the lack of initiative in departing from established methods and something seems to be needed as a spur to further development.

Diagrams for Keeping Control of Operations

An array of figures, no matter how well tabulated, can never be compared for ease and quickness in grasping changing conditions with the same figures converted into a diagram. It does not require an engineering training or any special knowledge to appreciate the meaning of an upward or downward trend of a line with a suitable scale at the side. Such diagrams were originally used by engineers but their value was so apparent and their field of application so wide and varied that they are now commonly used in all kinds of activities by business men, manufacturers, purchasing agents, storekeepers, etc. With a little ingenuity diagrams can be so laid out in such simple form that they can be filled in by any clerk. Thus far their use does not appear to be nearly as common in the railroad field as in many others, although their value is fully as great to a railroad man as to any other. By systematically plotting the figures from periodical reports, daily, weekly, or monthly, as the case may be, one can instantly see the trend and control matters accordingly. Thus the number of men employed, the number of engines turned per day, the length of time required for overhauling an engine or passenger car, the output of machines, the coal consumed by stationary boilers, are but a few examples of the places where the use of diagrams have proved helpful. To the storekeepers they are invaluable. As an illustration, 4 in. by 6 in., or any other standard size cards may have twelve vertical lines, one for each month, and a suitable scale selected by which the stock on hand the first of each month may be marked. A glance at such cards will tell at once whether the stock is sufficient. Many storekeepers and purchasers also find it important to keep similar cards showing stock drawn as an aid in placing requisitions or in making contracts for purchases. One of the best proofs of the value of diagrams is indicated by the fact that practically every one who has started to use them for one or two things has soon found other places where they may be applied to advantage. If you have not used them, why not take some particular case and see how much more of a story a diagram will tell you than a tabulation of figures?

Why Continue to Use Obsolete Machinery?

One of the first things which will occur to any "live-wire" industrial manufacturer, visiting the average railroad shop, is the number of old and obviously inefficient machine tools used. In most cases the shop foreman or master mechanic will say that appropriations for new machines cannot be secured, or if they are secured, the purchasing agent buys the cheapest machine available of the type needed. The result is that old machine tools cannot be replaced and often new machines purchased are of a type inferior to the particular ones requested. Such conditions exist largely because higher railroad executive officers, including the presidents, do not know exactly what the conditions are and fail to realize the needs. Maintenance of equipment is but one part and possibly a minor one of the many problems confronting these officers. They cannot appreciate the losses due to inadequate shop equipment unless these are forcefully demonstrated.

It is the duty of shop and mechanical department officers to show in an unmistakable way just what the annual loss is from operating inefficient shop machines. The higher railroad officers should be made to appreciate that large amounts of money are saved or lost depending on the condition of shop equipment and machinery. As an example of the failure of mechanical department men to get across with their story of shop needs, a specific case may be mentioned. A turret lathe manufacturer, socially acquainted with the president of a large railway system, had been trying to introduce his machines on the system. In four or five shops he tried and failed, the road having purchased additional old-style, cheaper and less efficient machines. The question was brought up at another shop and the mechanical officer in charge again recommended this machine but said that it was hopeless to secure approval from the management on account of its cost. In leaving the office, the manufacturer encountered the president of the railroad and during a brief chat, explained the purpose of his visit. The president asked the mechanical officer if he believed claims regarding the machine were accurate and was told that they were. He then stated that he would approve the purchase. A few months after the machine was installed, the president of the railroad again met the manufacturer and became quite enthusiastic about his machines saying that he had personally observed them doing about five times the work of the old machines. He then asked why these machines were not installed before and was told that for 10 years every requisition for them had been turned down in spite of the best efforts of the manufacturer with both the mechanical and purchasing departments.

If there is one duty more than another which is strictly up to the shop and mechanical department officers, it is to wake up and find out exactly how much their roads are losing every day by the operation of inefficient machinery and shop equipment fit only for the scrap pile. If accurate figures are compiled showing the cost by present methods and the savings possible with modern equipment, the figures will be sufficiently large to attract the attention of even the highest railroad officers to whom they are presented. As soon as the real need of the shops is appreciated by higher railroad officers, there will be far less difficulty in getting the required appropriations for new tools.

Mill Room Equipment Important

When the idea of the steel car was first advanced there was a general feeling that such cars would eventually replace all wooden equipment and last practically forever. This supposition has since been shown to be without basis in fact since steel cars do eventually deteriorate, and with great speed, especially in some kinds of service. In freight car equipment there has been a noticeable reaction in favor of the wooden, or at least of the composite car, and while the old fashioned railroad mill room may have lost forever its position of first importance in car repair work it is still a vital factor. Many men fail to appreciate the immense quantity of lumber worked up annually in railroad mill rooms and the consequent need of an adequate amount of modern, labor-saving, mill room machinery. A single large eastern railroad, for example, uses 100,000,000 board feet of lumber annually for bridge timbers, car sills, framing, flooring, roofing, siding, lining, etc., exclusive of ties. When it is remembered that there are about 200 Class I roads in the United States some of which use less but others probably more lumber than the road quoted, some conception can be had of the enormous total consumption of lumber. This lumber must all be machined to size and finished in accordance with the service expected of it and the railroads cannot afford to do this work with anything less than the best of modern wood-working machinery.

Not only should an adequate amount of modern machinery be installed but every effort should be made to keep present machines in the best of repair and working condition. In addition, it is essential to provide means for properly sharpening machine knives, cutters, saws and other tools. A sharp tool will do its work far better than a dull one; also more quickly and easily; in the majority of cases the best way to keep tools sharp is by means of automatic machinery developed for the purpose. While it is possible to sharpen a circular saw, for example, by hand the result is relatively unsatisfactory. It is impossible to get the same degree of regularity with hand filing as with an automatic machine and regularity is needed. To cut efficiently a circular saw must be accurately round with uniform teeth and with a gullet outline affording the proper hook for the wood being sawed. The term "wood-butchers" is aptly applied to those so-called practical men who cannot afford the time to keep their saws and cutting tools sharp. In consideration of the immense amount and value of the lumber that is cut and dressed and the power and labor expended the importance of sharp cutting tools and an adequate amount of modern mill room machinery is evident.

Grinding Car Journals

FOR some time the *Railway Mechanical Engineer* has taken the stand that grinding machinery and methods are not utilized as extensively in American railway shops as they should be. Among other uses, the grinding of locomotive and car axles presents an extensive field in which there is reason to believe that the grinding machine can affect great aggregate savings. According to one of our English contemporaries, railway shop managements in England have already taken active steps looking towards this use of grinding machines, as a result of tests of axles roughed out on axle lathes and finished at both the journals and wheel seats by grinding.

It is felt in England that the accuracy of machining railway equipment axles is second only in importance to the quality of the metal, and the machinist as well as the metallurgist can do much to increase the service secured from axles. In the tests referred to, axles were roughed out in accordance with previous practice on production axle lathes, but instead of being finish turned and rolled, both the journal and wheel seats were finished by grinding. The production times for the various operations were recorded. For example, one of the heaviest English axles, having a 5⅝ in. by 10¾ in. journal with a 7¾ in. by 8 1/16 in. wheel seat was roughed out on the journals and wheel seats in an axle lathe in 13 minutes. The axle was turned to within 1/16 in. of the finished size, using a feed of approximately 1/16 in. per revolution and without using any measuring device except the stops on the machine. This axle was then placed in the grinding machine and finished in 45 min. Admitting that 13 min. for rough turning and 45 min. for finish grinding were obtained under favorable test conditions, an increase of 25 per cent could be allowed to cover the contingencies occurring throughout the normal working time and still leave an attractive time-saving in favor of grinding as against turning and rolling for the axle finishing operation.

In addition to taking less time for the operation, grinding presents a more accurate method of finishing journals. The journals could be ground to within less than .001 in. of being perfectly round and straight with a marked improvement in the quality of the journal as regards weight carrying capacity. The above tests demonstrated the fallacy of the old argument that rolling provides a better method of finishing journals due to the surface of the metal being compressed and hardened. To quote from test data, "axles ground leaving a diameter .005 in. above size were rolled but no diminution of diameter was found and the surface was not improved. The axles were then reground to plus .0005 in. and gain rolled, the reduction in diameter being small and uneven. In some cases there was no reduction at all showing that the rollers only had an effect where a soft spot in the metal was encountered. The only result was to render the axle out of round." Hardness tests showed that ground axles are fully equal in this respect to rolled axles. A file will take hold with equal or less pressure on the rolled axle.

Not only should the journals be ground, but according to the tests it was a paying proposition to finish the wheel seats by grinding. The wheel-mounting pressure gage gives an indication of the quality of the fit and obviously there is a far greater chance of seizing in the case of turned fits than with the smoother ground fits. The small irregularities or tool marks in the wheel fit greatly increase the force required to apply the wheel. Once these irregularities are smoothed out, however, the wheel comes off easily and with less than the recommended mounting pressure. In the case of a ground fit, the surfaces are smooth with a long even bearing, enabling a uniform mounting pressure to be maintained. This pressure is not required to smooth off the rough places, but represents a true force fit. Railroad shops in this country have already introduced grinding machines for finishing the journal and wheel seats of driving axles and to a less extent car axles. In view of the decreased time required for the operation and the relatively better work, this practice should be more generally extended.

NEW BOOKS

Index-Digest of Decisions of United States Labor Board. 322 *pages, 6 in. by 9 in. Published by the Railway Accounting Officers' Association,* 1116 *Woodward building, Washington, D. C.*

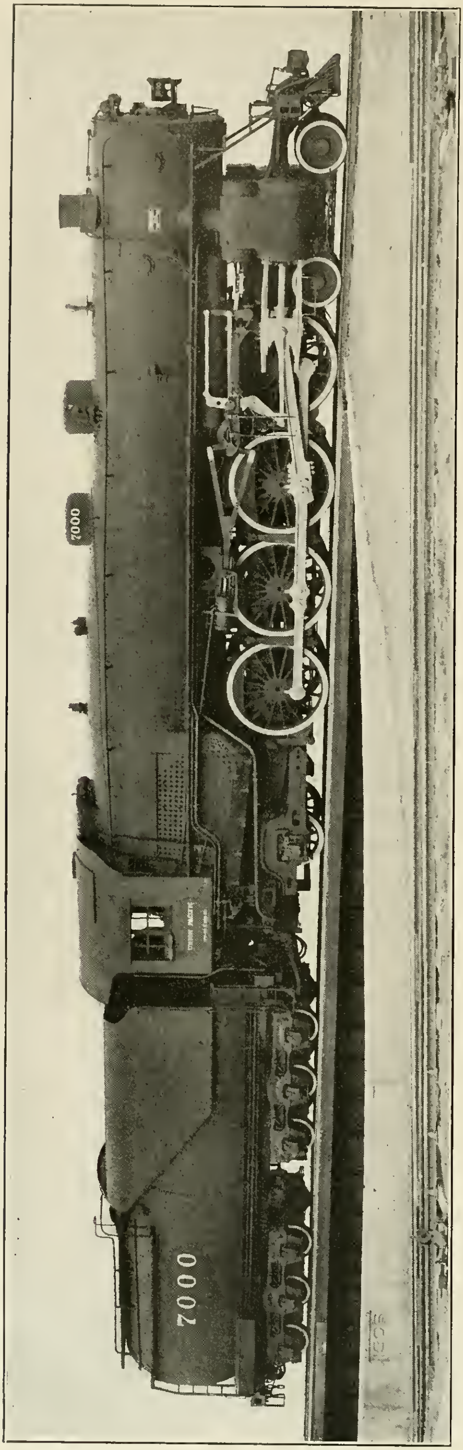
This is the second edition of a publication first issued in September, 1921. The decisions were compiled by the Bureau of Information of the Southeastern Railways and proved very useful to railroad officers who deal with labor matters. Numerous requests for bringing the book up to date led to the publication of the present volume.

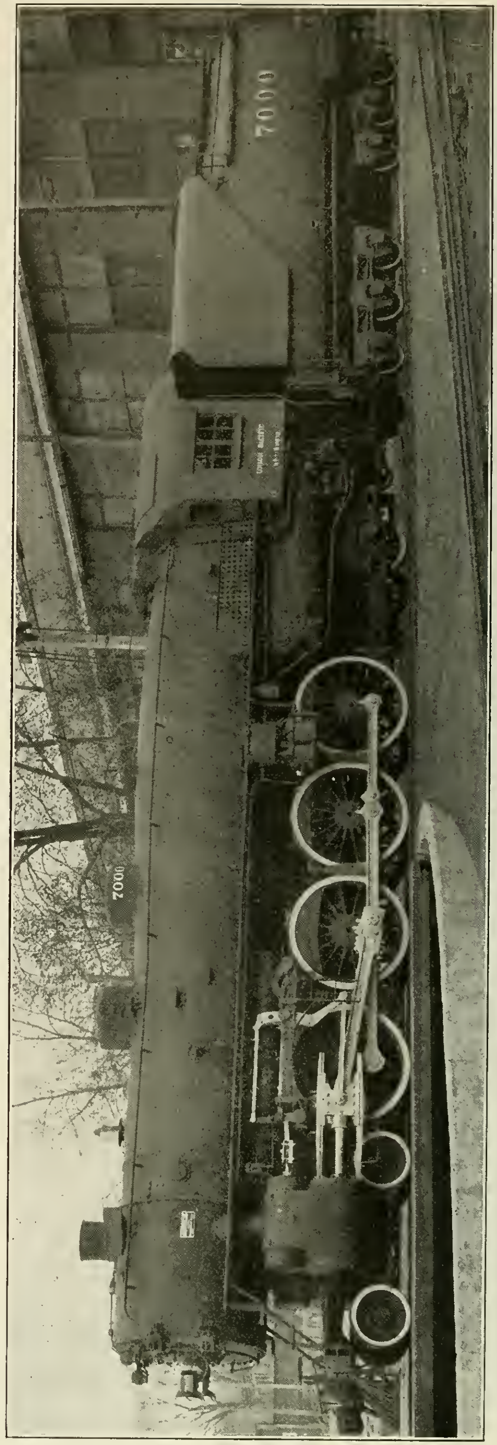
This Index-Digest gives the gist of every decision rendered by the Labor Board up to May 1, 1922. References are given so that the full text may be obtained whenever necessary. Experience has demonstrated, however, that the use of the book eliminates the time and labor of reading through the full text of the decisions. Under alphabetical subject headings is given a summary of every decision relating to each subject, containing all the necessary practical information that anyone would ordinarily have occasion to use. This arrangement is so convenient as to enable one to obtain readily any desired data regarding decisions of the Labor Board.

The present edition has the added feature of setting forth each decision rendered in connection with the individual labor organizations, similar information being given in connection with each railroad. These two additions prove especially useful in cases where the particular decision or principle involved is remembered by the labor organization or by the name of the railroad. The publication is indexed and cross-indexed in almost every conceivable way.

The book should prove indispensable to foremen, shop accountants, time keepers and all others who must be well informed regarding the decisions rendered by the Railroad Labor Board. Individual copies of the book are sold by the association for a nominal sum and the price is still further reduced when ordered in large quantities.

The Bureau of Mines has undertaken, at the Pittsburgh experiment station, an investigation of the mechanism of scale formation in steam boilers. The object of the investigation is to determine if the character of the precipitates forming in boilers may be made to assume a form in which they do not attach themselves to the walls, and also to ascertain if the material in the boiler wall exercises any influence.





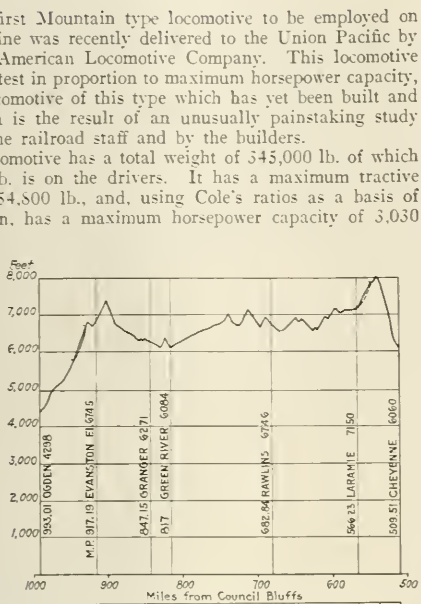
Union Pacific Mountain Type Locomotive for Heavy Passenger Service

A Mountain Type Locomotive for High Capacity

New Union Pacific Locomotive Is Lightest Per Unit of Power of Any 4-8-2 Yet Built

THE first Mountain type locomotive to be employed on its line was recently delivered to the Union Pacific by the American Locomotive Company. This locomotive is the lightest in proportion to maximum horsepower capacity, of any locomotive of this type which has yet been built and the design is the result of an unusually painstaking study both by the railroad staff and by the builders.

The locomotive has a total weight of 345,000 lb. of which 230,000 lb. is on the drivers. It has a maximum tractive effort of 54,800 lb., and, using Cole's ratios as a basis of comparison, has a maximum horsepower capacity of 3,030



Max. Up Grade	West Bound	0.6	0.82	0.82	0.82	.82	1.55
	East Bound	1.14	0.82	0.82	0.82	.82	D

Profile of the Line Over Which the New Mountain Type Locomotive Will Operate

with a 98.5 per cent boiler and a grate area about 4 per cent greater than that called for by Cole's ratios, in proportion to the evaporative capacity. The locomotives will burn a semi-bituminous coal, low in ash but high in moisture, which has a heat value of about 12,000 B.T.U. per lb. In point of weight per unit of capacity the new locomotive compares very favorably with No. 50000, the American Locomotive Company experimental Pacific type. This engine established a record of 110.8 lb. total weight of locomotive in working order per cylinder horsepower, by Cole's method of calculation. The new Union Pacific locomotive weighs 113.9 lb. per cylinder horsepower and 115.8 lb. per boiler horsepower. The No. 50000, with a 92 per cent boiler, weighs 120.5 lb. per boiler horsepower.

The new Mountain type locomotive is intended primarily for use in passenger service between Cheyenne, Wyo., and Ogden, Utah, a distance of 484 miles over which, because of the long and frequent grades encountered, passenger trains are now handled by Mikado type locomotives. The character of the line is shown in the accompanying profile. With trains varying from 8 to 13 cars the time card calls for schedules averaging from 28 to 31 miles an hour between Cheyenne and Laramie and from 26 to 32½ miles per hour between Evanston and Ogden.

Although the net difference in elevation between Laramie and Evanston is not as great as on either of the above named districts, the grades are long and numerous. Westbound the schedules vary from 33.3 to 43.7 miles an hour between Laramie and Rawlins, from 35 to 42.4 miles an hour from Rawlins to Green River and from 30.9 to 36.4 miles an hour from Green River to Evanston. Eastbound the schedules call for average speeds of from 33.4 to 36.1 miles an hour between Evanston and Green River, 34.3 to 36.6 miles an hour from Green River to Rawlins and 35 to 37 miles an hour from Rawlins to Laramie. Few stops are called for on any of the overland trains except at division points.

To maintain these schedules with Mikado type locomotives it has been necessary to resort to high running speeds on the down grades to make up for the comparatively low speeds on the heavy up-hill pulls. This has had a marked effect in increasing track maintenance and to some extent the cost of locomotive maintenance. The Mountain type locomotive with its high sustained capacity is expected to bring the maximum and minimum operating speeds more nearly to the average which, in addition to its effect on maintenance costs will produce more economical locomotive operation and facilitate the operation of the road generally.

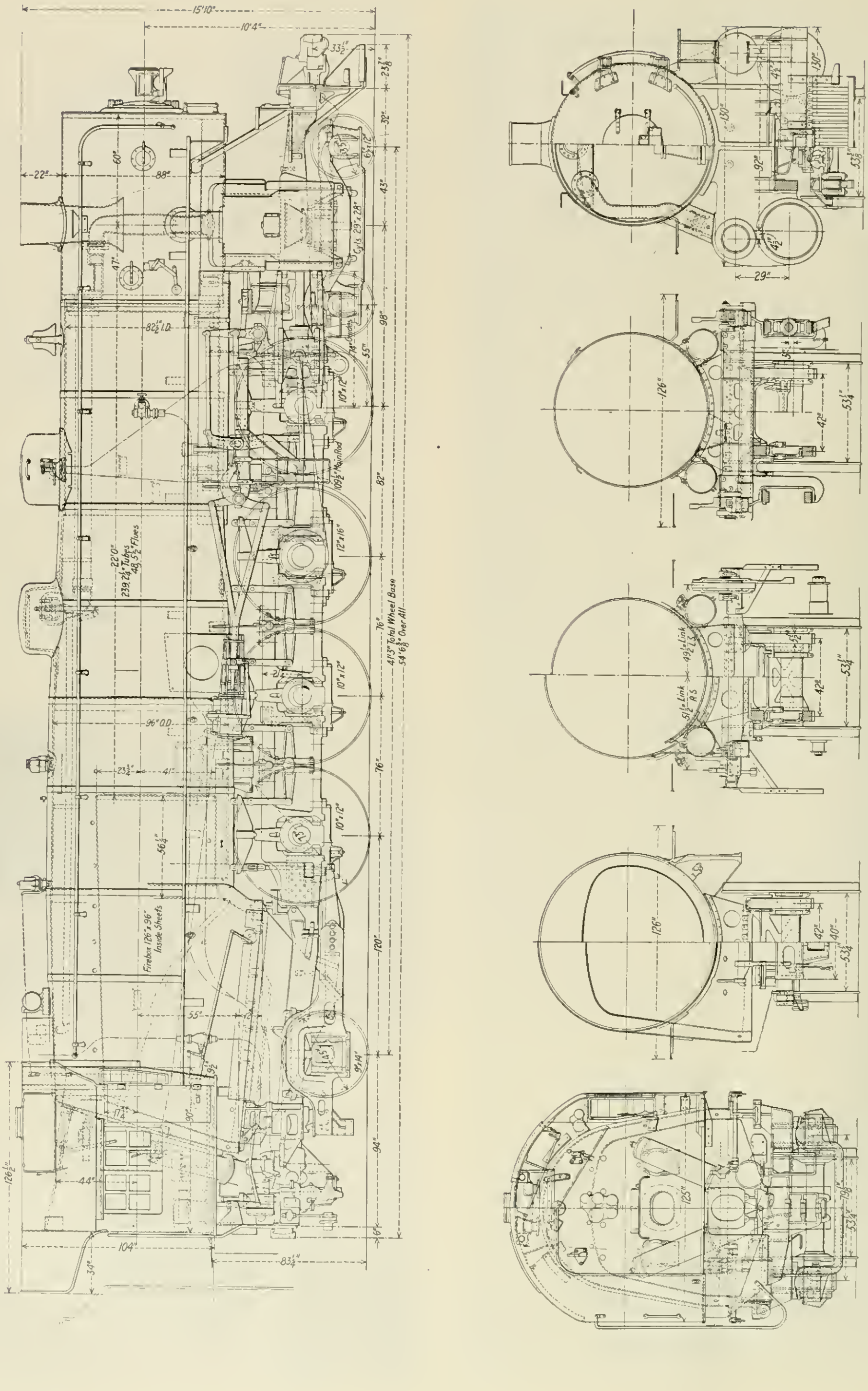
The design of a locomotive of this type was first considered in the fall of 1920. During the preliminary stages many valuable suggestions were received both from the Baldwin Locomotive Works and the Lima Locomotive Works, Inc., as well as from the American Locomotive Company. The final design, however, was worked out practically complete in detail by the railroad's own staff.

In general the boiler is similar in capacity and dimensions to the boiler of the Union Pacific 2-10-2 type locomotive. It is conical in form with an outside diameter of 84 in. at

The Firebox Side Sheets and Crown Sheet and Combustion Chamber Are All in One Piece, the Throat Sheet Being Welded in as Shown by the Light Line

the front barrel course, increasing to 96 in. at the combustion chamber course. The firebox measures 126 in. by 96 in. at the grate and includes a combustion chamber the length of which is such as to provide for tubes 22 ft. long. One of the notable features in the design of the boiler is the location of the steam dome on the conical course at a point above the center of oscillation of the water in the boiler. This provides a uniform steam space under all conditions of grade, considerably removed from the zone of violent ebullition over the crown sheet. The firebox is fed by a Duplex stoker and the boiler is fitted with a 48-unit superheater.

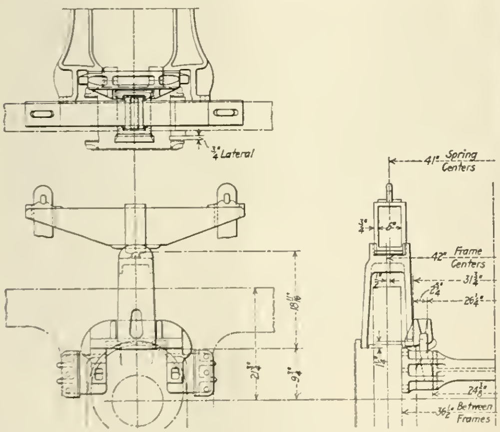
The boiler shell courses are of ¾-in., 13/16-in. and ⅞-in.



Elevation and Cross-Sections of the Union Pacific Mountain Type Locomotive material, respectively, and the wrapper sheet is 9/16 in. thick. The firebox crown, sides and the combustion chamber are of 3/8-in. sheets, with a 1/2-in. throat connection sheet welded in between the side sheets and the combustion chamber. The form of this sheet is shown in one of the photographs. The firebox is fitted with F.B.C. welded staybolt sleeves and bolts of reduced body diameter.

Steam distribution is controlled by the Young valve gear, and the Alco power reverse gear. The Young valve motion provides a maximum travel of 9 in. and drives a 14-in. piston valve. The locomotive is also equipped with a Fetters automatic drifting valve. This device insures the constant admission of a small supply of saturated steam to the cylinders as long as the locomotive is in motion with the throttle closed. The admission of saturated steam is controlled by a diaphragm operated valve, one side of the diaphragm being loaded at a pressure of 40 lb. per sq. in. by a small oil pump driven from the valve motion link trunnion, and the other acted on by the dry pipe pressure. Either the opening of the throttle or the stopping of the engine cuts off the saturated steam supply, thus making the device entirely automatic.

The frames are of straightforward, rugged design, in general following the practice of the builders as to the dimensions of the sections. Between the cylinder saddle and the front pedestal the frame takes the form of a deep slab section. This, however, has been lightened by coring out the middle portion of the slab for a part of the thickness on the outside, the reduction in the mass of metal at this point being of considerable advantage in the foundry. The binders of the main pedestal are fitted with three bolts, and



New Design of Woodard Lateral Motion Driving Box

heavy toes have been provided on the front and main jaws.

A notable feature of the frame construction is the location of the furnace bearer-supports directly under the sides of the mudring, these supports forming a part of the cradle casting. The furnace bearers are fitted with compression grease cups.

Several features of the running gear are of particular interest. The forward pair of drivers are fitted with the Franklin lateral motion device, which has recently been redesigned to effect a material saving in weight. The forward driving boxes are not joined together, as was the case in the former design, each being provided with a limited lateral movement by spreading the shoe and wedge flanges of the boxes to provide clearance both inside and outside the frame jaw. When not operating under lateral thrust each box is retained in a normal central position by means of an ingenious bell crank arrangement, the trunnions of which are carried on lugs projecting from the top of the box inside the frames. The horizontal arm of this bell crank extends laterally across the top of the box and forms the seat for the inside leg of the spring saddle. Normally, it rests on the top of the box. The vertical arm of the bell crank is carried down on either side of the axle, lugs on the lower ends fitting in recesses between the inside face of the frame and flanges on the cross braces bolted to the pedestal faces. The clearance in these recesses permits the movement of the box outward without operating the bell crank. Inward movement of the box, however, causes the engagement of the lugs

A Front View of the Locomotive

on the bell crank arm against the flanges of the cross braces and results in raising the horizontal arm of the bell crank up from the top of the box. This tilts the spring saddle and creates a load which, acting through the bell crank, resists the lateral displacement of the box. This device is shown in one of the drawings.

The main driving journals are fitted with long driving boxes, the design of which provides for the use of a spring saddle, rather than seating the spring directly on the cross equalizer. Instead of delivering the load at a single point at the center of the box this design permits the load to be applied equally at the two ends of the long main box the same as in the cases of boxes of the usual type located symmetrically with respect to the center line of the frame. Driving boxes are fitted with Franklin automatic wedges.

The engine truck is of the Woodard constant resistance type and Woodard constant resistance rollers have been incorporated in the design of the trailer truck.

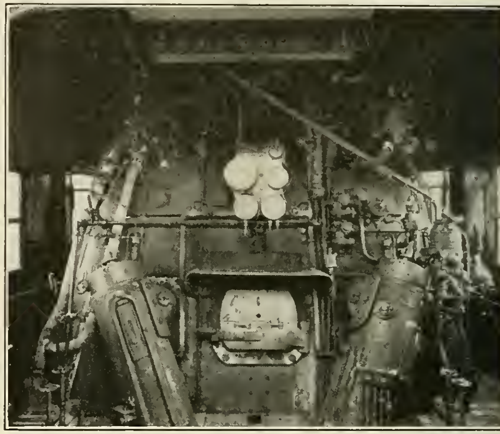
The side rods are fitted with spherical bushings on the front crank pins and a floating bushing has been applied at the main crank pin connections. Annealed carbon-vanadium steel has been used in the side and main rods, piston rods, driving and trailing truck axles and in the main crank pins. The piston heads are of Z-section cast steel, faced with phosphor bronze poured in place. The cylinder and valve bushings, the cross head shoes and piston rings are of Hunt-Spiller gun iron.

The following table shows the weights of the reciprocating parts:

Piston rod (hollow)	334 lb.
Piston head	505 lb.
Packing rings	100 lb.
Total weight of piston complete	939 lb.
Main rod, complete	864 lb.
Crosshead, with shoes	640 lb.

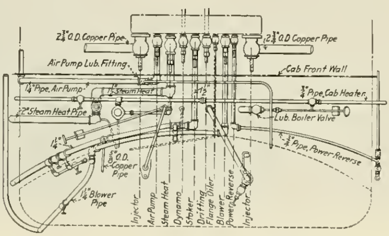
At a speed of 60 miles an hour this locomotive produces a dynamic augment of 27 per cent. At a speed of 73 miles an hour, which is equal to the diameter of the drivers, the dynamic augment is 39 per cent.

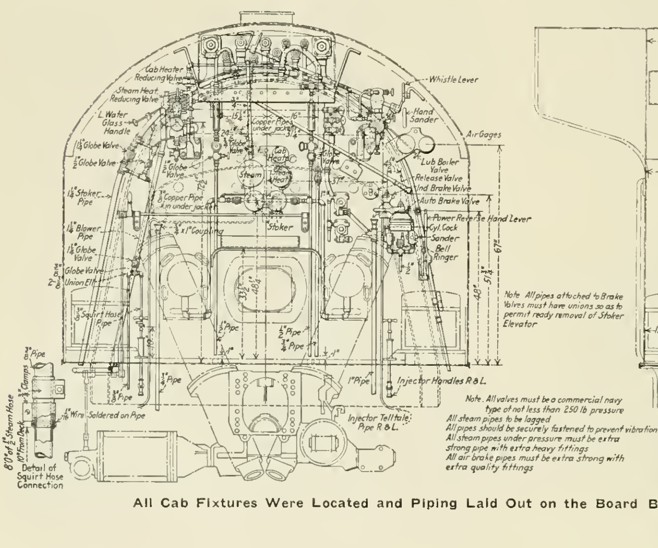
One of the notable features in the design of this locomotive is the care which has been exercised in locating the cab fittings and the piping, and in securing rigidity in the attachment of air drums, piping and other apparatus commonly secured to the running board. All the apparatus on the back boiler head and all piping on the locomotive was carefully located in the drawing room. One of the photographs shows the resulting neat and uncrowded appearance of the back head. It will be noted that the operating handles of the valves controlling the admission of steam from the turret to the auxiliaries have been carried out by means of flexible shafts to a location at a convenient height above the head of a person standing on the cab deck, where they are all supported in a horizontal rack, each one identified by a suitable label. All outside piping has been located under the running board, as little in evidence as possible, an arrangement which not only improves the appearance of the locomotive but offers an opportunity for the employment of effective clamps, subjected to the minimum of vibration. The main reservoirs are located well down under the barrel of the boiler, to which they are securely attached. The distributing valve, instead of being attached to the running board where it is subjected to considerable vibration, is carried on a heavy plate bracket which is secured directly to the cradle casting. The driver brake cylinders are bolted to pads which are cast integral with the main frames, each forming in effect an extension of the inside face of the frame just back of the cylinder casting.

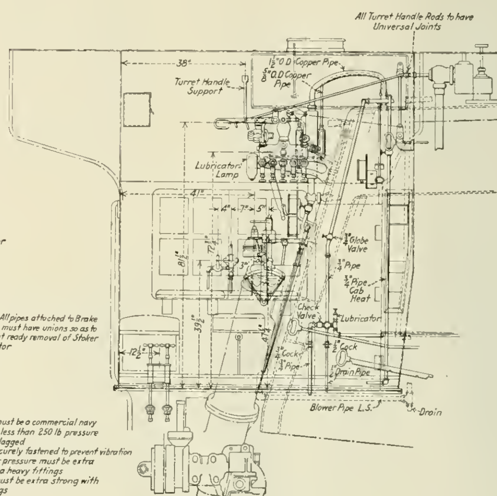


The Fittings Inside the Cab Are Unusually Well Arranged

Each side of the cab in front of the window opening is hinged at the front and may be opened outward to facilitate staybolt work or other jobs requiring access to the narrow space at the sides of the boiler. When the locomotive is in service and the doors do not need to be opened they are permanently closed with bolts.

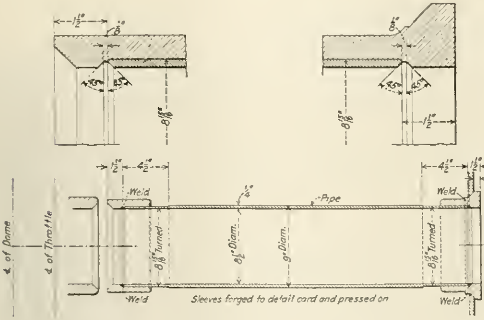






All Cab Fixtures Were Located and Piping Laid Out on the Board Before the Locomotive Was Built

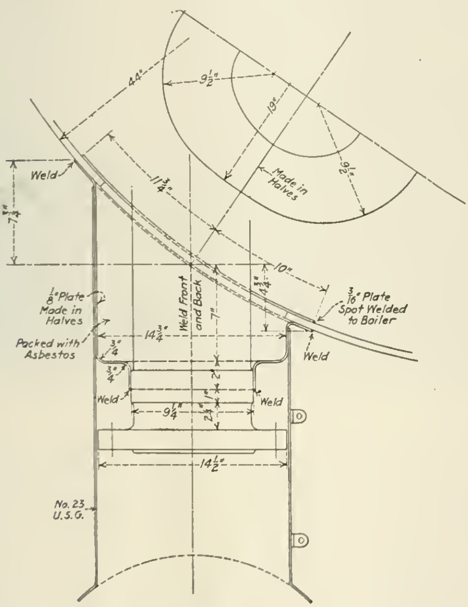
The tender is of the Vanderbilt type with a water capacity of 12,000 gal. and a coal capacity of 20 tons. The tank is carried on a Commonwealth cast steel underframe. The



Method of Welding the Dry Pipe

transverse members of the underframe, which form the tank saddles, are cored out to receive thin filler blocks of wood which are accurately surfaced to conform to the contour of the tank.

The tank is secured to the underframe by cast steel brackets of angle section the vertical flanges of which are bolted to the cross members of the underframe. The tender is carried on Commonwealth six-wheel trucks with



Arrangement of Outside Steam Pipe Casing Gland

6-in. by 11-in. journals and 33 in. wrought steel wheels. The engine and tender are connected by Unit safety draw bars and are fitted with Radial buffers.

Among the specialties with which the locomotive is equipped are Pyle-National headlight equipment, Nathan non-lifting injectors and lubricator, Paxton-Mitchell piston and valve rod packing, and Okadee blow-off valve, feed water strainers, cylinder cocks and smokebox hinges. The locomotive is also equipped with a Madison-Kipp force feed lubricator.

The principal dimensions and data of the locomotive are as follows:

DIMENSIONS, WEIGHTS AND PROPORTIONS

Service	Passenger
Cylinders, diameter and stroke	29 in. by 28 in.
Valve gear	Young
Valves, kind and size	Piston—14 in.
Maximum travel	9 in.
Outside lap	1¾ in.
Exhaust clearance	3/16 in.
Lead in full gear	¼ in.
Cut-off in full gear	90 per cent
Weights in working order:	
On drivers	230,000 lb.
On front truck	59,000 lb.
On trailing truck	56,000 lb.
Total engine	345,000 lb.
Tender	237,800 lb.
Wheel base:	
Driving	19 ft. 6 in.
Rigid	12 ft. 8 in.
Total engine	41 ft. 3 in.
Total engine and tender	79 ft. 11½ in.
Wheels, diameter outside tires:	
Driving	73 in.
Front truck	33 in.
Trailing truck	45 in.
Journals, diameter and length:	
Driving, main	12 in. by 16 in.
Driving, others	10 in. by 12 in.
Front truck	6½ in. by 12 in.
Trailing truck	9 in. by 14 in.
Boiler:	
Type	Conical
Steam pressure	200 lb.
Fuel, kind	Semi-bitum., 12,000 B.t.u.
Diameter, first ring, outside	84 in.
Firebox, length and width	126 in. by 96 in.
Height, grate to crown sheet, back	72 in.
Height, grate to crown sheet, front	84 in.
Arch tubes, number and diameter	4—3½ in.
Combustion chamber, length	56¼ in.
Tubes, number and diameter	239—2¼ in.
Flues, number and diameter	48—5½ in.
Tubes and flues, length	22 ft.
Grate area	84 sq. ft.
Heating surfaces:	
Firebox, incl. comb. chamber and arch tubes	382 sq. ft.
Tubes	3,084 sq. ft.
Flues	1,508 sq. ft.
Total evaporative	4,974 sq. ft.
Superheating	1,242 sq. ft.
Comb. evaporative and superheating	6,216 sq. ft.
Tender:	
Style	Cylindrical tank
Water capacity	12,000 gal.
Coal capacity	20 tons
Trucks	6-wheel
Truck wheels	33-in. steel
Truck journals	6 in. by 11 in.
General data, estimated:	
Rated tractive force, 85 per cent	54,838 lb.
Cylinder horsepower	3,030 hp.
Boiler horsepower	2,980 hp.
Speed at 1,000 ft. piston speed	46.5 m.p.h.
Steam required per hour	6,300 lb.
Boiler, evaporative capacity per hour	6,200 lb.
Coal required per hour, total	9,843 lb.
Coal, rate per sq. ft. grate per hour	117 lb.
Weight proportions:	
Weight on drivers ÷ tractive force	4.19 lb.
Weight on drivers ÷ total weight engine	66.7 per cent
Total weight engine ÷ cylinder horsepower	113.9 lb.
Total weight engine ÷ boiler horsepower	115.8 lb.
Boiler proportions:	
Boiler horsepower ÷ cylinder horsepower	98.5 per cent
Comb. heating surface ÷ cylinder horsepower	2.05
Tractive force ÷ comb. heating surface	8.82
Tractive force × dia. drivers ÷ comb. heating surface	644
Cylinder horsepower ÷ grate area	36.1
Firebox heating surface ÷ grate area	4.55
Firebox heating surface ÷ evap. heating surface	7.7 per cent
Superheating surface ÷ evap. heating surface	25.0 per cent

Turbine Locomotive Saves 52 Per Cent in Fuel

Design Brought Out by Ljungstrom Turbine Company of Sweden Has Many Novel Features

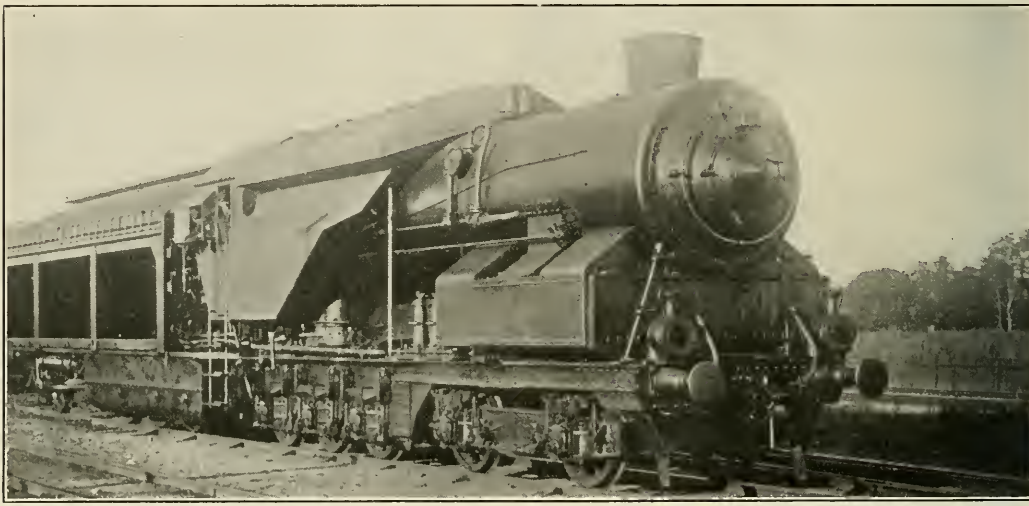
A CONDENSING turbine locomotive, designed by F. Ljungstrom and constructed by Aktiebolaget Ljungströms Angturbin, Stockholm, Sweden, was placed in service on the Swedish State Railways a few months ago. According to reports, the locomotive has performed satisfactorily and has shown remarkable economy in fuel. Complete details of the construction are not yet available but the photograph shown herewith indicates that it is a radical departure from conventional locomotive design in appearance as well as in mechanical construction.

The turbo-locomotive designed by Mr. Ljungstrom is intended to displace the Pacific type locomotives now used in passenger service on the Swedish State Railways. It is not a mere adaptation of the turbine to reciprocating locomotives, but is a new design in all respects. Unlike ordinary steam locomotives, there is no driving machinery under the boiler. Instead it is supported by two trucks, the forward with two and the rear with three axles. The driving machinery is located under the tender unit, which also contains the condenser and the necessary fans for aiding in condensation. The coal supply is carried in bunkers placed above and on each side of the cab, having a capacity of seven tons. The boiler is of the ordinary fire-tube type, carrying 285 lb. pressure. It has no small tubes, the heating surface in the barrel of the boiler being made up of large flues, each of which carries a superheater element, thus giving a high degree of superheat.

Another innovation is the arrangement for heating the air supplied to the fire. The space between the mud ring and the ashpan is tightly closed and the air needed for combustion passes through a special air preheater under the smokebox, where the temperature is raised by escaping gases from the smokebox. Draft is created by a fan propelled by a small turbine. A damper connected with the firebox door shuts off the draft when the door is open, thus preventing unnecessary cold air entering the firebox flues. The exhaust steam is not discharged from the stack but is led to a condenser on the tender.

The driving machinery consists of a high-speed turbine suitably geared to the six-wheel connected running gear which has drivers 58 in. in diameter and is located under the tender. The condensing tank has a capacity of 3,650 gallons but only half of that amount has been carried on the trial trips and has been found sufficient as the exhaust steam is not wasted through the stack but returns to a hot well from which it is pumped into the boiler as feedwater. As the feedwater is used over and over, very little scale will be formed in the boiler. The preheating of the air for combustion should also add to the life of the firebox and materially reduce the expense of boiler work.

The locomotive is being used in passenger service out of Stockholm on turn-around trips of 66 kilometers, or about 41 miles, each way. The time between the departure from Stockholm and the return is 2 hrs. 30 min. As no information is given as to the time at the turn-around point or the length of the stops en route, no estimate can be made as to the speed while on the road.



Turbine Locomotive on the Swedish State Railways

On a local run on this route with a passenger train weighing 603 tons, the coal consumption was 20.8 kilograms (45.8 lb.) per 1,000 ton kilometers, or about 67 lb. per 1,000 gross ton-miles. In through service the consumption was reduced to about 11.6 kilograms (25.6 lb.) per 1,000 ton kilometers, or 37.4 lb. per 1,000 gross ton-miles. Considering that this performance was obtained during the winter season the figures are indeed remarkable. Compared with the reciprocating superheated Pacific type locomotives used on the same run, the turbine locomotive shows a reduction of 52 per cent in the consumption of fuel. Further details of the locomotive construction and the results obtained in service will be published in a later issue.

Fuel Association Holds Annual Meeting

Heavy Program Includes the Consideration of Many Operating Problems Affecting Fuel Economy

EVIDENCES of the interest in and support of the railway fuel conservation movement on the part of executives and operating officers and an interest in the relation of fuel costs to other operating factors characterized the fourteenth annual convention of the International Railway Fuel Association, which was held at the Auditorium Hotel, Chicago, on May 22 to 25 inclusive. After the usual opening exercises the meeting, with over 450 members in attendance, was addressed by L. W. Baldwin, vice-president, Illinois Central, followed by the address of W. L. Robinson (B. & O.), president of the association. Mr. Baldwin spoke in part as follows:

L. W. Baldwin's Address

THE conservation of fuel rests largely with these two principles: 1. Interesting and educating the men who place fuel on the fires, and 2. Developing and using proper machinery. My experience has taught me that each of these constitutes a vast field of opportunity.

Coal means more now than it did prior to the war. The increased cost has made it necessary for us to get our coal burned in such a way as to use a minimum amount and get maximum efficiency. On the railroad of which I am an officer we maintain an organization to educate our men to burn coal scientifically. This organization has a car fitted up for holding fuel conservation classes and is constantly visiting the terminals, large and small alike. The men doing this educational work are peculiarly fitted for their duties. They have studied fuel production and uses from various angles, and they impart their experience to the men, display films, make replies to questions, and exchange views on all phases of fuel conservation in their meetings, in fact so impress officers and men that they actually appreciate it is a crime to waste fuel.

The education of the men and the carrying out of good practices cover a wide scope of endeavor on the part of those in charge of and who are to teach fuel conservation. Great care must be taken to insure the selection of men for such positions who are qualified by experience, are natural enthusiasts and in whom all who should be concerned in fuel economy have confidence.

We have distributed a book entitled "Fuel Economy on Locomotives" which deals with the subject at length, but we can't depend on the book to do the work. To get the best results, it is necessary to employ the personal contact method.

In addition, we have a General Fuel Conservation Committee, consisting of the general superintendent of transportation, the general superintendent of motive power, the engineer maintenance of way, the purchasing agent, the auditor of disbursements, and the superintendent of fuel conservation, and fuel committees on each division consisting of division officers, enginemen, trainmen and others. This General Fuel Conservation Committee has to do with purchase, inspection, storage and handling of coal, including all feasible economies that can be effected. The duty of the division fuel conservation committees is to study in more detail the ideas of the General Fuel Conservation Committee and general officers, circulate the results obtained by individuals as well as to instruct as to best methods to be used.

On the Illinois Central System we conducted a fuel conservation campaign throughout September and October, 1921. Enginemen and trainmen on the same terminals competed with one another, and divisions competed for rank. Daily reports of fuel consumed in freight, passenger and yard service were obtained from all divisions, and reports showing the number of pounds of coal consumed per 1,000 gross ton miles, per 100 passenger car miles and per yard engine mile for all divisions were promulgated daily. The campaign was an interesting and successful one and produced a saving on our lines of 30,000 tons in one month alone. I attribute the success of the campaign to the initial interest taken by enginemen, trainmen and other employees concerned in fuel consumption, and the spirited competition which resulted from posting individual accomplishments. Of course, the local officers must be duly credited for the intensive interest developed in preparing for and during the campaign.

I do not want to be quoted as saying that fuel conservation results are entirely in the hands of the men and local officers. There are a great many things for the managements of the railroads and other properties to consider and act upon. We must have fuel inspection at the mines, and, where coal is placed in storage, it must be scientifically handled to insure economical and proper results. Our purchasing departments must surround the purchase of coal with recommendations made by men competent to pass upon the grades and preparation of coal. Power plant and station use of coal on some railroads warrant specialized supervision, with a man in charge who is thoroughly trained in power plant operation.

Distribution of coal needs close supervision. It is sometimes necessary to burn various grades of coal on a railroad. Under such conditions the distribution should be regular. Proper tonnage rating of locomotives is a factor. Where engines can be assigned to individual enginemen it will go a long way toward conserving fuel because of the personal interest the enginemen manifest in the condition of the engines assigned to them. Efficient yard operation and dispatching of engines and trains, as well as not overloading the tenders, are important features. In fact, nearly every phase of operation is directly or indirectly related to fuel consumption, and it is this relation that must be considered to get the desired result.

Our mechanical departments must understand that they are largely responsible for fuel conservation or waste, at least to the extent that they are permitted to spend money. An engine that does not economically burn coal should be kept out of the service until conditioned. We have on the market a number of devices and improvements which have been demonstrated as coal savers. All may not agree on the merits of these devices, but I think it is well worth every mechanical man's time to watch and study the development and performance of every improvement and device designed to save coal.

Stationary boilers must be kept in good condition and a systematic method of inspection and to insure economical operation, and the results obtained posted to promote interest of the operators.

Further, roundhouse equipment, such as hot water boiler washing plants, water treating plants, plenty of ash pit room and modern coaling stations are important. These, of course, are expensive items, but the savings produced as a result of such expenditures have demonstrated that it is money well spent.

Our existence today depends upon coal. It moves our commerce. It prepares our food. It heats our offices and homes. Just because we see it in large volume should not detract from its value. It should be indelibly impressed on the minds of everyone that fuel conservation is needed and can be accomplished to a large extent, and that the money so saved can be applied to the general good of the properties upon which we and our families are dependent for a livelihood.

President Robinson spoke in part as follows:

President's Address

FUEL economy was long considered purely a mechanical department matter, but this association has for years advocated the policy of arousing all the departments to a realization of their share in the responsibility. There are at present many of our members, who may be classed as transportation or operating officers and much has been gained through papers and addresses delivered at previous meetings by general managers, general superintendents and other operating officers.

It is most encouraging that the executives of our railroads through the American Railway Association have so fully recognized the magnitude of the fuel problem and have urged and encouraged all departments toward greater interest in fuel conservation.

The Fuel Association's Committee on Fuel Tests in conjunction with the University of Illinois, and the United States Bureau of Mines, completed during 1917 at the locomotive testing laboratory of the University of Illinois, a series of tests of six sizes of coal from the same mine located in Franklin County, Ill. These tests developed that on a modern Mikado locomotive at the high rate of evaporation the 1¼ inch screenings are worth only 94 per cent as much as 2 in. screenings for stoker firing; and 2 in. screenings only worth 87 per cent as much stoker fired as mine run hand fired.

It was the original intention that similar and additional tests be made of coal from the various fields throughout the country. Due to the war, the matter has been held in abeyance, but within the past year the Special Committee has suggested to the American Railway Association that a continuation of the tests would be desirable and it is hoped that favorable consideration will be given this matter at an early date.

While little accurate data has been made public other than the University of Illinois tests, already referred to, concerning the relative efficiency of various sizes of coal, it can be stated that the matter of size depends to a large extent on the description of the coal considered, whether low or high volatile, coking or non-coking. However, from the results of the laboratory tests at University of Illinois as well as various road tests, it may be definitely stated that the physical characteristics of coal constitute a factor equally as important as the B. T. U. value in so far as concerns the effective burning of coal on grates in locomotives. The coal mining interests can do much to assist the railroads in reducing fuel consumption through decreasing the stack loss, by furnishing them coal with as low per cent of fineness as practicable.

It would appear that the railroads can with profit frequently conduct road tests to determine sizes best suited to their needs, and some roads have given consideration to this feature.

It may be of interest to mention briefly the results of some road tests which may serve as suggestions for further checking by laboratory tests, similar to those which have already been mentioned.

Comparison of Two Varieties of Coal in Two Sizes: A Mikado locomotive, 26 in. by 32 in. cylinders, 64 in. drivers, 54,587 lb. tractive effort, equipped with superheater arch and Street stoker, was tested on the road with dynamometer car and test conditions controlled as closely as practicable. Two varieties of coal in two sizes for each variety were used stoker fired in order to determine their relative economy. Description, proximate analyses and comparative performance of the coals were as follows:

	Fairmont high volatile		Myersdale low volatile	
	1½-in. N. P. & S.	¾-in. Slack	Mine run	1½ in. Screenings
Moisture	1.23	1.57	0.75	0.81
Volatile	36.47	35.74	18.17	17.52
Fixed carbon	53.94	52.78	69.07	70.06
Ash	8.36	9.91	12.01	11.61
Sulphur	2.59	3.30	3.33	2.31
B. t. u. (calculated)	13,100	12.900	13,800	13,870
Lb. coal per avg. h.p. hour	3.74	4.19	4.14	4.89
Equiv. evap. lb. water per pound of coal	6.71	5.98	6.62	5.50
Efficiency of boiler	46.6	41.9	46.1	38.0
Lb. coal per sq. ft. grate per hour	57.78	65.89	59.55	74.28
Value based on 1½-in. N. P. & S. 1.00	1.00	0.89	0.99	0.82

These tests indicate clearly the desirability of high volatile coal of as large size as permissible on stoker locomotives requiring screenings, unless length of haul or other factors make ultimate cost of low volatile coal equal or less.

Comparison of Two Mine Run Coals from Different Mines in Same Region: Similar tests were made of mine run coal (crushed by stoker in firing) from two mines producing from the same vein of coal but from different parts of the field. The coals were similar in analysis and heat content.

The results obtained showed that coal *A* was decidedly more economical. Consumption of coal *B* was about 15 per cent in excess of coal *A* per D. B. Hp. Hour. Equivalent evaporation with coal *A* was 17 per cent greater than with coal *B*. Boiler efficiency with coal *A* was about 16 per cent higher than with coal *B*. Coal *B* was the more friable coal running about 75 per cent slack, which is characteristic of the coal while coal *A* ran about 45 per cent slack.

Mine Run Coal Versus Two Inch Screenings: Dynamometer car tests were run with a Mikado locomotive of recent design under comparative conditions in slow freight service to determine the relative economy of high volatile mine run coal and N. P. & S. screenings from the same mine when the locomotive is equipped with the duplex stoker. The mine run coal averaged 45 per cent slack, the N. P. & S. screenings averaged 65 per cent slack, with average proximate analyses very nearly the same.

The results showed the following relative performance:

	N. P. & S.	Mine run	Per cent in favor Mine run
Pounds coal per h.p. hour	2.98	2.72	8.1
Pounds water per lb. coal from and at 212 degrees F	8.44	9.59	13.6
Efficiency of boiler	58.18	66.04	13.5

These tests would indicate that stokers of type that can be supplied with mine run coal, might profitably be substituted for one requiring a special size coal or screenings.

The cost of fuel and the wages of train and engine crews totals 50 per cent or more of the expense of our railroads for conducting transportation. (Cost of haul of fuel over own lines is not included in total audited cost, but is a considerable item in connection with conducting transportation expense). The fact that the volume of traffic at present being offered for movement does not by a material amount approximate the capacity of the available transportation facilities, results in present average operating conditions under which congestion is largely eliminated.

The opportunity to reduce overtime wages and standby fuel consumption through reduction of delays on line of road and extension of locomotive runs through intermediate terminals is presented by these conditions and many railroads are taking advantage of this opportunity to reduce the transportation expense.

Caution is required, however, to insure that the increase in speed of movement is not made at the expense of too great a reduction in the train load. The index of gross ton mileage produced per unit of combined wage and fuel expense should be employed as a check to determine the relative economy of performance.

Locomotive Fuel, the Life Blood of Transportation

By G. M. Basford
Consulting Engineer, Lima Locomotive Works

Fuel is the very life blood of transportation. We must use it as if we thought so. We must not treat it as we are tempted to treat water in the rainy season. We must not burn it as if there were a lot more where this came from.

Before those who direct and control the use of fuel on railroads lies a wonderful opportunity for money making, money saving. Wonderful improvements have already been made. More and even greater possibilities are available.

A fortunate fact about every feature in fuel conservation is that it helps railroad operation in ways that fuel does not directly touch. No one ever does anything to make more effective use of fuel without helping the road in other ways. Therefore, to co-ordinate all these possibilities and to organize the road into a Committee of the Whole to conserve fuel, fuel officers need to be very big, broad, influential men. They need to grasp and improve to the utmost the opportunity that lies before them. It is fortunate that they now have this opportunity and this wonderful organization back of them.

Fuel must take a new place in your hands. The fuel officer who is to bring fuel to its proper eminence has many strings to his bow. The fuel officer has back of him the locomotive builders with their extraordinary experience. He has many other supporters who have spent lifetimes in developing safe, sound and sane vitalizing factors that have never yet been employed to the limit of their capacity for improving the real efficiency of locomotives. He must also have the entire railroad back of him.

When business comes on again, look out! You have less railroad today than you had five years ago. You are short about 5,000 locomotives to keep the equipment curve anywhere near the curve of growth of the nation. C. B. Peck and V. Z. Caracristi show that locomotives are not used as efficiently now as they were 20 years ago, because of lack of maintenance facilities, but we know that as machines they are vastly more efficient. It is also clear that lack of adequate shop facilities is a great factor obstructing the application of fuel saving, capacity increasing improvements to locomotives now in service, each of which should, if run at all, run as economically and as efficiently, weight for weight, as the latest new power. These unmodernized engines are wicked wasters of fuel. To fix this situation right, new shop machinery is needed. This illustrates the breadth of the opportunity of the fuel officer. Adequacy of the equipment of shops affects his fuel record in several ways. It materially affects the number of new engines needed and controls the improvement of old ones. It also controls the condition of the power that is burning up his fuel.

As a railroad officer, acquire all the knowledge of the latest locomotive progress, learn of the perfectly sane and safe possibilities of power and its use, never yet put into general practice, and knowing to your own satisfaction that big improvements may be made, you may say, "As a railroad officer I cannot afford not to see this done." To the public the new locomotive and upkeep of present locomotives are more important than the question of rates and will continue to mean more to the public as to their own pockets, but the public does not know it.

Purchasing Agent

Why not help him by showing him what coal to buy and why let him supply unimproved real estate? Thirty-two years ago a big western road, then poor, now very prosperous, tested seven coals for main line service. Differentials in price were established. Poor local coals were discarded and truly economical coals provided. Operation of the road instantly reflected the value of the right fuel. Nothing means more than this in making long locomotive runs. Careful roads buy the coal that is cheapest in the end. They pay more to get clean coal and save by doing it. Then the coal should be uniform or locomotives cannot be kept right as to drafting. Drafting has been a difficult problem on many roads. Changing coal discourages efforts to keep front ends "right."

Yardmaster

Give this very efficient officer the kind of switch engines he needs; powerful, efficient, economical, snappy ones. Give him road engines that will clear the ladder tracks quickly. He knows, better than anyone else, the value of locomotive improvements that make for better acceleration of trains over the tracks that tie up the yard until they get away. Then watch him make up trains for an even load on the road, avoiding fleeting. Bunching trains raises havoc with fuel performance. Watch him send road engines back to the roundhouse singly, again avoiding the fleeting that clogs facilities of all kinds, particularly locomotive terminals, and piles up stand-by losses.

Do you not think that you can classify trains at terminals so as to main track some of them through other terminals? One road does this with 10 to 15 per cent of its freight trains. Avoid switching trains at terminals whenever possible. This makes for long runs.

Dispatcher

No one can do more for fuel than this officer when he has the tools to work with. Everything he does for fuel does even more for himself. He does not want to fleet trains. He wants them to get away and run. He needs efficient power, first in the yards and then on the road. He needs such tonnage rating and careful loading for all engines as will enable him to give a track for the big powerful ones to use without being checked and harassed by old unmodernized ones. He knows that it costs from 500 to 1,000 lb. of coal to stop a train and start it again, depending on how long it stands, but often he cannot help it. Take the dispatcher into the family and give him the best tools to work with. Then get him to use his engines with the realization that they are very costly and very scarce and that every lump of coal is precious.

Scheduling freights is a great improvement. Send them out at specific times worked out to suit conditions and to keep the wheels turning, avoiding delays of all trains as much as possible.

Superintendent

Knowledge and thorough knowledge of his locomotives means more to this officer than to any other on the road, even those who are responsible for locomotives themselves. Under his command are all those who use the power. When he has the traveling engineers he controls, and is in position to revolutionize locomotive handling and operation. He can control dispatching, control condition of power, direct firing and the use of locomotive cut-off. He more than any other officer can aid in making long locomotive runs and in providing equipment, men and supervision for locomotive maintenance and terminal attention. Superintendents also control the time lost at stations that must be made up by fast running that uses so much fuel. They are charged with fuel cost. They can do more than anyone else to save it.

In the superintendent the success of the divisional organization lies. Help him. Show him how the locomotive may help him.

Track Officers

Limitations of locomotive weight are sometimes arbitrary, but the tendency toward reducing dynamic augment, through lighter reciprocating parts, renders it possible to build even more powerful, more economical locomotives without requiring heavier rail and stronger bridges. Weight limits often prevent application of fuel saving improvements. The limit to locomotive capacity has not nearly been reached, but co-operation and understanding of this problem on the part of track people will be necessary. It will pay to relocate some water plugs, to change positions of some sidings for the sake of fuel. Improved acceleration of trains with a recent locomotive improvement has already affected these matters materially on a number of roads and will affect them much more. Track officers will find that locomotive improvements, other than light parts, will help them by avoiding the necessity for heavier rail and bridges. On the other hand they will find that they may do many things with track that affect fuel. They should interest themselves in what is happening to the locomotive, particularly as to application of the booster and reducing dynamic augment.

Signal Officers

These men know the cost of stopping trains. They are helping fuel by keeping trains moving. A new and vital problem lies before them. It will be up to them to secure the necessary safety from automatic train control without unnecessary stopping of trains. Get them into the fuel family as to the effect of this new development on the operation of trains of 60 to 100 cars and also as to the possible improvement of an occasional signal location. The possibility of increased acceleration of trains will affect these locations materially.

Mechanical Officers

When everybody else thinks of fuel, when the "business of owning locomotives" is understood and appreciated, when ultimate cost replaces "first cost" in the official mind, and when necessary improvements in accounting are made, mechanical officers will surprise everybody with the savings they will render possible. They will do it with modernized existing locomotives, with new and greatly improved locomotives, with competent maintenance, with tonnage ratings that mean maximum earnings. Their problem must be understood. They must have facilities, help, encouragement and support. They are ready, but they and their problems are not understood.

Condition of Power

A well known locomotive superintendent 15 years ago did a great thing to improve condition of power. He put several men in charge of matters that make or break fuel records.

1. Front ends, drafting engines for economy as well as for steam, air leaks into front ends and condition of superheaters. One man had charge of these.

2. Valve motion, best setting of valves for every class of engine and for every service was determined and it was this man's job to see that every engine on the road had economical and effective valve setting and that it was kept that way.

3. Boilers, this man was responsible for tight boilers, for clean flues and arch tubes, for grates, arches and ash pans.

4. Running gear, every box, pin, journal, shoe and wedge, was the responsibility of this expert. He supervised the shop and roundhouse work all over the road and had lubrication in charge.

These men had authority. At times they annoyed the master mechanics, but that was the reason for their appointment. Remarkable results were reported. Any road may do this. It means little in cost, but much in fuel. This is a good way to avoid fuel loss by leaky front ends, nozzles too small, leaky superheaters, fallen arches, leaky flues, hot boxes, knocking driving boxes and other things that defeat the best fuel efforts. Today, stokers, feed water heaters, grate shakers and power reverse gear would be added to the list, making it somebody's particular business to look after every one of them systematically.

Existing engines require this. As soon as the "bloom is off the peach" new ones need it also. Large capital expenditure is needed for the necessary maintenance facilities. The public has made it difficult for poor roads to raise the money, but a great deal may be accomplished by a gradual and relatively slow process, each step of which will make the next one easier. Get rid of the fatal monthly budget. Get to an annual basis. Consider annual cycles instead of straight line oversight. Do a little this year and invest the savings of this year for the time to come.

If our shops and roundhouses had adequate machinery and facilities for handling big work quickly, if they had enough to modernize all existing engines and to keep all engines up to condition there would be a surplus of power today for any load the roads have ever had to carry. This, however, will not provide for the load that is coming. New engines will be needed before they can be designed carefully to take advantage of available improvements, and before they can be built. But remember that the new ones will soon add to the shop load. There is no time to lose in this machinery matter or the loss to the public will bring the severest charges railroads ever faced. A new way for financing machinery additions must be found. This is now receiving attention with promise of success. Last February Secretary Hoover suggested government guarantees for improvements and equipment.

Engine Failures

Records for nine years on a well known road show 84 per cent reduction in the number of engine failures per month that cause a delay of five minutes, whether made up or not. Remember that time made up on the road is mighty costly in fuel and it should count against any failure that causes it. In the nine years referred to the number of engines dispatched per engine failure increased 251 per cent. Figuring on $250 as the average cost of an engine failure, and the cost may often reach five times that amount, this road estimates a saving of a quarter million dollars per year, and relatively it is a small road. An engine failure may cost $1,200 if it delays four or more trains. The particular failure that showed this figure could have been prevented by an expenditure of $25.

Long Locomotive Runs

Stand-by losses murder fuel records. Is yours as high as 30 per cent as it was recently stated to be on one big road? Popular demand for economies and growing public sentiment in favor of the operating economies of electrification have some foundation in view of the possible continuous service of electric locomotives eliminating stand-by losses Eight hours a day or perhaps half that, ought to be enough to condition a locomotive, leaving 16 or more, for service. It is not the fault of the engine that it does not work more than 16 hours or that it spends more than half its life at rest. After 150 miles the engine is well warmed up for another 500 miles.

Individual Fuel Records

Without individual performance records it is impossible to check tonnage performance of engines, to check up the value of vitalizing factors and to know whether the power improvements and economy they should give is really produced. A combination of four vitalizing factors should give the light government Mikado 50 per cent additional pull at 30 miles per hour for the same coal as a plain engine of the same size would use. Do we get this power? Only individual records of fuel and tonnage will show. J. N. Clark covered this question admirably before the Pacific Railway Club last year. He asks how the traveling engineer is to know what to say to 125 engineers and 140 firemen unless he knows what each one is doing?

He also asks: "How long would a large industrial plant remain a going concern if they had one item of expense amounting to 40 per cent of their operating expenses and had no idea as to whether it was sustaining a loss each month due to lack of supervision over details?" W. L. Robinson covered this subject in his paper before the New England Railroad Club in December, 1917.

By a few simple figures every run may be made a test run. We do this with automobiles. Any deficiency in miles per gallon leads to a prompt investigation because it touches our own pocketbooks. Some tests made three years ago proved 20 per cent in fuel saving by an improvement on a big engine, but it did not show on any record except that of the test. When a new type of engine goes to work it is most important to know its operating and fuel standing as compared with those that it replaced. This would help in ordering the next new ones. Those who do not know cannot wonder why new engines are ordered without consultation with them. Some general office buildings have four and five floors of accountants. Is it not possible to divert a few accountants to the vital statistics needed for locomotive operation, to make every run a test run, even if it is a rough test?

Co-operation of Engine Men

The major number of engine men take pride in their work. Their co-operation is a vital matter. They are intelligent, able men, but don't ask them to save fuel while someone else who directs their work wastes it faster than they can save it. Give them a chance to run. Give them a railroad to run on, give them track, give them signals and water plugs where they ought to be. Then show them films such as the "Fuel Conservation," films of the Southern Pacific. They would co-operate and turn their daily routine to the advantage of the company. Are your engine men with you as to fuel? Have you a right to expect them to be? Do you keep records of individual tonnage and fuel so that the good men can make a showing and so that the others will be encouraged to try?

Stationary Power Plants

Over 1,200 railway power plants offer opportunities for a lot of fuel saving. Heat losses alone account for 25 per cent of the fuel in the average steam plant without referring specially to railroad plants. Do we give careful attention to the operation of shop power plants to see what the firemen are doing? Do we train and do we check up power plant engineers and firemen? Do we keep brickwork tight? Do we apply superheaters and do we cover piping and stop the leaks of steam, water and heat? A few years ago a large manufacturing company saved ten per cent of its fuel in a large plant by merely stopping leaks. What could railroads save by covering pipes, stopping leaks and by replacing old locomotive boilers by proper boilers with superheaters for stationary plants?

Boiler Water Treatment

A very costly encumbrance is boiler scale. Many a railroad is regularly using waters not fit to be put into boilers, locomotive boilers least of all. It costs little to "doctor" those bad waters, little compared with the cost of driving heat through boiler scale which is the most effective heat resister known. For the benefit of your fuel records "medicine" these bad waters.

Personnel

It's the personnel of an organization and the skill and spirit of its members, the team work, that gets the results, good or otherwise, out of any equipment—army, navy, manufacturing or railroad. Hand in hand must go improved men, improved supervision and improvements in material. To be ready for better locomotives it is necessary to lead men to bring the present equipment and its use to a point of high efficiency. Improve the men and when they get the best work out of present machinery they will be ready for better machinery. A suitable plan for recruiting, training and promotion of men—real apprenticeship—is the thing railroads need more than any other one thing today. What are you doing about this? Ask the roads that have systematically provided apprenticeship whether it pays. Ask the Santa Fe people. Only one road has applied this year to a certain famous technical school for some of its graduates. Was it your road?

Morale

Morale is the first thing to fix. Perhaps by inspired leadership this may be accomplished. Leaders always know what they want and how to get it. Everybody sees coal come in quantities by train loads. Is it not possible by leadership to induce everybody to use it as if it were their own?

Those Next New Locomotives

To order new engines now is a big responsible job which should be approached with full knowledge of the business possibilities of locomotives reinforced by experience and willingness to take advantage of everything that will produce efficient engines that will save money. There is little danger of going too far in refinement. There is great danger of perpetuating the brutal in present locomotive practice.

Unnecessary Weight

This is the first big thing to tackle. Many big engines today are doomed to carry literally tons of unnecessary weight, and to carry them for 20 or 30 years. Think of the fuel required to drag the heavier engine around. Many engines have been built recently that were too heavy to take important fuel saving factors. Here is where the fuel officer comes in on refinement of present brutal weights. He comes in again in saving of fuel by long locomotive runs to which refinement of design and better steels will contribute. One railroad has gotten down to less than 100 lb. of weight per horsepower. Is it your road? There must be a definite weight limit or your fuel records suffer.

Undoubtedly the new engines will have trailing wheels. Boosters add to capacity, produce quicker acceleration to speed, help over critical points on grades, clear yard ladder tracks in shorter time and really put a trailer type of engine into the next class above it in starting power. It saves fuel by avoiding doubling and by putting a light engine in position to do the work of a heavier one. You should consider building Atlantics today with boosters for suburban and frequent stop service, releasing heavier engines and make a little money on such trains.

Stokers should be considered for new engines in a new way—as fuel savers. They are generally advocated to throw more coal than a man can fire. They should be used as fuel savers, enabling the fireman to use his head when he is relieved from the heavy work of firing. Power grate shakers reduce the starving of a fire for air. They are needed to make long runs and to facilitate cleaning fires. New engines call for most careful attention as to lubrication. Long runs already made prove this necessity. Heat conservation by feed water heaters will add to the power of the new engine or save fuel for the same power. Feed water heaters have been demonstrated to be a success and should be considered on every new engine.

All new engines have arches, but a new and double arch is available. Through its supporting tubes water equivalent to the entire contents of the boiler will circulate every seven or eight minutes when the engine is working hard. So also the thermic syphon is available. Their effect on combustion and also their influence on improved circulation must be considered. Boiler circulation may be accelerated in several ways. New engines with necessarily big boilers should have the fuel saving advantage provided by them. With improvements of this class circulation may be so rapid as to require steam separators to prevent the superheater from being compelled to evaporate water. This question will be answered soon. To help boiler circulation, reduce boiler repairs and reduce engine failures why not use ten or 12 inch mud rings?

No engines are built in these days without superheaters, but new ones should have the advantage of higher superheat and superheated steam for the auxiliaries which altogether use a lot of steam. This should save many a ton of fuel. This is now being worked out with promise of success.

Improved valve gears and power reverse gears are necessary on big engines. Cut-off control is only now becoming appreciated as a fuel saver and power increaser. The power

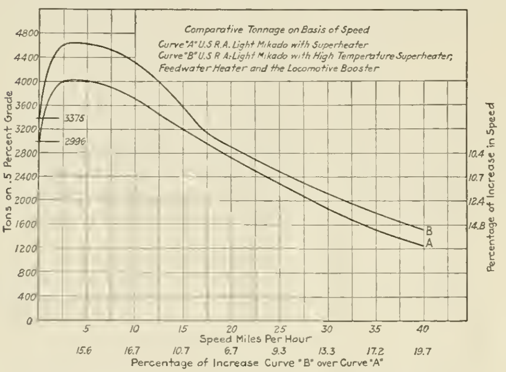


Fig. 1—Effect of Fuel-Saving Appliances on Tonnage and Speed

Curve A indicates the maximum tonnage which can be moved on a 0.5 per cent grade by the U. S. R. A. light Mikado at various speeds; while Curve B represents the possible increase in tonnage which may be obtained by equipping this locomotive with a feedwater heater, high temperature superheater and the locomotive booster.
The increased capacity, as shown by curve B, may be utilized in increased speed of operation, as indicated on the right margin of the diagram; for instance, the speed of a 1,600-ton train may be increased 14.8 per cent.

reverse gear that is to do the work on future big engines must be able to run for long periods without attention and without creeping. Such a gear is now available. For very powerful freight engines the 50 per cent maximum cut-off which has been so successful on the Pennsylvania should be taken into consideration, and after that comes the three cylinder engine to bring bearing pressures down.

This is not by any means a complete list. Skillful combination of design using these factors and others will produce locomotives that will surprise everybody. Up to the time this is written the locomotive that uses all of these, combined with skillful detail design, unrestricted as to first cost, but constructed for ultimate cost and operating economy, has not been built.

A Prediction

We think we know the locomotive. We do not. We will not until a certain thing is done that has never yet been done. Put this up right and you will get it.

Give an order to one of the three locomotive builders, or better give one to each of them, such an order as you give to electric locomotive builders. Give an order for a new locomotive for certain traffic on your road. Make no limit on price, but order the most economical engine that can be built for that work, all things considered, ton-miles per hour, per ton of locomotive metal, per dollar of locomotive mainte-

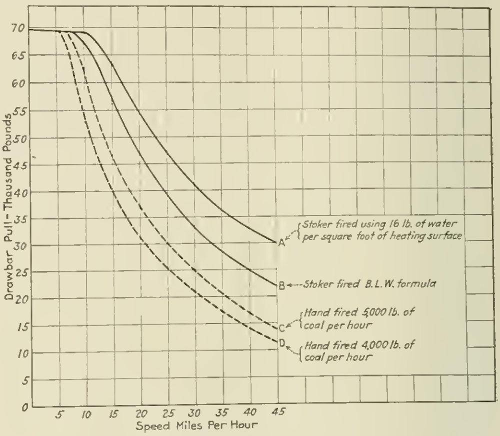


Fig. 2—How Stokers Increase Tractive Effort of Large Locomotives

The capacity of a fireman is limited to about 4,000 lb. of coal per hour over considerable periods; for short periods a man can fire at the rate of from 5,000 to 6,000 lb. per hour.
Curves D and C indicate the drawbar pull on level straight track that can be expected from the U. S. R. A. heavy Santa Fe type locomotive with hand-firing at the rate of 4,000 and 5,000 lb. per hour, respectively.
Curve B illustrates the normal output in drawbar pull of this locomotive as rated by the builders when it is equipped with a mechanical stoker; this involves an evaporation of from 12 to 13 lb. of water per square foot of heating surface and fuel consumption of about 120 lb. per square foot of grate per hour.
Curve A indicates the increase in drawbar pull over the normal capacity which may be expected when the boiler is forced to about 20 per cent beyond its normal capacity.
It will thus be seen that in emergency the stoker can be used to increase the locomotive capacity, although it should be borne in mind that such increase is obtained at a loss in efficiency.

nance and per dollar of track maintenance cost. Enlist the leaders and best engineering talent of the solid, reliable, reputable companies producing the vitalizing, capacity increasing and fuel saving factors that render the modern locomotive possible. Tell all hands, without exception, to cut out every pound of unnecessary weight and make every one of them do it. They will do wonders in this direction when they must. They have never yet been made to do it. But the builders can do more than all the rest. In all things insist on efficiency. Use alloy steels whenever possible, but do not take a chance on anything that has not abundantly made good. Above all things insist on quality material everywhere and get it, as you do when ordering electric locomotives.

When this engine is delivered take good care of it, but make it work every possible minute as every machine should work. Put an experienced man on the job of following the engine to see that it has a "show," as the electrical people do when they install electric locomotives. Then see to it that operation is made to fit the locomotives *as the electric loco-*

motive people do and thereby correct a lot of faults that steam locomotives have always had to endure. Keep track of the tons of freight, fuel, water and the time. Get the dispatcher to give the locomotive the rails to run on, show the men how to run it and then give the right amount of thought to its maintenance.

Then tell the chief executive the results in money saved. He will tell the "Board" the same day. That day will begin a new kind of money making railroading.

Some new, quick, deep, intensive thinking on the locomotive is needed and needed now.

This is an effort to interest real railroad men in some things they are overlooking. It is a challenge for the short-sighted gentry who refer to important locomotive improvements slightingly.

Look, think, act. When you build new engines build ten that will do the work of 20 old ones and cost less to keep up.

Who orders new engines on your road? When he orders two million dollars' worth of engines get him to see how much efficiency he can buy instead of how many engines he can get for his money without regard to their efficiency.

[Accompanying Mr. Basford's paper were numerous charts showing the effect of fuel-saving devices on tractive effort, tonnage, speed, fuel and water rates and acceleration. Two of these charts are reproduced in this abstract.—Editor.]

Discussion

H. C. Woodbridge (Locomotive Stoker Company), said that fuel economy must be considered in connection with other operating costs as well as with considerations of revenue, calling attention to the fact that while stokers have not generally shown as good an evaporate efficiency as hand firing, they have actually reduced ton-mile fuel costs. Recent tests, however have demonstrated that the stoker can actually increase the evaporation per pound of coal over that obtainable under comparable conditions by hand firing.

Pennsylvania—Labor Board Dispute

The legal controversy between the Pennsylvania and the Labor Board, was re-opened on June 2, when hearings were held in the United States Circuit Court of Appeals at Chicago, as the result of an appeal from the recent decision of Federal Judge George T. Page. Judges Baker, Alschuler and Evans heard the arguments by Messrs. Blackburn, Esterline and W. D. Riter, representing the Labor Board, and T. J. Scofield and J. B. Heiserman for the Pennsylvania.

In making the closing argument on behalf of the Board, Mr. Esterline held that the Board is an arm of the government, analogous to the president or committees of Congress and that, therefore, the Board could not be sued or enjoined. He pointed out that the injunction issued by the Circuit Court, restraining the Board from issuing a decision inimical to the Pennsylvania's interests, stated that the Board's powers were only advisory. He therefore declared advisory powers could not be enjoined any more than the President could be enjoined from submitting a message to Congress or a congressional committee from reporting its recommendation.

These contentions apparently did not meet with the approval of Judge Baker, who said:

"I do not consider that that question is involved. The fundamental question is whether the Board acted within its jurisdiction in its order to the railroad and, if it did, whether or not the power under which it acted is constitutional."

Mr. Scofield and Mr. Heiserman for the Pennsylvania, argued that the Board acted without jurisdiction in issuing the order and while admitting the right of the Board to prescribe just and reasonable rules, denied the Board's power to direct how the rules governing employees should be made. The arguments of the railroad's and the Labor Board's attorneys followed the arguments in previous hearings.

The court subsequently took the case under advisement and Mr. Esterline announced that if the injunction is upheld the Board will carry the case to the Supreme Court.

1922 OFFICERS OF THE AIR BRAKE ASSOCIATION

Seated, left to right: Mark Purcell, first vice president; L. P. Streeter, president; George H. Wood, second vice president; R. C. Burns, executive committee. Standing: M. S. Belk, executive committee; F. M. Nellis, secretary; H. L. Sandhas, executive committee; H. A. Clark, executive committee.

THE QUESTION BOX

Design of Crank-Pin and Crank-Pin Hub

A Solution of the Problem

By H. J. Coventry

This is another answer to the questions published on page 202 of the April issue. A previous answer was published on page 330 of the June issue.

1. Fibre stress in crank-pin hub due to pressing in the pin with a pressure of 140 tons: It can readily be seen that the load required to press pin into hub is equal to the holding force of hub multiplied by the coefficient of friction, or

$W = P \times u$ ....(a)

Taking u = .25, the value of the gripping force of hub is found thus

$$2{,}000 \times 140 = P \times .25$$
$$P = 1{,}120{,}000 \text{ lb.}$$

This force will act normally to surface of pin if the pin fits throughout its surface. Therefore, pressure per square inch of surface of hub bore is

$$\frac{P}{\text{area}} = \frac{1{,}120{,}000}{7.5 \times \pi \times 7} = 6{,}790 \text{ lb. per sq. in.}$$

Now this pressure acts upon the hub similarly to fluid pressure in a thick cylinder, the maximum skin stress occurring on the inner surface and its value may be found by the formula of Lamé.

$$f_1 = p_1 \frac{r_1^2 + r_2^2}{r_1^2 - r_2^2} \text{ ....(b)}$$

here f_1 = Stress lb. per sq. in. on inner surface of bore
p_1 = Pressure lb. per sq. in. on inner surface of bore
r_1 = External radius of cylinder or hub
r_2 = Internal radius of cylinder or hub

In our case $f_1 = 6{,}790 \left(\frac{6.75^2 + 3.75^2}{6.75^2 - 3.75^2}\right)$

$$= 6{,}790 \times 1.895$$
$$= 12{,}833 \text{ lb. per sq. in.}$$

(2) Maximum pressure at which crank-pin can be pressed in without causing hub to burst: The material of pin-carbon steel forging has an ultimate strength of 80,000 lb. per sq. in. with a yield of 40,000 lb. per sq. in.

The cast steel of hub has 65,000 lb. per sq. in ultimate, 29,200 lb. per sq. in. yield and elastic limit 26,000 lb. per sq. in.

To find maximum pressure which hub will withstand, substitute stress at elastic limit in above equation. Then

$$26{,}000 = p_1 \times 1.895$$
$$p_1 = 13{,}720 \text{ lb. per sq. in.}$$

That is intensity of pressure between hub and pin may be 13,720 lb. per sq. in. without bursting hub.

Total holding force = 13,720 × surface of pin
= 13,720 × 7 × 7.5 × π
= 2,270,000 lb.

Driving or pressing force required

$$= \frac{2{,}270{,}000 \times .25}{2{,}000}$$
$$= 282.5 \text{ tons}$$

Or this pressure may be found directly thus

$$140 \times \frac{13{,}720}{6{,}790} = 282.5 \text{ tons}$$

(3) Fibre stress in hub due to pressing in pin plus stress due to thrust from main rod: To find the force acting at hub take moments about w.

$W \times (9.75 + 7) = w \times 7$ ....(c)
$w = 2.392\ W$

This force tends to tear the hub apart across a diameter and the area of metal supporting this force is

$$2\ (3 \times 7) = 42 \text{ sq. in.}$$

Load W on pin due to piston thrust

$$= \frac{25^2 \pi}{4} \times 180 \text{ according to data given}$$
$$= 88{,}356 \text{ lb.}$$

$$\text{Stress on hub} = \frac{2.392 \times 88{,}356}{42}$$
$$= 5{,}020 \text{ lb. per sq. in. tension}$$

Total stress on bore of hub due to thrust of piston and pressure of fit of pin = 12,833 + 5020 = 17,853 lb. per sq. in.

(4) Strength of pin:

Bending moment = fibre stress × modulus of section or

$W \times l = f \times \frac{\pi d^3}{32}$ ....(d)

Here W = piston thrust
l = distance between load and point considered
d = diameter of pin in inches
f = stress lb. per sq. in.

$$\text{then } 88{,}356 \times 9.75 = f \times \frac{\pi \times 7.5^3}{32}$$

$$f = 20{,}800 \text{ lb. per sq. in. at largest diameter.}$$

The fibre stress at any other diameter along the pin may be found similarly.

At end of 7¼ in. diameter portion

$$f = \frac{88{,}356 \times 9.5 \times 32}{\pi \times 7.25^3} = 22{,}400 \text{ lb. per sq. in.}$$

At end of 6½ in. diameter portion.

$$f = \frac{88{,}356 \times 3.75 \times 32}{\pi \times 6.5^3} = 12{,}250 \text{ lb. per sq. in.}$$

The stresses throughout this design are too high with the exception of that at the 6½ in. diameter portion of pin but even this diameter is insufficient to keep the limiting bearing pressure of rod brass within 1,600-1,700 lb. per sq. in. of projected area.

The design is unsuitable for a 25 in. cylinder at 180 lb. steam pressure.

Suitable diameters would be 8¼, 8, 7½, instead of 7½, 7¼, 6½, as given.

A useful expression for relating "fit allowance" on pin and maximum stress allowed on hub is

$$\frac{x}{d} = \frac{f}{E}\left\{\left(\frac{m-1}{m} + \frac{1}{m'} \times \frac{E}{E'}\right)\frac{r_1^2 - r_2^2}{r_1^2 + r_2^2} + \frac{E}{E'}\right\} \text{ ....(e)}$$

where x = allowance for fit on pin in inches
d = bore of hub in inches
f = stress produced, lb. per sq. in.
E = modulus of elasticity of pin material
E' = modulus of elasticity of hub material
r_1 = external radius of hub
r_2 = internal radius of hub
m = Poisson's ratio for pin material
m' = Poisson's ratio for hub material

For similar material E' = E and m = m_1.

The values for cast and forged steel are sufficiently close to be taken as equal: namely, 30,000,000 lb. per sq. in. for "E" and 4 for "m." Then equation above becomes

$$\frac{x}{d} = \frac{f}{E}\left(\frac{r_1^2 - r_2^2}{r_1^2 + r_2^2} + 1\right) \ldots\ldots\ldots\ldots (f)$$

A suitable allowance for the pin given may be found from above, taking say a maximum stress of 12,800 lb. per sq. in. on hub as previously found.

$$\frac{x}{7.5} = \frac{12,800}{30,000,000}\left(\frac{6.75^2 - 3.75^2}{6.75^2 + 3.75^2} + 1\right)$$

$$x = \frac{128}{300,000} \times 1.528 \times 7.5$$

$$\text{Allowance} = .0049 \text{ in.}$$

This would require a pressing force of 140 tons. From Equation (f) allowance, stress or hub thickness may be found by giving values to any two. It is interesting to note that by increasing the value for "r_1"; that is, the outside radius of hub while still retaining a fixed value for x, the allowance, not only is the hub stress reduced but what is of greater usefulness the holding power is increased and too this will increase much more rapidly for increments of hub thickness than the stress on material decreases. Therefore, security of pin calls for thick hubs quite apart from considerations of strength.

The expression relating fit allowance and gripping pressure per sq. in. is given thus

$$\frac{x}{d} = \frac{p_1}{E}\left\{\frac{m-1}{m} + \frac{E}{E'}\frac{1}{m'} + \frac{E}{E'} \times \left(\frac{r_2^2 + r_1^2}{r_2^2 - r_1^2}\right)\right\}$$

When hub and pin are of similar material this becomes

$$\frac{x}{d} = \frac{p_1}{E}\left(2 \times \frac{r_2^2 + r_1^2}{r_2^2 - r_1^2}\right) \qquad \text{or}$$

$$p_1 = \frac{x E \times (r_2^2 - r_1^2)}{2 d \times (r_2^2 + r_1^2)}$$

p_1 = gripping pressure per sq. in

For derivation of the above formulæ and a full discussion of the stresses produced by forced fits the reader is referred to Morley's "Strength of Materials" (Longman Green & Co.).

Design of Crank-Pin and Crank-Pin Hub

Criticism of Solution in June Issue

By H. J. Coventry

The following comments are offered in regard to the answer published in the June issue of the problem given in the April issue.

The assumption of one or two per cent smaller diameter of bore than pin is unwarranted seeing that the allowance is a function of the driving force which is given as 140 tons. Also the practice of coning the pin is open to question and is by no means considered good practice as the fit is not

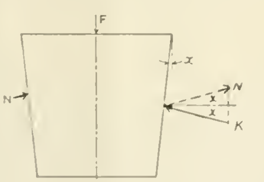


Fig. 1

as tight as a parallel pin and bore while if the pin should creep at all it speedily comes loose.

However, waiving these points and assuming a taper of 1/100, we get an angle of slope to center line of 1/200, or X is an angle whose tangent is 0.005. Therefore, X = 17′, not 35′. The force F is balanced by the two forces N and K normal to the surface of the pin.

By the triangle of forces (Fig. 1),

$$K = N \text{ and } N = \frac{F}{2 \sin X}$$

The friction angle must be added to X and taking the coefficient of friction at .23 gives an angle of 13 degrees so that

$$N = \frac{F}{2 \sin (13° \; 17')} = \frac{140}{2 \times .229} = 305 \text{ tons}$$

$$\text{Pressure per sq. in.} = \frac{305}{0.5 \times 7 \times 7\tfrac{1}{2} \times \pi} = 3.7 \text{ tons per sq. in.}$$

This is quite a different result from that of your correspondent who has apparently neglected the coefficient of friction, resolved the force wrongly and overlooked the fact that across any diameter we have force N acting on half the surface area while K acts on the other half.

Fibre stress in hub

$$T = 3.7\left(\frac{R^2 + r^2}{R^2 - r^2}\right) = 7 \text{ tons}$$

Maximum allowable forcing pressure

This is correctly calculated although there is evidently a numerical error as it is stated that "the safe working load = 75,000 lb* = 7½ tons. A limit stress of 13 tons would be about right for 65,000 lb. cast steel and substituting this in above gives

$$13 = p\left(\frac{R^2 + r^2}{R^2 - r^2}\right) \qquad p = \frac{13}{1.89}$$

$$p = 6.87 \text{ tons per sq. in.}$$

$$\text{Total pressure} = 6.87 \times 165 = 1,135 \text{ tons}$$
$$\text{Pressing force } F = 1,135 \times .229 = 260 \text{ tons}$$

Your correspondent gives only the total surface pressure instead of maximum driving force required without bursting hub as the question calls for.

The load assumptions are not warranted by practice; for instance, it would be a very poor engine which in full gear had a steam chest drop of 20 lb. per sq. in. pressure and a back pressure of 20 lb. per sq. in. Twenty pounds per sq. in. *absolute* might be nearer the mark.

It is not usual in cylinder and motion design to take anything less than full boiler pressure acting on the total area of the piston, thus giving the piston thrust and maximum force acting on the crank-pin. It is quite true that thrust along the connecting rod is higher than that on the piston when the connecting rod is at an angle to the centre line but for locomotive rods which are usually long compared to the stroke, the amount is small and is amply covered by taking the maximum piston thrust.

$$\text{Piston thrust} = 180 \times 25^2 \times \frac{\pi}{4} = 88,356 \text{ lb. or } 44.178 \text{ tons.}$$

Strength of pins

The crank pin is a cantilever and the maximum bending moment

$$M = Wl \text{ where } l = 9\tfrac{3}{4} \text{ in.}$$
$$W = 44.178 \text{ tons}$$

The section modulus = $0.098d^3$ and
$Wl = .098d^3f$ where f = stress, say 8½ tons

The maximum bending moment occurs at the face of the hub which is 9¾ in. from the center of the load, not 7½ in.

$$44.178 \times 9.75 = .098 \times 8.5 \times d^3$$

$$d = \sqrt[3]{\frac{44.178 \times 9.75}{.098 \times 8.5}} = 8 \text{ in.}$$

A 7½ in. diameter pin is, therefore, inadequate. The strength at the other diameters may be found similarly using appropriate l. The other diameters are also too highly stressed except the 6½ in. diameter portion, but this has insufficient bearing area to limit pressure to 1,700 lb. per sq. in. projected area, the actual bearing pressure being

*This is a typographical error and should have read 15,000 lb.—Editor.

1,815 lb. per sq. in. Locomotive driving wheels make from 300 to 400 r. p. m. so that an empirical formula for bearing pressure based on 150 r. p. m. is unsuitable.

Stress in hub due to load W and pressure of pin

The moment R_1 and R_2 surely act at planes A′A and C′C which can be easily understood if the pin is imagined to be loose in the bore.

R_1 and R_2 are equal and opposite, tending to tear the boss across a diameter and therefore putting the metal in tension. There is, of course, a crushing influence starting at a maximum on the bottom of plane A′A at point A in Fig. 4 decreasing to 0 at center line B′B and similarly on section from B′ to C′, but it will be found that the boss is stronger against crushing than in tension across the diameter. This might be illustrated by Diagram A.

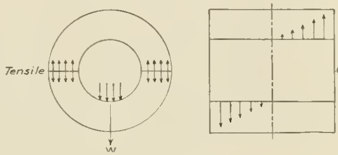


Diagram A

$$R_1 = W \times 9.75$$
$$R_2 = W \times 7$$

$$W = \frac{9.75W}{7} = 1.393W \text{ at plane C'C and}$$

$$W + w = 2.393W \text{ at plane A'A} = 105.5 \text{ tons}$$

$$\text{Crushing stress} = \frac{105.5}{D \times \frac{1}{2}} \text{ not } \frac{105.5}{\frac{1}{4}\pi Dl}$$

$$= 4.025 \text{ tons per sq. in.}$$

$$\text{Tensile stress} = \frac{105}{7 \times 2 \times 3} = 2.5 \text{ tons per sq. in.}$$

Total tensile stress in hub due to load W and pressing in of pin

$$= 2.5 + 7 = 9.5 \text{ tons per sq. in. or } 19{,}000 \text{ lb. per sq. in.}$$

As the compression reaction and the tensile stress act on planes at right angles to one another the tension never relieves the compression. This may be seen better by taking an elementary area at the bottom of the bore (see Diagram B). This will have a compressive stress of 4.025 tons per sq. in.

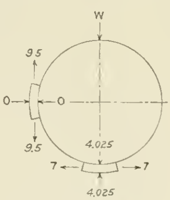


Diagram B

and at right angles to it a tensile stress of 7 tons, or that due to forcing in pin only. A similar element at right angles to above will have a tensile stress of 9.5 tons per sq. in. and no compression at all. The stresses will, therefore, fluctuate from 7 to 9.5 tons per sq. in. tension and from 0 to 4.025 tons per sq. in. compression.

All these stresses and general proportions of the hub and pin indicate that it is entirely too small for a 25 in. cylinder working at 180 lb. per sq. in.

If, as is good practice, the pin is made parallel, the expression for normal pressure becomes

$$N = \frac{F}{2 \sin X} \text{ as before, but as angle X is now } 0'$$

$$N = \frac{F}{2 \times 0} = \frac{F}{0} = \text{Infinity}$$

$$\text{and } F = 0$$

This result is quite logical as it merely means that if F is a definite quantity, then N may be anything definite up to infinity, depending on amount of increase of pin diameter. While if no driving force is required, no normal pressure is produced; that is, the pin becomes a sliding fit.

This is given to illustrate the writer's contention that the terms of the problem were not adhered to by Mr. Montangie in assuming a taper pin. If the pin is parallel, the above expression will not be soluble and this method would not apply.

AIR BRAKE CORNER

I. C. C. Power Brake Hearing to Be Resumed in July

During the second week of the hearing in May, Spencer G. Neal, chief engineer, Automatic Straight Air Brake Company, was on the stand for two days. He was followed by J. E. Grant, special agent of the Bureau of Explosives. Other witnesses called by the Automatic Straight Air Brake Company were H. B. McFarland and George L. Fowler, consulting engineers, and A. J. Schuyler, general car inspector, Virginian Railway.

The first two witnesses presented by the Westinghouse Air Brake Company were W. S. Bartholemew, vice-president, and George W. Wildin, general manager. They were followed by T. W. Dow, Erie; J. F. Gannon, New York Central; P. J. Langan, Delaware, Lackawanna & Western; and George E. Terwilliger, New York, New Haven & Hartford. The Westinghouse Air Brake side of the case was closed with evidence by Prof. S. W. Dudley, Yale University (formerly chief engineer W. A. B. Co.), and C. C. Farmer, director of engineering, W. A. B. Co. The only witness for the New York Air Brake Company was B. J. Minnier, local manager.

Others who appeared were J. H. Phillips, who described a metallic hose connector, and W. H. Sauvage, who requested permission to describe his air brake system and also the automatic slack adjuster made by the Gould Coupler Company.

The hearing was adjourned on Monday night, May 29, subject to call. Notice has since been sent out reconvening the hearing at Washington on July 17.

Jumping Action of Air Compressor

Question.—Sometime ago I had an engine terminating here which was equipped with an 8½-in. cross-compound pump. Just about the time the pressure was pumped up to where it affected the governor, the high pressure steam piston would commence to jump up and down in such rapid succession that it would shake the whole engine. I at first concluded that as the governor was closing, the steam pressure around the reversing valve was not sufficient to hold the valve seated and the weight of the valve and reversing stem would cause the valve to drop and reverse the pump before the piston had time to reach the end of its stroke, in fact the length of the strokes did not appear to be more than ¼ in. With the idea of overcoming the trouble I made a flat spring of proper length and placed it between the shoulders in the top of the reversing rod and back of the reversing valve, so that the reversing valve would be forced hard against the seat at all times, but the modification was fruitless as it did not overcome the trouble. Finally after about 30 days the action was less frequent and gradually ceased to exist. Can you advise what the trouble was?—F. N.

Answer.—This question is somewhat difficult to answer for while a good description of the action has been given, there are several things that might have brought it about. It is possible that a bend in the valve rod caused it to rub against the reversing valve plate on the steam piston and thus brought about a shifting of the reversing valve and a reversal of the piston movement before the reversing valve plate came in contact with the shoulder or button on the valve rod. This unusual friction may have existed only for a short period and ceased after a slight wear occurred thus resulting in the trouble gradually disappearing as described.

(If any of our readers have observed similar action, we would be pleased to learn the cause and how it was corrected. —*Editor*.)

Answers to Questions in June Issue

Several answers have been sent in to the five questions given in the *Railway Mechanical Engineer* for June 1922. As some were received just before this issue was published, it was decided best not to print the answers until the August number. If any other readers desire to send in answers, they should do so promptly so that they will reach the New York office before July 15.—*Editor*.

WHAT OUR READERS THINK

Vacuum Brake Tests on English Goods Trains

Derby and Doncaster, England.

To the Editor:

In the article which appeared in your April number on the tests of vacuum brakes described in our paper before the Institution of Civil Engineers, it is pointed out that the retarding effect of the vacuum brake compares unfavorably with tests of the Westinghouse brake made in America as far back as 1887.

We wish to point out that the tests on the Great Northern railway were in no way intended to ascertain the shortest distance in which a freight train fitted with vacuum brakes could be stopped; the object of the tests was to ascertain whether satisfactory stops with existing equipment could be made with, what are in this country, long freight trains consisting of up to 100 wagons. The wagons were not fitted with special apparatus to give the highest braking effect and the results, therefore, should not be compared with the Westinghouse brake as regards stopping distance.

As a matter of fact, tests made in this country and also on the continent, indicate that long freight trains fitted with the vacuum brake stop in as short a distance as trains fitted with the Westinghouse brake.

(Sir) Henry Fowler.
Chief Mechanical Engineer, Midland Railway.

H. N. Gresley.
Locomotive Engineer, Great Northern Railway.

Superheated Steam for Locomotive Auxiliaries

Sioux City, Iowa

To the Editor:

It has been stated that 22 lb. of coal per hour is required to run a headlight dynamo. Tests have shown that superheated steam is some 25 per cent more economical than saturated steam. Such being the case, if superheated steam was used for this purpose, there would be realized a saving of one-fourth of 22 lb., or 5½ lb. per hour. On a typical main line division of a middle western railroad there are four scheduled night runs. It takes about 10 hr. for each run, or 40 hr. for the four runs. Forty times 22 lb. per hour equals 880 lb. of coal per night and 880 lb. times 30 days equals 26,400 lb. per month—approximately 13 tons of coal per month on four runs at $5 per ton equals $65 per month for the headlight dynamo alone. If superheated steam were used, it would give a saving of $16.25 per month for 12 months, or $195 per year for these four runs. Assuming that the 18 divisions of the system had four night freight runs each, this would equal $3,510 ($195 times 18) saving per year on 72 freight runs for the headlight dynamo alone.

It takes about 200 lb. of coal per hour to run a train dynamo and the dynamo is run in summer as well as winter months. There are eight trains which run a dynamo from Chicago to Omaha. Assuming that this is two-thirds of the dynamo trains on the system, there would be approximately 12 trains times 12—assuming the schedule to be 12 hrs.—or 144 hrs. at 200 lb. per hour, or 28,800 lb. of coal per day; 864,000 lb. per month and 10,368,000 lb. per year for the train dynamos. In tons this would be approximately 5,134 tons at $5 per ton, or $25,670 per year. If we substituted superheated steam for the train dynamos, it would give one-fourth saving in coal alone, which would amount to $6,417 per year.

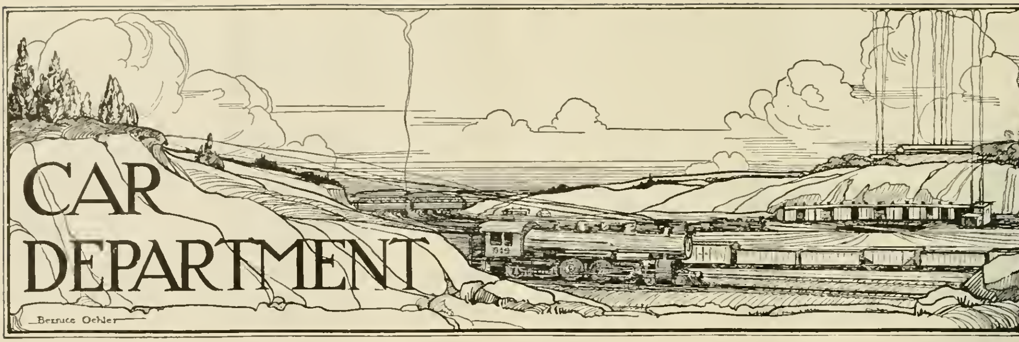
For the headlight dynamo we can take the same number of passenger trains. Assuming that this is all the passenger trains that use a headlight dynamo, 144 hrs. times 5½ lb. per hour equals approximately 800 lb. for the trains per day; 292,000 lb. or 146 tons per year at $5 per ton, or $730.

The foregoing has shown a saving of $6,417 for train dynamos, $730 for passenger locomotive headlight dynamos and $3,510 for freight locomotive headlight dynamos or a total of $10,657 per year on one large trunk line.

It has furthermore been stated by good authority that it cost the railroads of the United States 6,000,000 tons of coal to supply the leaks in the air brake train line alone. Assuming an equal amount of air is required to charge the brake for applications, etc., the air pumps would use 12,000,000 tons per year. This at $5 per ton would be $60,000,000 per year, and one-fourth saved by the application of superheated steam would be $15,000,000 per year on the steam for air pumps.

A study of the figures given presents a strong argument for the use of superheated steam for dynamos, air pumps and other locomotive auxiliaries which should not be overlooked in attempts to reduce operating costs.

M. M. Crowley.



Some Notes on Railway Refrigerator Cars*

Survey of Existing Equipment; Efficiency of Insulation; Special Systems of Refrigeration

By W. H. Winterrowd
Chief Mechanical Engineer, Canadian Pacific

In an endeavor to sense the trend of refrigerator-car design, proportions, and construction, the writer addressed and inquiry to a number of railways and private-car owners. A comparison of the most interesting returns is shown in Table 1, and makes a very interesting study, although in any consideration of this table the fact must not be overlooked that possibly some of the railroads or owners, if building equipment today, might modify their designs.

Every road or owner represented owns at least one thousand cars. As far as possible the cars shown were chosen from quantities built in comparatively recent years. Many of the old timers, really not refrigerator cars at all, were omitted. Even so, some of the cars built in recent years provoke question.

Another point is that during the past three years car building or rebuilding has been at a minimum. Even so, it is of great interest to note that many of the cars built within this period, or being designed or constructed today, embody in great measure those principles which make for an efficient and economical unit.

Types of Cars and Ice Containers

Generally speaking the cars can be divided into two types: one, equipped with brine tanks and generally used for carrying meats; the other, equipped with bunkers, and used principally for carrying commodities such as eggs, butter, vegetables and fruit.

In connection with this distinction, based on ice containers, it is interesting to note that Dr. Pennington has stated that a car of the basket-bunker type, such as the U. S. Railway Administration Standard, will carry meat hung from rails quite as successfully as a car built especially for meat. The statement is also made that there is not visible in practical results the advantages supposed to accrue from the retention of the brine, provided coarse rock salt is placed on top of the ice in the bunker and so forced to bore its way through the whole mass before finding an exit.

But there is a very important problem in this connection that must not be overlooked if salt is to be used with ice in a basket bunker, and that is the method of disposing of the brine. The subject of brine drip is one that has received a great deal of attention by railway engineers. It is common knowledge that if brine falls on journal boxes, side frames, arch bars or other truck parts, as well as upon rails, tie plates, bridge members, etc., the resulting damage is great and a factor involving heavy maintenance cost.

The subject is so important that the American Railway Association interchange rules specify that after July 1, 1922, no car carrying products which require for their refrigeration the use of ice and salt and which are equipped with brine tanks, will be accepted in interchange unless provided with a suitable device for retaining the brine between the icing stations. If salt is to be used with ice in basket bunkers, a practical and economical arrangement is necessary to retain the brine so that it can be disposed of between icing stations.

The data submitted do not show any car of the basket bunker type equipped with overhead meat racks. They show that cars built for carrying meats and products requiring a low temperature are equipped with brine tanks.

Twenty-seven railroads and owners are represented in Table 1. Out of this number the principal cars of 16 are equipped with bunkers, and the remainder are equipped with brine tanks. Out of the 16, 11 or practically 69 per cent are of the basket type; the remaining five, or approximately 31 per cent, are of the box type. The majority of the cars recently built, or now under construction, are equipped with the basket type of bunker. The demand for refrigeration and the special-service car, as well as greater efficiency of the permanent basket type, appear to be decreasing the demand for the collapsible bunker.

Another distinction that prevails and will prevail as long as cars are built for some particular service is the difference in construction due to the commodity to be transported.

In meat cars the lading is hung on hooks suspended from a meat rack placed just below the ceiling. This rack generally consists of stringers and cross bars supported by the roof and walls of the car. In a car of this type it is necessary to make the framing heavier so that in addition to its

*Conclusion of abstract of a paper presented before the American Society of Mechanical Engineers at New York, May 16. The first part of the paper was abstracted in the June issue, page 339.

other functions, it will adequately support the weight of the lading. A meat rack and hook installation was illustrated in Fig. 4 (June issue, page 340). Very often additional lading is stowed or placed on the floor racks beneath the suspended load, in order to obtain the maximum carrying capacity of the car.

Bulkheads.— The majority of the cars tabulated are equipped with solid bulkheads. These are either built into place or are hinged from the walls or ceiling so that they can be swung open.

A few cars are equipped with the syphon system, in which the bulkhead consists of a framework holding a series of galvanized iron louvres supposed to direct the air back and down into the bunkers. The theory is that air entering the bunker over the top of the bulkhead becomes chilled, and in its downward motion creates a suction or siphoning effect which draws air from the body of the car into the bunker through the openings in the bulkhead. Although this system is on some cars of fairly recent origin it is significant that many railroads or owners who used it on their older cars have abandoned it in favor of the solid bulkhead.

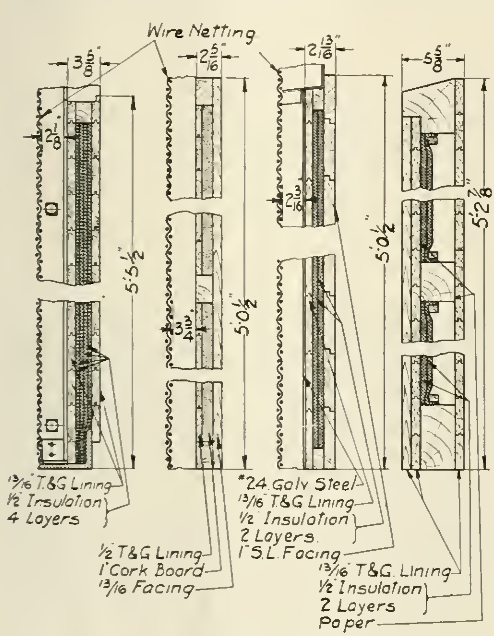


Fig. 5—Typical Cross Sections of Bulkheads

The prevailing trend of construction indicates a recognition of the value of solid and insulated bulkheads. The general trend seems to be to use two layers of ½-in. hair felt between two walls of 13/16-in matched-and-dressed-wood lining. An interesting exception, and on a quite recent car, is the use of one layer of 1-in. cork insulation. Some bulkheads are constructed of two walls with a few layers of waterproof paper between them. Occasionally an air space is contained between the walls. In one instance, in addition to a dead-air space, two layers of ½-in. hair felt are provided. Some cross sections of bulkheads are shown in Fig. 5.

Space Below Bulkheads.—The space between the bottom of the bulkhead and the car floor varies considerably, ranging from 7 in. to 2 ft. 7 in. On the car with the 7-in. space the bulkhead is brought right down to the level of the floor rack. On the bottom of this bulkhead a canvas strip is fastened to prevent cold air passing out above the racks. The cars with the very large openings at both bottom and top of bulkheads are generally used for meat shipments.

The majority of the cars have a bottom opening of from 9 to 15¾ in. The average is about 12 in. As the floor racks on these cars average about 4½ to 5 in. in height it can be seen that the cold air has access to the body of the car above the rack as well as through the space beneath it.

The writer has endeavored to ascertain if there is any relation between the size of the openings above and below the bulkhead and the velocity of the air in circulation, but inquiry has not produced anything definite. There is some unanimity of opinion, however, in favor of the design in which there is an opening of from 2 to 7 in. above the floor racks. If there are any data on this subject they should be of considerable interest, but if no definite information exists the matter appears to be one worthy of careful investigation. It is evident that any improvement in circulation would help to bring about more uniform temperatures, an obvious benefit.

In the matter of efficient refrigeration the distance between bulkheads is an important one. The tabulation shows that this varies between 28 ft. 8 in. and 38 ft. 10 in. The general trend is between 32 and 34 ft. On the latest cars the spacing is approximately 33 ft., or slightly greater. The size of the standard egg crate has been a large factor in the establishment of the exact dimension.

Difficulty in obtaining proper temperatures at the center and top of the lading has been responsible for the thought that longer cars and less deep loading would bring better results. Longer cars have been demanded also as the result of a desire to increase their capacity.

The principle has been emphasized that heat transmission varies directly as the number of square feet of surface enclosing the car space. A study of some of the long cars indicates that this principle has not been followed closely in determining the kind and amount of insulation.

Floor Racks.—Space between the top of the floor rack and the floor of the car averages between 4½ and 5 in. The majority of the modern cars are equipped with these racks, but an examination of the tabulation would indicate that their importance is not fully recognized. This fact is borne out by an examination of hundreds of refrigerator cars at a fruit-and-produce-distributing station. Many of the cars with long slats or runners fastened to the floor are of such construction and equipped with such types of bulkheads that floor racks could be applied easily and cheaply.

Car Construction and Maintenance

An impression seems to prevail that the life of a railway refrigerator car is about 6 to 8 years. In 1919 a committee of the Mechanical Section of the American Railway Association reported that the average life of railroad-owned wooden refrigerator cars dismantled was 17.1 years, and of private-line wooden refrigerator cars dismantled, 21.9 years, making the average life for all wooden refrigerator cars dismantled 19.4 years. It was also stated that the average life of railroad-owned wooden refrigerator cars was largely affected by two lines reporting the dismantling of a large number of cars of an average life of only 15 years; by excluding these two lots of cars, the average life for railroad-owned wooden refrigerator cars was 21.3 years, and for private-line-owned cars 21.9 years.

The life of refrigerator cars equipped with steel underframes or steel framing and superstructure is a matter upon which there are little data, because such cars are comparatively modern. There seem to be no reasons, however, barring those of possible evolution, why such cars should not

TABLE 1—DETAILS OF CONSTRUCTION OF REFRIGERATOR CARS (SEE FIG. A FOR KEY TO DIMENSIONS)

Service	Road or owner	A Over striking castings, ft.-in.	B Truck centers, ft.-in.	C Between bulkheads, ft.-in.	D Width inside, ft.-in.	E Height clear, ft.-in.	F Door height, ft.-in.	G Door, width, ft.-in.	H Height of floor rack	K Height opening below bulkhead	L Height opening above bulkhead	Type of bulkhead	Tank or bunker	Floors: Layers: Wood	Floors: Layers: Waterproof paper or fabric	Floors: Layers: Air space	Floors: Layers: Insul. mat'l	Floors: Kind of insulating material	Sides: Layers: Wood	Sides: Layers: Waterproof paper or fabric	Sides: Layers: Air space	Sides: Layers: Insul. mat'l	Sides: Kind of insulating material	Type of outside roof	Roof: Layers: Wood	Roof: Layers: Waterproof paper or fabric	Roof: Layers: Air space	Roof: Layers: Insul. mat'l	Roof: Kind of insulating material	Type of underframe	Road or owner
Freight	1	42-5¼	31-2	34-4¾	8-7⅜	6-8 Meat rack 7-3½ ceiling	6-9⅝	5-0	5½"	7"	16½"	Solid, swinging to side	Brine tank	4	2 Paper	2	4	½" Keystone hairfelt	3	..	2	3	½" Keystone Hairfelt	Outside metal	5	1 Paper	4	6	½" Keystone Hairfelt	Steel	1
Freight	2	41-8½	30-8	33-2¾	8-2¾	7-0 3/16	6-8⅛	4-0	4⅞"	12"	14"	Solid, rigid	Basket bunker	2	1 Paper	..	1	2" Cork	3	2 Paper	3	3	½" Keystone Hairfelt	Outside metal	3	1 Paper	2	4	½" Keystone Hairfelt	Steel	2
Freight	3	42-1½	31-1½	33-2¾	8-2¾	7-0 7/16	6-8¼	4-0	4¾"	12"	12"	Solid, rigid	Basket bunker	2	..	..	1	2" Cork	3	3 Fabric	1	2	1" Insulation	Outside metal	3	2	2	3	....	Steel	3
Freight	4	40-8½	29-10½	32-2⅜	8-0½	7-2	6-4¼	4-0	⅞" Slat	..	3½"	Swinging to roof	Bunker (collap.)	3	1 Paper	1	4	½" Insulite	3	4 Paper	3	4	½" Flaxlinum	Wood	5	5 Paper	3	4	½" Flaxlinum	Steel	4
Freight	5	34-0 Endsills	24-0	28-8	8-1	7-4½	6-0	4-0	...	2'7"	17"	Solid, swinging to sides	Brine tank	5	8 Paper	3	1	1" Hairfelt	4	6 Paper	2	1	1" Hairfelt	Wood	5	5 Paper	4	2	1" Hairfelt	Steel	5
Freight	6	42-1½	31-1½	33-2¾	8-2¾	7-0 7/16	6-8¼	4-0	4¾"	12"	14"	Solid, rigid	Basket bunker	2	..	..	1	2" Cork	3	1 Fabric	1	2 1	½" Keystone 1" Hairfelt	Outside metal	3	1 Fabric	2	2 2	½" Keystone ¾" Hairfelt	Steel	6
Freight	7	36-11⅛	26-0	29-10¾	8-2¼	7-1⅞	6-3	5-0	4½"	12½"	14⅞"	Solid, swinging to side	Brine tank	4	2 Paper	3	1 1	Keystone Woolfelt	3	4 Paper	2	1	Keystone	Wood	5	3 Paper	2	1 1	Keystone sawdust	Steel	7
Freight	8	37-9¼ Endsills	26-10	36-0 Bet. ends	8-3⅜	8-0 1/16	7-0	6-0	...	..	.....	......	Ice boxes at roof	3	..	4	3	½" Flaxlinum	3	2 Paper	3	2	½" Flaxlinum	Outside metal	3	..	2	4	½" Flaxlinum	Steel	8
Freight	9	37-10⅛	....	31-0⅛	7-9⅜	7-1 5/16	5-9¼	4-0	...	2'-6"	16¾"	Solid, rigid	Brine tank	5	6 Paper	3	1 1	½" Hairfelt 1" Hairfelt	3	3 Paper	3	1	½" Hairfelt 1" Hairfelt	Wood	6	..	5	2	½" Hairfelt	Wood	9
Freight	10	42-1½	31-1½	33-1¾	8-2¾	7-1	6-4¾	5-0	4¾"	15¼"	11½"	Solid, rigid	Basket bunker	2	..	..	1	2" Cork	2	2 Paper	2	4	1" Flaxlinum	Outside metal	3	1 Paper	2	1 1	½" Hairfelt 2" Hairfelt	Steel	10
Freight	11	40-10 Endsills	30-9⅜	33-5⅜	8-2⅝	7-5⅛	6-4	4-0	...	16"	12"	Solid, rigid	Box bunker	5	1 Paper	2	3	½" Hairfelt	3	2 Paper	3	3	½" Hairfelt	Outside metal	3	1 Paper	2	4	½" Hairfelt	Steel	11
Freight	12	43-3½	32-0	34-6	8-10½	7-3½	6-3⅜	4-0	...	12"	12"	Solid, rigid	Basket bunker	5	4 Paper	3	4	Woolfelt	..	..	..	..	....	Wood	5	5 Paper	5	4	Woolfelt	Steel	12
Freight	13	41-2	30-1	32-10½	8-10½	7-2 7/16	6-5	4-0	4¾'	12"	10 13/16"	Slat syphon, rigid	Box bunker	4	1 Fabric	2	4	½" Flaxlinum	3	..	1	4	½" Flaxlinum	Outside metal	..	..	2	5	½" Flaxlinum	Wood	13
Freight	14	40-9½ Endsills	31-9½	33-6¾	8-2¾	7-0 7/16	6-8¼	4-0	4¾"	..	.....	Rigid	Basket bunker	2	..	..	1	2" Cork	3	2 Paper	1	4	½" Arctic Keystone	Outside metal	3	..	2	1 2	½" Arctic Keystone 1" Hair	Steel	14
Freight	15	40-0 Endsills	30-0	32-6⅞	8-3¼	7-4 13/16	...	4-0	13/16" Slats	11"	3¼"	Syphon, swinging to roof	Bunker (collap.)	4	7 Paper	1	2	½" Flaxfelt	3	3 Paper	3	4	½" Flaxfelt	Wood	4	6 Paper	3	4	½" Flaxfelt	Steel center sills	15
Freight	16	40-0 Endsills	30-0	33-1½	8-3¼	7-4 13/16	...	4-0	13/16"	15¾"	8⅛"	Solid, rigid	Box bunker	4	1	2	4	½" Arctic Keystone	3	..	3	4	½" Arctic Keystone	Wood	4	..	3	4	½" Arctic Keystone	Steel center sills	16
Freight	17	41-8	30-10	33-2¾	8-2⅝	7-2½	5-9¼	4-0	...	12½"	12"	Solid, rigid	Basket bunker	2	..	..	1 1	½" Insulite 1½" Cork	2	1 Paper	1	1 1	½" Insulite 1½" Insulation	Wood	3	1 Ruberoid 1 Waterproof coat	1	1 2	2" Hairfelt ½" Insulite	Steel	17
Freight	18	41-4¾ Endsills	31-6	33-0	8-4⅞	7-2⅛	5-8⅛	5-0	5"	..	10"	Solid, rigid	Basket bunker	3	..	1	1	2" Cork	3	2 Paper	2	4	½" Insulation	Outside metal	3	..	2	4	....	Steel	18
Freight	19	40-0 Endsills	30-0	32-10	8-3⅝	...	6-2⅜	4-0	...	..	.....	Slat syphon, rigid	Box bunker	3	1 Paper	2	2	½" Linofelt	3	2 Paper	3	2	½" Linofelt	Wood	3	1 Paper	3	1 2	⅜" Insulation ½" Linofelt	Steel	19
Freight	20	41-10	30-2	32-7	8-4⅝	7-4	5-10	4-0	...	10"	8"	Slat syphon, rigid	Box bunker	5	1 Fabric	3	3	½" Hairfelt	3	4 Paper	3	2	½" Hairfelt	Wood	5	6 Paper	4	3	½" Hairfelt	Steel	20
Freight	21	38-7⅜	26-10½	30-11½	8-4	7-1	5-11½	4-0	5"	9"	14"	Solid, rigid	Box bunker	4	1	2	2	½" Hairfelt	3	2 Paper	3	2	½" Hairfelt	Wood	5	2 Paper	3	2	½" Hairfelt	Steel	21
Freight	22	41-11½ Endsills	31-8¼	32-10	8-3	7-1 3/16	6-3⅝	4-0	5"	11⅝"	12"	Solid, rigid	Basket bunker	2	2 Paper	1	1	2" Cork	2	9 Paper	1	4 2	½" Hairfelt Cork at bottom	Outside metal	3	13 Paper	1	6	½" Hairfelt	Steel	22
Freight	23	37-3⅛	26-4	30-4⅝	7-10⅞	7-2 7/16	6-2¼	4-0	...	2'-4"	21"	Solid, rigid	Brine tank	5	5 Paper	3	3	½" Hairfelt	5	5 Paper	4	3	½" Hairfelt	Wood	5	7 Paper	4	3	½" Hairfelt	Steel	23
Freight	24	42-6	32-6	32-11½	8-4⅜	7-3 3/16	6-2	4-2	Slat	12"	12½"	Solid, rigid	Basket bunker	2	3	2	2	1" Corkboard	2	2 Paper	3	3 3	½" Keystone Cork at bottom	Outside metal	2	2 Paper	5	4	½" Keystone	Steel	24
Passenger	25	48-8¾	34-0	38-4¾	8-7¾	7-3½	6-9⅝	5-0	5½"	7"	18½"	Solid, swinging to sides	Brine tank	3	2 Paper	1	4	½" Keystone	3	..	2	3	½" Keystone	Outside metal	5	1	4	6	½" Keystone	Steel	25
Passenger	26	45-0 Endsills	33-8	38-10	8-1⅞	7-2½	6-3	5-0	4½"	10"	15"	Solid, swinging to side	Brine tank	3	1 Paper	2	2	½" Keystone	4	1	1	4	½" Keystone	Wood, canvas covered	3	1 Canvas	2	4	½" Keystone	Steel	26
Passenger	27	43-0	30-4	35-5	8-7⅜	7-4	6-3¾	5-0	4¾"	9⅜"	15¾"	Solid, swinging to side	Brine tank	3	1 Paper	2	2	1¼" Tucork	4	..	4	3	½" Keystone	Inside metal	3	..	3	4	½" Keystone	Steel	27

have a long life and require little for maintenance by reason of their better design and construction.

It is not difficult to appreciate the causes responsible for the high cost of maintenance of old wooden cars; the refrigerator type does not stand alone in this class. But in addition to more severe traffic conditions, this type of car has required attention on account of the difficulty in keeping moisture away from the insulation as well as from the wooden framing and flooring. If the insulation becomes broken, wet, or sags so that air can circulate around it, the car rapidly loses its efficiency. Table 1, and the cross sec-

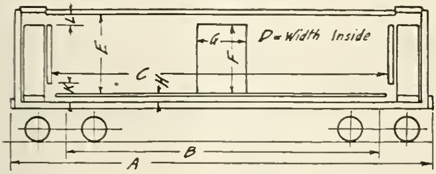


Fig. A—Diagram of Dimensions Shown in Table 1

tions in Figs. 6 to 14 inclusive, give a general idea of some types of cars, and what has been done to improve design and construction. Figs. 12 and 13 represent cars of relatively low efficiency. The others show more modern cars and indicate the more recent trend in the matter of improved insulation and general construction.

The cross sections really speak for themselves, but a brief discussion under the separate headings floors, walls and roofs will be of some interest.

Floors.—The chief problem in floor construction is to make the structure waterproof, as well as a good insulator. Moisture and water finding its way through the floor or along the floor boards into the walls of the car, have been responsible for much trouble and expense.


Fig. 15—Method of Applying Insulation and Waterproofing in Floor

The insulating value of all materials that absorb moisture is greatly decreased when water is absorbed. In addition, water causes most of the insulating materials popular in refrigerator construction to become mushy and sag or drop out of place. It also causes wood floors, lining and framing to decay and weaken, thereby making it more difficult to keep the general structure tight.

Nearly all the modern or at least recently built floors employ a construction involving cork as an insulating material. With two exceptions, shown in Figs. 8 and 9, the cork is applied in one layer. To keep moisture away from the cork various waterproofing compounds or waterproof materials are used. Fig. 15 shows a photograph of the floor and manner of applying insulation.

The one exception to this general trend is shown in Fig. 14, where the insulation consists of four massed layers of ½-in. hair felt. Moisture is kept away from the top of the insulation by means of two layers of floor boards between which is laid a layer of waterproofing compound. The surface of the top floor is covered with a layer of waterproofing compound into the surface of which sand has been rolled.

Figs. 12 and 13 show a floor insulation with intervening dead-air spaces. In past years it was the opinion that this type of construction gave the highest insulation value in walls and roofs as well as in floors. More recent opinion differs because experience has shown that unless unusual methods of construction or maintenance are used, it is very difficult to keep the air spaces tight. To be insulators, they must be dead-air spaces; once circulation starts their efficiency is destroyed.

It has been intimated that in some cases cork as a floor insulator has not been entirely satisfactory because in time it becomes brittle and crumbles. Specific information on this subject would be very valuable, as it would indicate whether the trouble was inherent or due to some particular method of construction.

Walls.—In connection with a waterproof structure, it is interesting to note the various methods employed at the junction of the floor and side walls to keep water from getting past the lining and into the insulation. This point has been a source of great trouble. Some particularly interesting methods of construction at this point are shown in Figs. 11 and 14.

An exceedingly interesting example of waterproof construction is contained in some all-steel refrigerator cars designed by W. F. Keisel, Jr., Mechanical Engineer of the Pennsylvania Railroad.*

An interesting feature in connection with these cars is the fact that the body of the car consists of an all-steel container placed within an outer container, the space between the walls being filled with insulation. At the floor, the sections of the inner container are welded together, thus making the floor practically one piece and water-tight and thereby affording maximum protection to the insulation.

Inspection of the various cross sections indicates a general trend toward massing wall insulation and eliminating air spaces between the layers of insulation. As a rule the insulation is applied in a continuous strip from door post to door post. The advantage of applying insulation in this way lies in the fact that a continuous or unbroken surface presents no joints or openings through which air can pass or circulate. It has been the experience that where insulation is applied in sections, unusual construction is required to prevent eventual air circulation. Wall insulation is rarely less than 2 in. thick on the most recent cars. In some cases this insulation is applied in two massed layers. In one case the single layer is 2-in. thick. In the majority of cases four massed layers of ½-in. insulation are used.

The construction employed by the U. S. Railway Administration is indicated in Fig. 6 and shows the insulating material massed beneath the outside sheathing. Air space is provided between the inner lining and the blind lining. This construction was advocated as a method of preventing dam-

*See *Railway Mechanical Engineer* for March 1917, p. 133.

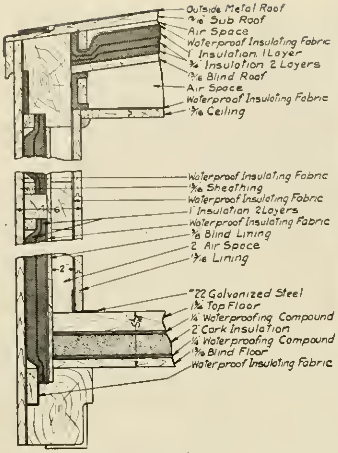


Fig. 6

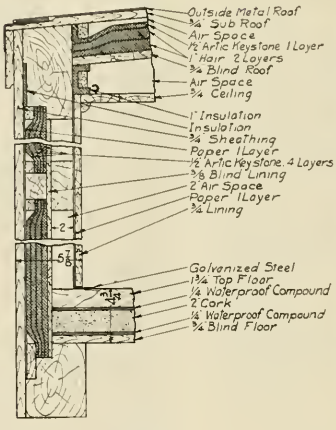


Fig. 7

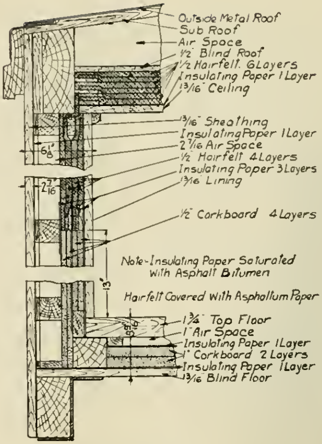


Fig. 8

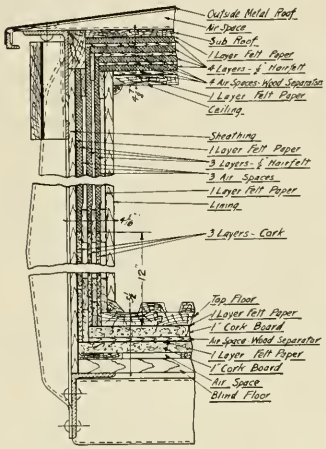


Fig. 9

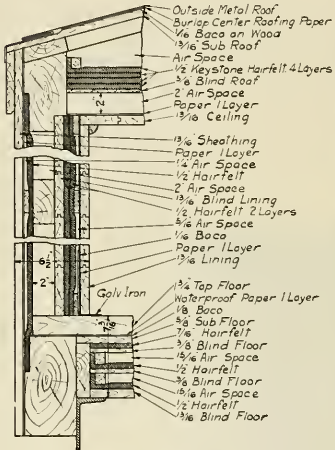


Fig. 10

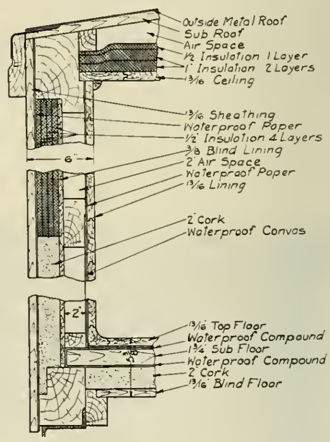


Fig. 11

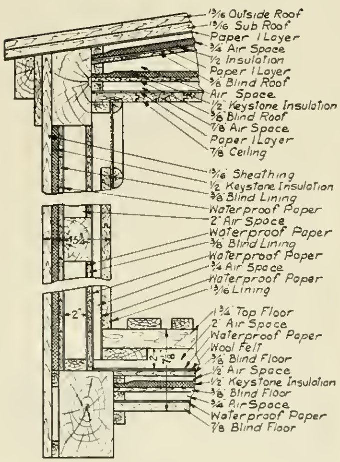


Fig. 12

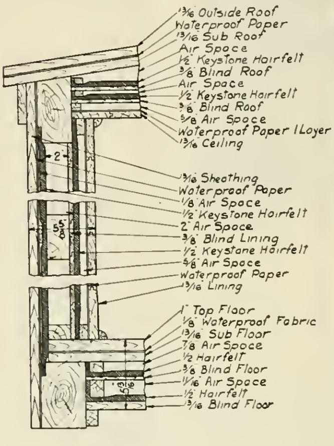


Fig. 13

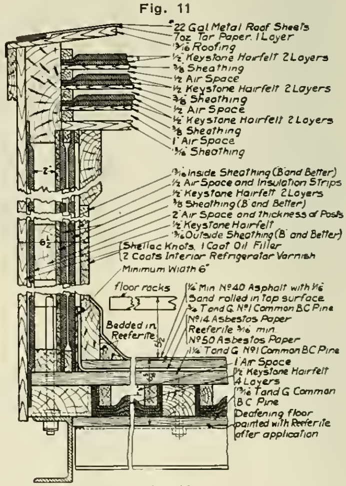


Fig. 14

Cross Sections Through Bodies of Typical Refrigerator Cars age to the insulation should nails be driven through the inside lining.

A great many cars are insulated in this way, but there are some interesting exceptions, one of which is shown in Fig. 8. The advantage claimed for such construction is that if a car becomes cornered or damaged to such an extent that sheathing is cut or broken, the insulation stands a much better chance of remaining intact or becoming only slightly damaged, and the lading not subjected to risk caused by loss of cold air. It is also claimed that by the use of properly constructed wood forms or spacers, and by proper loading methods, no necessity should exist for driving nails through the inside lining. A great many railroads are conducting an educational campaign in this connection.

Two interesting wall structures are shown in Figs. 8 and 9. In these figures it will be seen that layers of cork board are used below the insulation, the hair felt starting at a point 13 in. above the level of the floor.

Roofs.—The tendency is to apply massed insulation in the

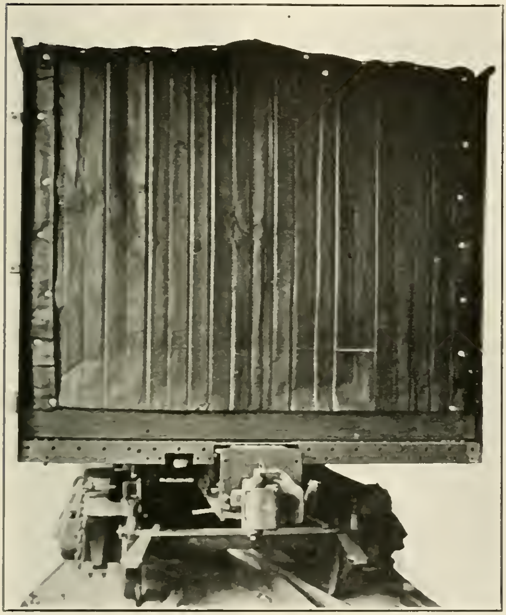


Fig. 16—End View of Pennsylvania All-Steel Refrigerator Car

roofs. As a rule the most modern cars have 2 to 2½ in. of insulation applied in this way. The car shown in Fig. 8 has 3 in. of such insulation.

Some cars are equipped with a carefully designed double-board roof with waterproofing compound between the layers. There are many advocates of this type of roof, but it is interesting to note the number of outside-metal roofs that are applied to cars of this type. The advocates of the outside-metal roof claim a saving in weight and greater protection to the sub-roofs and insulation from moisture, claiming that with proper insulation the metal roof has no effect on the interior temperature of the car.

Miscellaneous

Doors and Hatches.—Doors and hatches are being made with more insulation and are being strongly and properly constructed so that they will fit the door openings tightly, and not permit any loss of refrigeration due to leakage. In this connection, any other openings into the car should be so constructed that they can be kept tightly in place and easily maintained. An efficient door-locking device is no small item in keeping doors tight, and thereby maintaining the efficiency of the car.

Painting.—Refrigerator cars should be kept well painted in order to preserve all exterior surfaces. This is in the interest of obtaining long life for the car. Metal parts should be given particular attention in this respect.

The writer believes that refrigerator cars should be painted with a light or non-heat absorbing color. Dark colors absorb heat. An inquiry addressed to the owners of white and yellow cars indicated that no specific data existed on the subject, but it was the general belief that the light colors were an advantage in this respect. Accurate information on this subject would be of great interest.

Insulation

The previous references to insulation have been very brief, and have referred principally to its use in general car construction. The following paragraphs contain some notes regarding insulating materials.

It has been stated that the function of the insulation is to afford protection to the contents of the car by minimizing heat transmission through the walls, roof, and floor. A good insulator must not only be a poor conductor of heat, but must be a material having the qualifications of reasonable cost, adaptability, durability, light weight, imperviousness to moisture, freedom from odors, and be proof against vermin. In any study of insulating materials for use in railway refrigerator cars, these factors must all be kept in mind.

There are some materials that have a low thermal conductivity, but their other qualifications make them unsuitable for practical use in the type of car under discussion.

A good insulation, but one which adds greatly to the weight of the car is undesirable. In the interest of economical transportation the car should be no heavier than is necessary to obtain the required efficiency and the required strength to insure continuity of service and low cost of maintenance.

A material with low thermal conductivity, but one which is difficult to apply economically, is also undesirable. On the other hand, there may be materials easy to apply but which will not stay in place or which will not retain their insulating value under service conditions; these are equally undesirable.

In addition, the material should be of a kind easily handled as well as easily applied. Materials difficult to handle and difficult to apply add unnecessarily to the first cost of the car, as well as to possible future maintenance.

It seems to be generally conceded that the best insulating materials are those which contain a very great number of minute dead-air cells, or interstices containing dead-air. If these air cells become filled with moisture, the thermal conductivity of the material is increased. This is one of the reasons why it is so important to protect insulation from water, and why it is desirable to use a material highly resistant to moisture.

Some materials when subjected to moisture fall out of place or sag, and if a large air space, or pocket, is not formed, air circulation frequently results, the effect of which greatly decreases the efficiency of the car.

No argument is necessary to indicate the advantage and value of insulating material free from odors and vermin-proof.

Thermal Conductivity.—The question of thermal conductivity of various materials and compound structures is one that has been a matter of study and investigation for many years. The greatest part of the information available upon the subject is the result of tedious, exact and difficult experimentation.

The subject of heat transmission through the walls of a railway refrigerator car is one upon which there is some difference of opinion, this difference dealing largely with variables or factors which have not yet been reduced to absolute terms.

It is not within the scope of this paper to elaborate upon these differences or to enter into a discussion of all the factors involved. The most important of these deal with the effect of air velocity and moisture upon surface transmission, the effect of moisture upon conduction, the effect of radiation as a corrective factor, and the importance of knowing the condition of the general structure in order to determine the value of the so-called dead-air spaces. The bibliography at the end of the paper refers to literature in which these subjects are discussed in some detail.

In calculating heat transmission through a compound wall, it is essential to know the thermal conductivity of the various materials contained in the structure.

Table 2—Thermal Conductivity of Insulating Materials

Material	Remarks	Thermal conductivity[1]	Density[2]
Air	If no heat is transferred by radiation or convection	4.2	0.08
Calorax	Fluffy mineral powder	5.3	4.0
Kapok	Hollow vegetable fibers, loosely packed.	5.7	0.88
Pure wool		5.9	6.9
Pure wool		5.9	6.3
Hair felt	Fibers perpendicular to heat flow	5.9	17.0
Pure wool		6.3	5.0
Slag wool	Loosely packed	6.3	12.0
Keystone hair	Hair felt and other fibers, confined with building paper	6.5	19.0
Mineral wool	Loosely packed	6.5	12.0
Corkboard	No artificial binder, low density	6.5	6.9
Mineral wool	Fibers perpendicular to heat flow	6.9	18.0
Cotton wool	Medium packed	7.0	5.0
Pure wool	Very loose packing, probably air circulation through material	7.0	2.5
Insulate	Pressed wood pulp	7.1	12.0
Mineral wool	Firmly packed	7.1	21.0
Lincfelt	Vegetable fiber confined with paper, flexible and soft	7.2	11.3
Ground cork	Less than 1/16 in.	7.1	9.4
Corkboard	No artificial binder	7.3	9.9
Balsa wood	Very light wood, across grain	7.5	7.1
Balsa wood	Same sample with 13 per cent waterproofing compounds	8.3	8.0
Flaxlinum	Felted vegetable fibers	7.9	11.0
Fibrofelt	Felted vegetable fibers	7.9	11.0
Rock cork	Mineral wool and binder	7.9	16.0
Balsa wood	Across grain, untreated	8.3	7.4
Corkboard	With bituminous binder	8.4	16.0
Balsa wood	Medium weight wood	9.2	8.8
Sawdust	Various	9.7	12.0
Air cell (½-in.)	Corrugated asbestos paper, enclosing air spaces	11.0	8.8
Air cell (1-in.)	Corrugated asbestos paper, enclosing air spaces	12.0	8.8
Asbestos paper	Built up of thin layers	12.0	31.0
Balsa wood	Heavy	14.0	20.0
Fire felt sheet	Asbestos sheet, coated with cement	14.0	26.0
Fire felt roll	Flexible Asbestos sheet	15.0	43.0
Cypress	Across grain	16.0	29.0
Asphalt roofing	Felt saturated with asphalt	17.0	55.0
White pine	Across grain	19.0	32.0
Mahogany	Across grain	22.0	34.0
Oak	Across grain	24.0	38.0
Maple	Across grain	27.0	44.0
Virginia pine	Across grain	23.0	34.0

[1]Thermal conductivity in B.t.u. per day (24 hr.) per sq. ft. per deg. fahr. per in. thickness.
[2]Density, lb. per cu. ft.

The most recent determinations of thermal value of various materials is shown in Table 2, taken from the very interesting paper, The Thermal Conductivity of Heat Insulators, by M. S. Van Dusen, in the October, 1920, journal of the American Society of Heating and Ventilating Engineers.

As previously indicated, the value of air space has been a subject of considerable discussion, because there is some question regarding the length of time that the so-called dead-air spaces remain tight and function as true dead-air containers. A great deal has been said in favor of filling air spaces with a light insulating material.

The following calculations have been made in two ways: first by assigning an insulating value to the air space, and second, by eliminating it entirely. Comparative results are shown in Table 3. Laboratory tests show that the resistance of an air space is a direct function of its width up to about 0.6 in., after which the resistance is practically a constant. In the following calculations the value of the thickness in inches divided by the thermal conductivity per hour per deg. F. for air is used as 1 when the space varies from 0.6 in. to 6 in. in width. For example, the resistance of a ⅜-in. air space would be 0.375/0.600 or 0.625.

TABLE 3

Comparison of B.t.u. per sq. ft. per deg. diff. fahr. per 24 hr. in cars shown in Fig. 6 and Fig. 13.

	Including air space		Excluding air space	
	Fig. 6	Fig. 13	Fig. 6	Fig. 13
Roof	1.702	2.328	1.953	3.12
Wall	2.172	2.80	2.388	3.768
Floor	2.46	2.544	2.46	3.24

To indicate the difference in the efficiency of walls, roofs and floors in cars of different design, the following examples are offered. In the calculations the car cross-sectioned in Fig. 6 is used as an illustration of good construction and relatively high efficiency. The car shown in Fig. 13 is used in comparison in order to show the greater rate of heat transmission or lower efficiency caused by different methods of insulation and construction.

Some slight value can be attributed to such factors as waterproof papers, fabrics and compounds, but for other ordinary practical purposes these values are given but little consideration, and are generally eliminated from the calculation.

In considering the thermal conductivity in sheathing and lining, the thermal conductivity value of Virginia pine is used. Inquiry indicates that the conductivity of this material is practically the same as that of fir or yellow pine.

Materials and Workmanship

Proper materials are a very important factor in refrigerator-car construction. The right grade of lumber should be used wherever required, and it should be properly dried before being placed in the car. Workmanship should be of the best. Insulation should be handled carefully, care being taken to see that it does not become torn or damaged. Such insulation placed in a car makes a weak link in a possibly otherwise strong chain. Some care in initial construction with attention to these details makes for an efficient car, as well as one that will have a longer life and lower maintenance cost than a car not receiving such attention.

While on the subject of materials, it is important to note the growing interest in the use of car lumber which has received preservative treatment. Lumber so treated has received considerable attention from car builders and car owners for several years, and much of it is now in service. Sufficient time has not elapsed to indicate what increased life can be obtained, but experience to date indicates treated lumber to be more durable, and one that will resist moisture and decay.

The Marsh Refrigerator Service Company has used creosote-treated lumber in certain parts of its refrigerator cars, such as sills, sub-floors and roof boards, and appears to be the pioneer in the use of treated lumber in refrigerator cars. The writer has been advised that this lumber is giving excellent service, and that no objection can be made to it on account of any odor caused by treatment. The treated lumber in these cars is submerged for a number of hours in hot creosote oil, after which it is placed in a drip rack and permitted to drain. It is estimated that this treatment will result in large saving, doubling the life of the roofing boards and sills, and effecting considerable saving in labor that would otherwise be necessary to properly maintain these parts in the course of time.

An interesting report in connection with the use of treated lumber for use in the construction of cars was presented recently before the American Wood Preservers' Association. This report calls attention to the fact that decay is the principal cause of failures in lumber, and that great economy is possible by the use of a preservative.

It is evident that if some of the wooden parts of a refrigerator car can be made moisture proof or highly resistant to moisture, the efficiency of the car can be maintained at a much higher average.

The writer has been advised that some refrigerator cars are in service in which Balsa wood is the principal insulating material. This wood is very light in weight, having in its natural state a density of 7.1 lb. per cu. ft. It is a South American wood that grows very rapidly, and is of cellular structure. Table 2 shows it to have a thermal conductivity of 7.5 in its natural state and 8.3 when treated with waterproofing compounds.

It would be of great interest to know if treated or untreated Balsa wood is used between the ordinary walls of a car as insulation, or if the material figures largely in the construction of the superstructure of the car, such as lining and sheathing. Its strength is insufficient for its use in framing. It would also be of interest to know if the material is durable and efficient in this class of service, if any modification of car structure is necessary for its use, and if any reduction of car weight can be accomplished by its employment.

Some Other Systems of Refrigeration

A previous statement indicated that some reference would be made to other systems of refrigeration. In the cars described in the cross sections and tabulation, refrigeration is accomplished by means of air circulation, the air being cooled by contact with ice or ice containers placed at the ends of the car.

Fig. 17—Car with Overhead Brine Tanks, Showing Also Heater Pipes on Floor

One modification of this system is a car in which ice containers are placed just below the roof and in the center of the car. In this system it is claimed that maximum refrigeration can be applied where the air within the car is at its highest temperature.

There do not appear to be a great number of cars of this type in modern service. The principal objections to such a system are decreased head room in the center of the car, weight of ice near the roof of the car, and difficulty of adopting this system for use with meat racks placed below the ceiling of the car.

Another system consists of a brine tank built into the roof at each end of the car. These tanks extend about 9 in. below the ceiling and are heavily insulated on top, sides and bottom. The tanks at each end of the car are connected to each other by pipes hung about 2 or 3 in. below the ceiling. The pipes are not insulated. In each tank is a partition running lengthwise of the car. In one partition are some check valves opening to the right; in the other partition some check valves open to the left. The theory is that when ice and salt are placed in the two tanks the swaying of the car in motion automatically circulates the brine through the pipes, refrigeration being accomplished by contact of the air within the car against the surface of the pipes connecting the two tanks. Comparatively speaking, this system has not been in service a very great length of time. The advantages claimed for it are increased loading space, decreased consumption of ice, uniform temperatures, and a car that can easily be changed from a refrigerator to a heater car. The writer understands that these cars are being tested in various fields of service. It would be interesting to have some information regarding the ability of this system to supply refrigeration when the car is not in motion, and what the system can accomplish in the way of quick pre-cooling when the car is placed at the loading shed or platform.

The interior of such a car is shown in Fig. 17. This illustration shows the floor racks propped up against the side walls so that the piping along the floor beneath the racks can be seen. This piping is used when the system is used to heat the contents of the car. Canvas troughs are placed beneath the piping located beneath the ceiling in order to catch any condensation or frost slush that may drop from these pipes.

Pre-Cooling

The importance of pre-cooling the lading and the resulting economy in the use of ice and labor were mentioned in a preceding paragraph. There are two distinct methods of pre-cooling cars and lading. The first is known as shippers' pre-cooling; and the lading is placed in cold storage rooms in which the proper temperature is maintained, and where the lading is allowed to remain until it cools to the proper temperature, after which it is loaded quickly into cars that have been pre-iced. The second method is known as the carriers' pre-cooling, and generally consists of a system in which the car is loaded, after which the interior of the car and the lading are pre-cooled by mechanical means, usually by forced circulation of cold air.

Great economies are possible due to pre-cooling. Where small tonnage originates little pre-cooling has been done by mechanical methods on account of the high cost of the plant and equipment. Most mechanical pre-cooling is done where large tonnage originates. At such points the shippers frequently combine to build such a plant. Pre-cooling is receiving more and more attention in connection with various commodities and additional economy in the way of ice and labor may be expected.

General Conclusion

The inquiries upon which these few notes on railway refrigerator cars are based, indicate that a very great improvement has been made in refrigerator-car construction and design, particularly within the last few years, but there is also evident indication that the field of investigation in connection with cars of this type is still a most fertile one. Some fairly recent cars indicate that subject of refrigeration in transit is not appreciated in some quarters as it should be. The subject of efficient refrigeration is a most important one, because cars that can be kept in continuous service with a minimum cost of maintenance and which are sufficiently efficient to protect the lading in transit, mean dollars and cents to the railways.

View of North Side of North Track Showing Elevated Runway Used by Rivet Burners and Backout Men

Cutting Steel Car and Locomotive Boiler Rivets

Alleged Disadvantages of Electric Rivet Cutting Discounted by Installation on Chesapeake & Ohio

By E. A. Murray,

Shop Superintendent, Chesapeake & Ohio, Huntington, W. Va.

FOR several years the practice of burning off rivet heads on steel cars with the electric arc has been in vogue at the Chesapeake & Ohio shops at this point. Recently this method was extended to locomotive boilers and we find that we can obtain equal success burning off rivet heads on boilers as well as steel cars. For cutting rivets we use a General Electric motor generator set, which consists of a 2,000-ampere, 80-volt, direct-current generator, direct connected to a 225-hp., 440-volt, induction motor. This set is operated by a manually operated starting compensator which is equipped with overload relay and no-voltage release.

The slate control panel, 5 ft. 4 in. by 3 ft. 4 in. in size, is equipped with an ammeter of 3,000 amperes rating, a 0 to 120 voltmeter, a polyphase watthour meter, circuit breakers and a rheostat for adjusting the voltage of the welding generator.

The rivet burning tracks are situated about 10 ft. from the generator room. They consist of two tracks about 5 ft. apart and are 450 ft. long. The rails are bonded at each joint with No. 0000 rail bonds. In addition to this the four rails are bonded together by ½ in. by 3 in. iron bonds every 40 ft. Running between the two tracks and on the outside of each track is a substantial wood scaffold 6 ft. high with a 3-ft. walkway which extends the entire length of tracks. These are used in cutting rivets which cannot be reached from the ground. On the middle scaffold directly beneath the walkway there is a 1½-in. solid copper bar running the entire length of the platform. To this is connected at intervals of every 40 ft. a Cutler-Hammer, type T.C. grid resistance bar. These grids have a resistance of .04 ohms. and will allow each operator to use a maximum of 500 amperes. The feeders running direct from the control panel in the generator room consist of two 1,000,000 circular mil, slow-burning cables. These are run under ground in waterproof boxes. The positive line is connected direct to the bonded rails, while the negative side runs up to and is connected to the 1½-in. solid copper bar. The resistance boxes are connected between this bar and the leads of the special cutting electrodes.

The cutting tool, Fig. 2, is 35 in. long and is made of a piece of ½-in. square copper rounded about 1½ in. on each end and threaded with ½-in. standard threads. The square part is covered the entire length with a round wood handle *W*, Fig. 2, which is split in halves and grooved to fit the copper bar. The two halves of the handle are glued together and in addition to this a metal hose clamp is placed on each end. To one of the threaded ends is screwed a female brass connection. This connection is cast in the

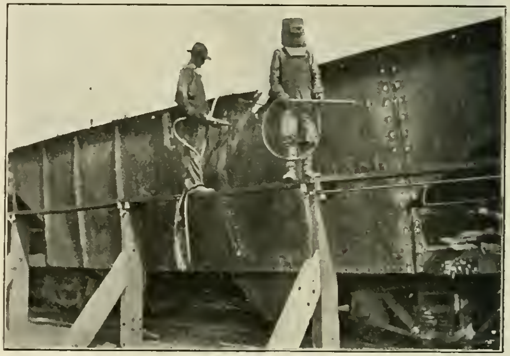


Fig. 1—After the Rivet Heads Are Burned Off the Rivets Are Backed Out With a Pneumatic Tool

shape of ¾-in. rod; it is 4 in. long, one end being tapped ¾ in. deep with ½-in. standard thread. The other end has a 5/16-in. slot in it 3 in. long. Through this end are drilled two 5/16-in. holes for bolting two ⅛ in. by 1 in. by 6 in. clamps, *C*, which have the ends forged to fit graphite sticks,

G. 1 in. in diameter. These clamps also have a 7/16-in. hole drilled about 2 in. from the end for a 3/8-in. bolt by which the carbon is tightened in the clamp. The clamps are forged on the end so that when the cutting tool is in a horizontal position, the carbon is at an angle of 45 deg. The total weight of this tool is 4 1/2 lb. Connected to each resistance box by means of copper terminals are two No. 2 General Electric flexible arc welding cables 50 ft. long. On the other end is soldered a female connector which screws into the cutting tool. When the operator finishes cutting on one car, he unscrews his tool and goes to the next car where he can attach the tool to the next lines. This does away with the work of carrying the heavy leads from place to place.

We get the best results with about 500 amperes and 55 volts at the arc. An operator easily cuts four 1-in. rivet heads in a minute and averages about 1,000 rivets in eight hours.

For cutting rivets on the bottom of cars or flat surfaces we use the same tool with the addition of a 3/8-in. air pipe, A, Fig. 2, attached and so bent that the end points directly at tip of the carbon. The flow of air is controlled by a small push

Fig. 2—Burning Tool in Use on a Flat Surface

valve, V, on the side of the tool handle. When the operator makes an arc on a rivet in the floor and the metal starts to run, he pushes the valve and the air jet blows the molten metal away making a clean cut.

At present we are using 10 operators in cutting steel car rivets. We formerly used carbon sticks in the rivet burners, but on account of the great durability of the graphite sticks, we discontinued the use of the carbon. We find that the graphite sticks burn off from five to six times as many rivets as the carbon and give considerably better service. The carbon electrode will heat over its full length and in some cases burn the holder, while the graphite heats only about 2 in. from the end on which the arc is produced and does not burn the holder.

Our records show that a saving of 50 per cent is being made in doing this work by this process. This work was formerly done by using rivet busters which were found to be unsatisfactory, especially is this true when the car sheets are thin and badly deteriorated. This method has proved so

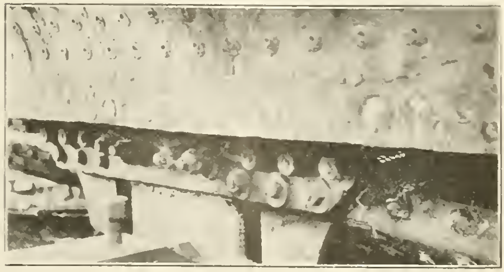


Fig. 3—Locomotive Fire Box. Rivet Heads on Mud Ring Have Been Burned Off

satisfactory that it has also been applied in the locomotive department. Fig. 3 shows an example of the work done.

White Gasoline Rail Car

A NEW design of gasoline propelled motor passenger car, having a seating capacity for 41 persons and a baggage compartment, has been developed by the White Company, Cleveland, Ohio. The first car of this type, built for the Union Transportation Company, recently made a demonstration trip over the Pennsylvania Railroad from Philadelphia to Washington, where it was on exhibition during the annual meeting of the American Short Line Railroad Association. The car made daily runs during the

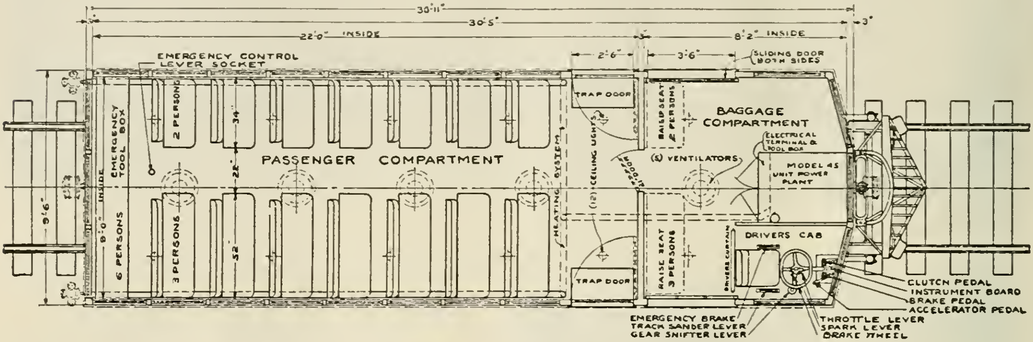
Interior of the Passenger Compartment

convention over the tracks of the Washington & Old Dominion Railway, carrying as passengers representatives of the various short line roads.

The trips over the Great Falls division of the Washington & Old Dominion were considered a severe test for the car as the road is a succession of grades and curves, the grades running as high as 3 1/2 to 4 per cent and the curves up to 10 deg. The car ascended the grades with ease and a fair speed was maintained even under the most severe conditions. To demonstrate its reserve power the car was brought to a stop on some of the heaviest grades and again started. Under these conditions it accelerated readily and continued to the top of the grades without difficulty.

The new White gasoline rail car has a seating capacity of 41, with a baggage compartment directly in the rear of the driver who controls the car from the right hand side. The body is of semi-steel construction built by the J. G. Brill Company, Philadelphia. It is mounted on a specially designed White rail car chassis with an I-beam frame. The car has a four-wheel pivotal truck in front and two driving wheels in the rear. It is designed for a speed of 33 miles an hour. This speed was maintained with ease on the demonstration run. The speed in reverse is 9 miles an hour.

The motor and transmission are identical with those used in the White motor truck, the engine, clutch and transmission being embodied in a unit power plant. The engine has four cylinders, cast "en bloc," with a 4¼-in. bore and a 5¾-in. stroke. The transmission is of the selective type with three speeds forward and one in reverse. The operating controls are located on the extreme forward right hand side of the coach. The foot throttle, clutch and drive shaft brakes are operated by pedals. The rear wheel brake and sander mechanism are controlled by levers and the brakes on the pivotal truck by a hand wheel. Means are provided in the rear of the coach to disengage the clutch and apply the brakes in emergency. The rear axle has double reduction gear drive. The gears are entirely enclosed and run in oil. The rear wheels are of cast steel with locomotive type steel flanges and annular ball bearings. The seating arrangement and general dimensions of the body are shown in the drawing.



Floor Plan of the Car, Showing Arrangement of Compartments and Controls

After being exhibited at Washington, the rail car was placed in operation on the line of the Union Transportation Company on a 25-mile run between Pemberton, N. J., and Hightstown.

This same company placed a 29-passenger rail car in service several months ago and its successful operation led to the purchase of the second car of larger capacity. The experience of the Union Transportation Company shows that passengers prefer to ride in gasoline rail cars rather than in steam trains. For this reason the gasoline rail car has been adopted because it offers an opportunity of giving more frequent service at a cost far below that resulting from the operation of short steam trains.

Very Varied Values.—Interesting examples of unusual sources from which scrap can be reclaimed are furnished by the practice of the Southern Pacific at its central reclamation plant. Sealing wax is obtained from worn-out dry cells; tin drinking cups and grease cans are made from coffee cans; scrap boiler tubes are threaded or welded and used for water drain lines, air lines and conduits; old shovel blades are made into washers; parlene, a by-product of Pintsch gas plants, is used for painting the underframes of cars; scrap rope is unwound and used for binding company shipments instead of twine; sediment from acetylene generators is used in place of lime for whitewashing and in the company's steel foundry.

Exterior View of the White Rail Coach

Pouring Bronze Hub Liners on Engine Truck Wheels

By J. H. HAHN

Assistant Machine Shop Foreman, Norfolk & Western, Portsmouth, Ohio

A JIG has been developed at the Norfolk & Western shops, Portsmouth, Ohio, for pouring hub liners on engine truck wheels without the necessity and consequent delay of facing off these hub liners after they are poured. Details and an assembled view of this jig are shown in Fig. 1. Both the cost of applying the hub liners and the number of liners which must be applied are reduced about 50 per cent and due to the large number of engine truck wheels involved, the aggregate saving possible by the use of the jig is large.

The jig, as shown in Fig. 1, consists of a circular plate in two sections bored large enough to go over the journal. The sections are held together by two ¾-in. clamping bolts with special nuts, arrangement being made to hold the plate at the proper position on the journal by means of two brass tipped, ⅞-in. set screws. The clevices and clamps are all attached to the circular plate in their proper relative positions by electric welding. A circular band wide enough to accommodate the widest hub liner and provided with a pouring gate at the top is also arranged in two sections drawn tightly around the circular plate by draw keys as illustrated.

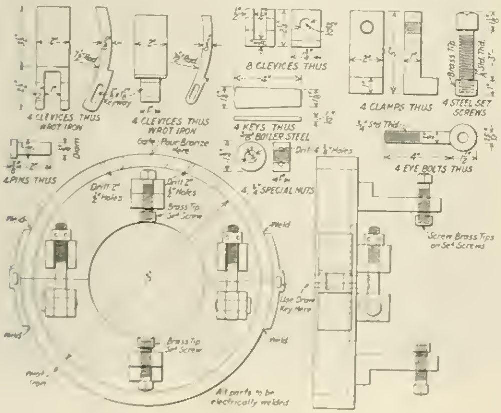


Fig. 1—Details and Assembled View of Pouring Jig

In applying hub liners by this method the first operation is to remove the old liners and machine the hub faces, cutting a recess about [illegible] in. deep by 1[illegible] in. wide, dovetailed on both sides to about 45 deg. The circular plate is then applied around the journal and adjusted for the desired lateral play, the brass tipped set screws being tightened to hold the plate in this position. The band is applied around the plate, being tightened by the draw keys. Pulverized asbestos is applied behind the jig to prevent bronze from running out over the spokes of the wheels; also between the circular plate and the journal when pouring liners on wheels with journals below the standard dimensions. The wheels do not have to be heated nor do they have to be up-ended. Both liners are poured at one time. The bronze is poured in the gate shown at the top of the jig and as soon as the metal has cooled sufficiently, the jig is removed. The box may then be applied, as liners poured by this method require no subsequent machining. Experience has shown that these liners give better service and wear longer than liners that are riveted on and the cost of application is reduced about 50 per cent. The hub liner just after being poured, cooled and the jig removed is shown in Fig. 2. Less than two per cent of the liners applied by this method crack after cooling in spite of the fact that the wheels are not preheated.

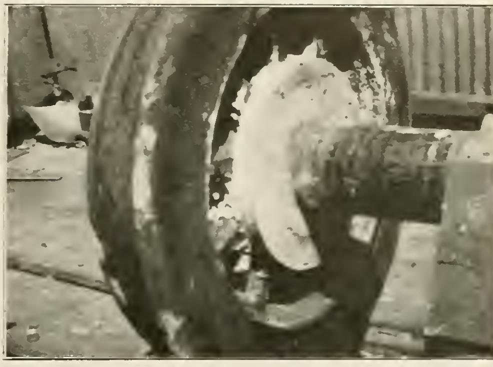
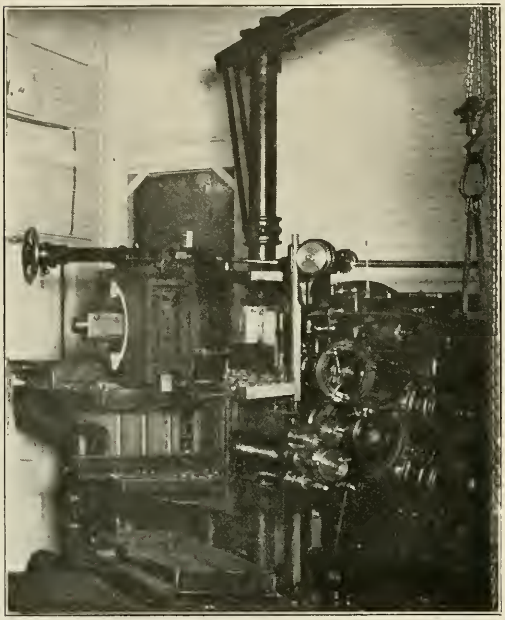


Fig. 2—View Showing Bronze Liner after Being Poured

Driving Boxes Machined in Record Time at Atlantic City

A PRODUCTION record of one driving box machined every hour and 15 minutes was made on a Morton heavy duty draw-cut railroad shaper, exhibited at the Atlantic City American Railway Association Convention in June. The Morton Manufacturing Company, Muskegon Heights, Mich., manufacturers of the machine, obtained from a prominent eastern railroad 24 heavy cast-steel driving boxes for the purposes of the test. The crown diameter of these driving boxes was 12¼ in., the axle and cellar clearances being 10⅝ in. and 12⅛ in. respectively. The boxes measured about 13 in. parallel with the axis. The average stock removed from around the crown fit required a depth of cut of ½ to ¾ in. In other words, the finished diameter of the crown was increased from 1 to 1½ in. over the rough diameter. The average material removed from the axle clearance was from 1 in. to 1⅜ in. on each side. The exceptional amount of stock on the axle clearance was explained as being an allowance to serve as a riser in the casting in order to insure a better grade of material.



Morton Draw Cut Shaper Used in Driving Box Machining Test

The order of operations was as follows: A driving box was first placed in the special holding chuck, as illustrated, being lined and clamped firmly in position for machining. The box was laid out in position in the chuck. Material was first removed from the axle clearance. In the early part of the test the entire amount of stock was removed at one cut from 1 in. to 1⅜ in. deep, using a 1/16 to 3/32 in. feed. This practice had to be discontinued, however, due to lack of a suitable rigid foundation on which to bolt the machine and driving motor. The stock was then removed in two cuts using a greater feed. The machine was set with the ram centered for machining the crown, a tool being placed in the tool holder and the material notched out to the depth of cut for the crown. The same tool roughed out a large share of the stock for the under-cut lug fit. The tool was then changed and the entire stock removed from the crown fit. The feed during this cut varied from 3/32 to ⅛ in. for the different boxes and the operation required about 20 or 25 min.

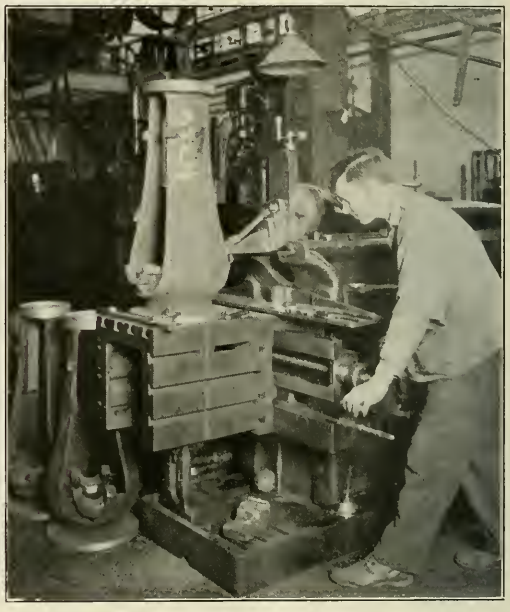
In ordinary practice the smoothness of the roughing cut would be sufficient for the finished box but in this case an allowance of .005 in. was made for a finishing cut. Before taking the finishing cut, the undercut lug fit was finished, this being a short operation because of the special forming tool used and a special relieving attachment, giving the tool proper clearance, eliminating back drag on the work and making a straight lug fit. The 24 driving boxes were machined in the axle clearances, the crown fits (roughing and finishing cut) and the under-cut lug fits, the average time being one hour and 15 minutes (floor to floor) per driving box. The chuck used for holding the driving box is so designed that a second driving box can be placed on the machine and laid out while the first is being cut. This method was not used at the convention, however, on account of the limited space occupied by the machine. As shown in the illustration the crane could not swing far enough to handle the second box.

The machine exhibited at the convention was electrically driven and provided with attachments for chucking driving boxes and machining crown brasses, the faces of shoes and wedges after being laid out, and rod brasses. The heavy cuts taken in this test and the accuracy of the finished boxes were made possible by the well-balanced, rigid construction of the draw-cut shaper and especially the stiffness inherent in the Morton ram design.

An Unusual Shaper Job

The illustration shows an out-of-the-ordinary job performed on a 24-in. Gould & Eberhardt shaper with economy from the viewpoint of handling the work, ease of setting up the job and actual cutting time. The operation consists of planing the bearing seats for the caps on compressor frames. A special extension tool holder with an over reach of 6 in. beyond the regular tool position is used. It enables the tool to plane the entire length of the bearing (4⅝ in.) without having the shaper head interfere with the compressor frame.

The two sides of one bearing are planed; then the casting is turned through 180 deg., bringing the opposite bearing in



Short Planing Job Done on Gould & Eberhardt Shaper

place to be planed. With a strongly supported table a shaper is well adapted to holding heavy castings and on account of the convenient size table, permitting the operator to work on three sides, the work of setting up is facilitated. The rigid construction of the ram permits taking heavy cuts in roughing operations and accurate finishing cuts.

Actual time studies proved that a saving of 30 per cent in time for handling and setting up and machining the casting is being effected by using the shaper instead of a planer.

Manufacturing Piston and Valve Rings

Details of a Method of Manufacturing Durable Packing Rings at Low Cost: Production Results Obtained

By A. G. W.

Packing Ring Tested for Accuracy

A PROMINENT railroad in eastern territory manufactures all piston and valve packing rings in its own shops as it has been demonstrated that an adequate supply of finished rings can be made and kept in stock for the maintenance of locomotives at a lower cost than when purchased from the manufacturers. The greater portion of these rings are machined in the manufacturing department of the main repair shop where suitable machines are equipped and assigned to this work. An increased production of high quality and accurately made rings is thus obtained at a minimum cost.

Piston Packing Rings

Two grades of piston packing rings are machined. One is made from ordinary grey iron for use exclusively in the cylinders of saturated steam locomotives and in the low pressure cylinders of Mallet type locomotives. The other

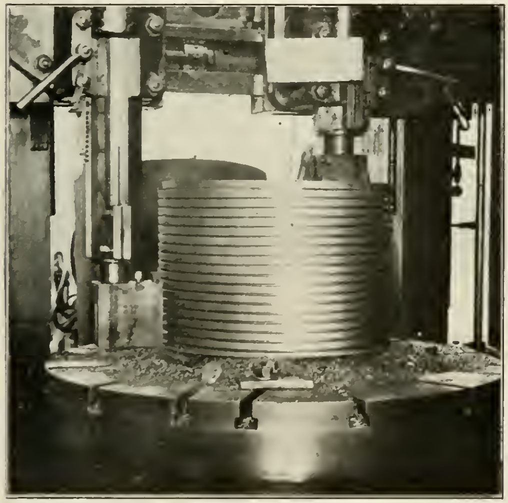


Fig. 1—Boring Inside Surface of Packing Tub Automatically Severs the Finished Packing Rings

grade of rings is made from high grade cast iron for use in the cylinders of superheated steam locomotives.

Piston packing rings are machined from castings commonly called packing tubs, from which an average of 18 finished rings are turned. These tubs are cast with four lugs on the bottom for the purpose of bolting the casting to the table of the machine. Piston packing rings are machined on vertical boring mills, one of which is shown in Fig. 1, five operations being necessary to finish 18 rings from one casting. These operations are performed in the following sequence:

Operation 1—Top of casting faced, using right head.

Operation 2—Outside diameter of the casting rough turned, using right head.

Operation 3—Grooves cut in casting with four-cutter gang tool, using left head.

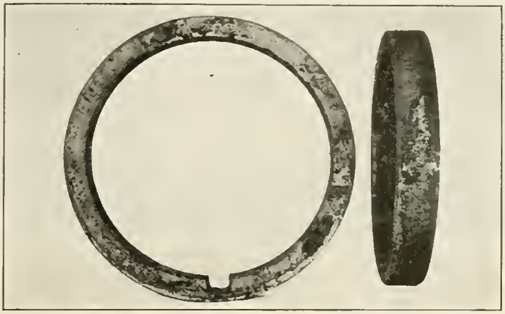


Fig. 2—Rough Packing Tub from which Two Valve Packing Rings Are Made

Operation 4—Outside diameter of casting finished, using right head.

Operation 5—Inside surface of casting rough bored to finish size which severs rings from the casting.

In the performance of the above operations, two heads of the machine are operated simultaneously whenever practical.

After Operation 1 has been performed with the right head, Operation 2 is started with the same head and proceeds until about 4 in. of the outside surface of the casting has been rough turned, when Operation 3 is started and both operations proceed simultaneously until Operation 2 is completed. By the time Operation 2 has been completed, 12 grooves have been cut by Operation 3 which is discontinued while the outside of the casting is finished by Operation 4. The grooving operation is again resumed with the left head and the right head is used to perform Operation 5 which consists of rough boring the inside surface of the casting to finished size. This operation automatically severs the rings from the casting, as shown in Fig. 1.

An average of 45 piston packing rings (30 in. or less in diameter) are machined on one boring mill in the above mentioned shop by one machine operator during an eight-hour shift. One 52-in. vertical boring mill, continuously assigned to machining piston packing rings and operated eight hours each day, will produce an average output of approximately 13,770 high grade and accurately made rings annually.

Valve Packing Rings

Valve packing rings are machined from packing tubs made of a high grade cast iron, two finished rings being turned from each packing tub. While it has been found practical to machine these rings from tubs cast with an opening across the casting to allow for tension, this style of tub is not used because it is covered by a patent, for the use of which a royalty must be paid. Therefore, the tubs now used are cast with a 5/8 in. by 1 in. groove across the inside surface of the casting, making the casting about 7/16 in. thick at the groove, as shown in Fig. 2. This necessitates sawing out a section of the casting at the groove to allow for spring, a method which has proved entirely satisfactory.

Valve packing rings are sawed on power hack saws and machined on semi-automatic machines. One operation on the saw and nine operations on two semi-automatic machines finish two rings from one casting, one ring being completely machined on one automatic (Fig. 3) and the second ring of the same casting completely machined on another automatic

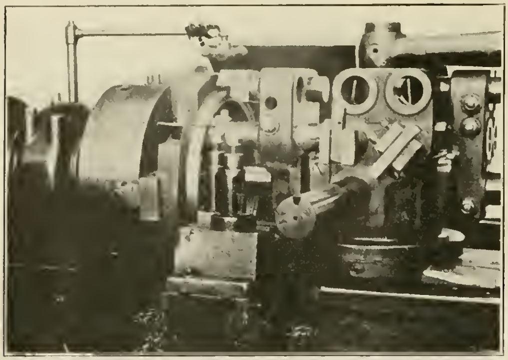


Fig. 3—Turning and Boring One Valve Packing Ring on First Semi-Automatic Machine

(Fig. 4). Both of the above machines are operated simultaneously and by one operator.

The operations necessary to machine valve packing rings are performed in the following order:

Operation 1—Piece sawed from ring at groove (½-in. piece sawed from 12-in. ring and 9/16-in. piece sawed from 14-in. ring).

Operation 2—Packing casting chucked in semi-automatic machine with a 3/32-in. metal liner applied in opening.

Operation 3—One side of casting (one ring) rough machined (includes inside surface and counterbore rough bored, face and outside surface rough turned), all of Operation 3 being performed simultaneously, as shown in Fig. 3.

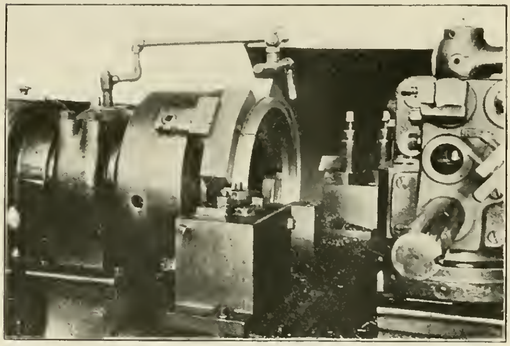


Fig. 4—Cutting First Ring from Tub and Facing Second Ring

Operation 4—Same side as above, finishing cut (includes inside surface and counterbore bored to finished size, face and outside surface turned to finished size), all of Operation 4 being performed simultaneously.

Operation 5—Casting removed from machine ready for second machine.

Operation 6—Finished side of casting chucked in another semi-automatic machine, as shown in Fig. 4.

Operation 7—Other side of casting (one ring) roughed (includes inside surface and counterbore rough bored, face and outside surface rough turned, all of Operation 7 being performed simultaneously.

Operation 8—Same side as above, finishing cut (includes inside surface and counterbore bored to finished size, face and outside surface turned to finished size), all of Operation 8 being performed simultaneously.

Operation 9—First ring cut from casting and remaining ring faced to finished size, as shown in Fig. 4.

Operation 10—Second ring removed from machine.

Operation 11—Finished rings gaged in a ring gage by operator to insure against defective work.

Operation 12—Operator's initials and size of ring stencilled on ring with steel stencils and ring placed in cabinet ready for inspector.

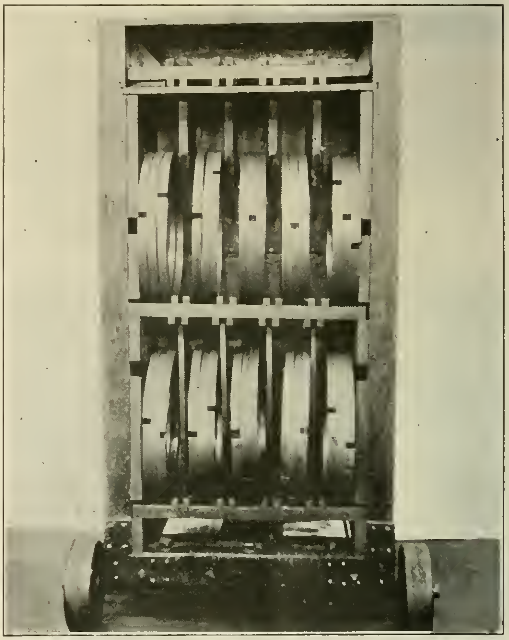


Fig. 5—Portable Cabinet in which Valve Packing Rings Are Placed as Completed

Fig. 5 shows a cabinet in which the operator places completed rings.

Two semi-automatic machines are operated by one man, performing Operations 2, 3, 4 and 5 on one machine and Operations 6, 7, 8, 9 and 10 on the other machine. Both machines are in operation continuously except when Operations 2, 5, 6 and 10 are being performed, at which time one machine is in operation.

An average of 40 castings, equivalent to 80 rings, can be sawed on one power hack saw during one eight-hour shift. An average of 22 rings are machined from 11, 12-in. castings on two semi-automatic machines operated by one man during one eight-hour shift. Twenty rings are machined from 10 14-in. castings on two semi-automatic machines operated by one machine operating during one eight-hour shift.

All packing rings are thoroughly inspected by competent inspectors before being delivered to the storehouse. The rings are inspected for workmanship and accuracy as well as being gaged and it is found that 95 per cent of the rings gage within .003 in. of being perfectly round.

The records indicate that the rings manufactured from this type of casting give exceptionally good service.

Master Boiler Makers Assembled for the Opening of the Convention.

Master Boiler Makers Hold Annual Convention

Survey Made of Autogenous Welding Practice on Principal Roads and Methods of Treating Hard Water

THE thirteenth annual convention of the Master Boiler Makers' Association opened Tuesday, May 23, at the Hotel Sherman, Chicago, with Charles A. Patrick, president of the association, in the chair. During the course of the meetings about 275 members registered, which number included representatives of practically every road in the country. The opening invocation was given by past-president John H. Smythe, chaplain of the association.

In the absence of Mayor Thompson, who was to have addressed the association, his representative, W. D. Saltied, assistant corporation counsel of Chicago, extended official greetings to the association.

Mechanical Problems to Be Solved

H. T. Bentley, superintendent of motive power of the Chicago & North Western, then described the real work of the convention by outlining certain problems facing not only the boiler makers on the railroads today, but every man interested in the construction, maintenance and operation of locomotives. An abstract of his remarks follows:

Water treatment and purification have not received the attention necessary although a few roads which have pioneered in this work are now reaping real benefits from their investment. Formerly it was considered economy on most roads to use solid staybolts and drill tell-tale holes in place, but undoubtedly most of the roads now purchase hollow bolts, eliminating a great deal of work. The ordinary sheet steel ashpan is a constant bill of expense and it has taken us a long time to learn that the cast-steel pan can be installed and maintained at a much lower cost.

Now that flexible staybolts have gotten beyond the experimental stage there is an opportunity for the association to investigate the effect that these bolts have on the life of firebox sheets and whether they are more economical for complete equipment on an engine where it is necessary to remove the caps every two years or to put in hollow bolts and inspect them every 30 days.

The fuel saving problem can be materially improved by checking the flue cleaners and being sure that boilers are properly washed out and air leaks in the front ends and around the outside steam pipes eliminated.

All members of the association undoubtedly appreciate the good results obtained by using hot water to wash out and fill locomotives. This is especially important in connection with the efforts of the railroads to conserve fuel. Advantage should be taken of hot water for this work whenever practicable.

Association Business

President Patrick's address was followed by the report of the secretary, H. D. Vought, and the treasurer, W. H. Laughridge, who gave the financial statement of the association for the period ended March 31, 1922. F. W. Fritchie, master mechanic of the Baltimore & Ohio, and representing the Master Boiler Makers' Association on the Bolt, Nut and Rivet Proportions Committee of the American Society of Mechanical Engineers' Standards Committee, reported the progress made at the organization meeting held March 16. The work of the committee has been divided among seven special committees.

Promoting Locomotive Safety

At the opening of the Wednesday session, A. G. Pack, chief inspector, Bureau of Locomotive Inspection of the Interstate Commerce Commission, addressed the association on the duty which both the Bureau of Inspection and the members of the Master Boiler Makers' Association must perform in constructing and repairing boilers in such a manner that they will render economic service without unnecessary peril to those who are called upon to operate them.

Approximately 70,000 locomotive boilers come under the jurisdiction of the chief inspector and an opportunity is afforded to the department to better observe the general conditions of motive power in the country than is given to any other group of individuals. Investigations of accidents due to the failure of boilers and their appurtenances indicate conditions which impress upon those responsible for the construction, inspection, repair and operation of such boilers, the necessity for great care and thoroughness in their work. Many of the most insignificant causes oftentimes lead to disastrous explosions. One instance of this recently coming to the attention of the department was the case of a washout plug bushing which blew out of a boiler carrying 200 lb. pressure. This accident resulted in the death of two men with the serious injury of three others. Upon investigation it was disclosed that the hole in the back head where the bushing had been inserted was practically void of threads, it having been only slightly scratched by the tap when the bushing was originally applied.

A number of accidents reported to the bureau have been caused by ends of broken staybolts blowing out of firebox sheets while being calked. It was found that the tell-tale hole in each case was either riveted over or plugged. Leaky staybolts, crown stays and firebox sheets do not contribute to the efficient operation of locomotives nor do the defective, unsafe and inefficient operation of locomotives contribute to the efficient operation of the railroads.

C. P. Patrick, Retiring President

Thomas Lewis, President

H. D. Vought, Secretary

W. H. Laughridge, Treasurer

Number of Boiler Accidents Decreasing

Since the establishment of the locomotive boiler inspection law the number of accidents and casualties has been greatly decreased. The comparison of the first nine months of the current fiscal year with the same period of 1912 shows a decrease of 67 per cent in the number of accidents, 74 per cent decrease in the number of persons killed and a 67 per cent decrease in the number of persons injured due to the failure of some part of the locomotive boiler only. This result has been brought about by the requirements of systematic inspection and repairs, not before consistently carried out.

It is a comparatively easy job to wash a boiler thoroughly and properly and clean an arch tube, yet neglect of such work will necessitate repairs costing far more than the saving accomplished. Water registering appliances can be easily cleaned and maintained in a safe and proper condition yet some of the most disastrous explosions are caused by failure to keep these devices functioning.

Autogenous welding is frequently employed where other means of construction and repair could be more profitably as well as more safely used. This statement does not imply opposition to autogenous welding where it can be safely, properly and economically employed, but only where, through failure, increased loss of life and property result.

Autogenous welding is one of the great modern inventions. Its judicious use can be made to accomplish great savings in time and money, but it has not yet reached the state of perfection where it can be safely used on any part of a high pressure boiler wholly in tension while under working conditions or where the strain to which the structure is subjected is not carried by other construction which meets the requirements of the law. These conclusions are based upon conditions brought out in reports covering accident investigations in which autogenously welded seams were involved. During the fiscal years 1916 to 1921, inclusive, the records show that there were 81 crown sheet failures in which autogenous welded seams were involved, in 63 of which the welding failed. From July 1, 1916, to May 1, 1922, these seams have been involved in 22.1 per cent of the crown sheet failures, causing 44.1 per cent of the total number of fatal accidents. It has been said that these accidents were primarily caused by low water permitting the crown sheet to become overheated but the violence of the explosion and the consequent results were greatly increased by the failure of the seams.

Another condition, which has on many occasions been stressed by the bureau, is the application of arch tubes. There have been many cases where the tubes did not extend through the sheet as well as where they did not extend far enough to be either belled or beaded over to secure them in place. Many such conditions have been found by the bureau inspectors in the course of their regular work and proper repairs required before accidents occurred. Other arch tubes have pulled out of the sheets resulting in serious injury and death.

Where arch tubes are used, they should be thoroughly washed each time the boiler is washed and scaled with an automatic cleaner at each monthly inspection. The great majority of the accidents which occur could be prevented by means which are known to every well-qualified mechanic, official and employee in charge of the inspection, repair and operation of locomotives and tenders. Every means should be practiced by members of the Master Boiler Makers' Association to safeguard the lives of the traveling public and those who operate the locomotives.

Report on Autogenous Welding

The purpose of this special committee was to investigate autogenous welding by personal observation owing to conflicting reports by different members on the floor of our convention. Your committee has visited at least one shop on each of 25 railroads and as many as eight shops and roundhouses were visited on some of the railroads.

We found that autogenous welding for firebox repairs is used by every railroad visited and in most cases successfully. We do not believe that it is necessary to go into detail as to what is being done on the various roads by autogenous welding, other than to say that we found complete fireboxes with no rivets above the mud ring. Patches, collar patches around fire holes, corner patches, one-half and full side sheets, one-half flue sheets and one-half door sheets, cracks, checks out of staybolt holes and crown sheets and combustion chamber sheets are welded in. Your committee is satisfied from their investigation that, as a general proposition, autogenous welding of fireboxes is successful.

It is our opinion that inexperienced operators, poor welding material and improperly prepared work have been the principal causes of failures in autogenous welding.

Proper Materials Essential to Good Welding

From our observations and discussions with various boiler foremen, we have agreed that it is necessary that work be properly prepared; that openings be neither too large nor too small, and above all that they be kept free from dirt. To secure good welding, firebox sheets must be clean. It is necessary that any of the material used in the repairs going into the firebox should be just as good as the original firebox material, and it is our opinion that all welding wire should be made to specifications.

Welding Flues to Back Flue Sheet

The success of welding flues, whether done at the time of application or after the locomotive has been in service for some time, in our opinion, depends on several conditions which must be taken into account. Some of these are: feed water conditions, the kind of coal used, use of injectors, whether the firebox is with or without a combustion chamber, and whether or not the water is treated. This report was prepared by Thomas F. Powers (chairman), John Harthill, John F. Raps, H. J. Wandberg, C. E. Elkins and W. J. Murphy.

Discussion

An extended discussion took place following the reading of this paper, more or less limited to the method of applying flues and the use of the electric arc process in this work. A great many roads throughout the country operating in both good and bad water districts electric weld the flues in their boilers. Members of the association generally favor the method, but vary slightly in the procedure employed. In good water districts flues installed in the usual way by expanding in most cases give excellent service, many running for the entire four years allowed by the Interstate Commerce Commission.

In bad water districts the welding of superheater flues increases their life but most members did not believe that this held true for small tubes. Whether the tubes are welded or not, it is necessary to keep the scale removed from around them if they are to be maintained tight. Most railroads are successfully welding fireboxes, side sheets, half side sheets, door sheets and general firebox repairs. Care must be exercised in this work, however, that strains are carried by other construction than the welded parts.

Buttonhead or Taper Crown Stays

This report was prepared by Lewis Nicholas, Jr. (chairman), Thomas F. Powers and J. J. Mansfield, who recommended the general adoption of the crown stay with a large taper riveted over, for the following reasons:

1. That it is of ample strength.
2. Easier to apply than the buttonhead on account of being tapered.
3. Less work needed to replace it on account of the taper in the firebox; can be cut free in the roof sheet and firebox and driven clear of crown sheet, thereby avoiding a lot of extra work cleaning broken ends off the crown sheet where, as often happens, the bodies of bolts become fast between the braces and cannot be removed.
4. Easier to tighten and does not strip; can be pulled up tight regardless of the angle of the sheet.
5. Gives little or no trouble in service, while the buttonhead type of bolt leaks very easily and when it does leak it is hard to calk; if not calked properly it is wedged away from the sheet, making it necessary to renew the bolt.
6. Gives a cleaner crown sheet both on the water and fire sides of the sheet, and does not collect dirt and cinders as does the buttonhead; gives a more even head surface.
7. Can be made at less cost than the buttonhead stay.
8. Gives a saving in tool bills, both in making bolts and in reaming and tapping, as the one tap and reamer can be made to do for three or four diameters.
9. Can be carried in stock threaded at both ends ready for use.

Discussion

With coal-fired engines the buttonhead crown stay has given satisfactory service generally but where roads have converted their power to oil burners the taper radial has been found almost a necessity. The taper in such cases varies from 1½ in. to 2 in. in 12 in., many of the members favoring one or the other for reasons of added strength, ease of fitting to the sheets, etc.

On the Chicago & North Western when engines were first converted from coal to oil burners, a great many of the buttonheads were cut off and hammered over but they were found difficult to maintain. Taper bolts at first also gave considerable trouble. For 10 years, however, these bolts have been used satisfactorily having a 1½-in. taper.

In hard water districts the question of scale enters the problem and it seems reasonable that the additional heat conducting surface of the buttonhead bolt causes greater precipitation of scale adjacent to it with the result that a heavy coating of scale forms around the bolt. Any advantage of strength with this type bolt is more than counterbalanced by the greater tendency to scale formation.

The results of low water investigations where boilers are fitted in some cases with buttonhead bolts and in others with taper head bolts indicate that the former do not hold up any better than the latter. The experience of the Bureau of Locomotive Inspection has been that the hammered head radial bolt is one of the best bolts used in a locomotive boiler. They hold up under all ordinary conditions and leaks do not occur to a fraction of the extent that they do with buttonhead bolts.

The final conclusion of the majority of members was that the taper stay with the 1½-in. taper in 12 in. is the most satisfactory crown stay to use.

Abstracts of additional reports and discussions will appear in a subsequent issue of the *Railway Mechanical Engineer*.

The officers of the Master Boiler Makers' Association elected for 1922-1923 are: President, Thomas Lewis (L.V.); first vice-president, E. W. Young (C. M. & St. P.); second vice-president, Frank Gray (C. & A.); third vice-president, Thomas F. Powers (C. & N. W.); fourth vice-president, John F. Raps (I. C.); fifth vice-president, W. J. Murphy (P. R. R.); secretary, Harry D. Vought; treasurer, W. H. Laughridge (H. V.).

Executive Board for one year: Harry F. Weldin (P. R. R.); E. J. Reardon (I. C. C.); Capt. J. M. Guiry (G. N.). For two years: Henry J. Wandberg (C. M. & St. P.); George Austin (A. T. & S. F.); C. E. Elkins (M. P.). For three years: L. M. Stewart (A. C. L.); John Harthill (N. Y. C.); C. H. Browning (G. T.). L. M. Stewart was elected chairman of the executive board and E. J. Reardon, secretary.

Principles of Oxyacetylene Fusion Welding Part Three—Welding Cast Iron

By Alfred S. Kinsey*

THE oxyacetylene flame can weld any of the metals to be found in shop practice. Each metal, however, has its own peculiarities which must be respected by the welder if a good weld is to be obtained. One reason why some oxyacetylene welds fail is because the welder does not know enough about the physical and chemical properties of the metal with which he is working. It might not be amiss, therefore, to point out some of the principal characteristics of the metals being welded in railroad shops, and also explain the real reasons for certain practices during the making of the welds.

One of the most interesting and complex of such metals is cast iron, and no less interesting and involved are the problems to be met as, for example, in the oxyacetylene welding of a cast iron locomotive cylinder.

Reasons for Ordinary Welding Practices

In order to make welds in cast iron of full tensile strength, non-porous and soft enough to be machined the following directions are offered:

1.—*Cast Iron Should Be Beveled for Welding.* In preparation for an oxyacetylene weld the two edges to be fused should be beveled at an angle of 45 deg. each, or a total angle of 90 deg. from one beveled surface to the other. If this vee is made less than 90 deg. the torch flame and the filling metal cannot be properly applied. If it is made wider there will be a waste of time, gases and filling metal. Single beveling will do for thicknesses of ¼ to 1 in. Beyond that double beveling should be used, that is, each piece of metal should be beveled on one side from the top surface down to half of its thickness and then beveled the same way on the other side. When the two ends to be welded are joined they will form a double vee, first one being filled with welding rod and then the other by turning the job over.

The beveling of a weld is necessary in order that the flame of the torch may be able to apply the heat directly to the middle of the cast iron and melt it and so weld the bottom of the vee first.

The oxyacetylene cutting torch may be used to cut the bevel on a cast iron weld, or the beveling may be chipped or ground. The latest method is by the cutting torch.

2.—*Cast Iron Bevels Should Be Blunt at the Bottom.* The bottom of the bevel of a cast iron weld should be left about ⅛ in. thick for ordinary thicknesses of metal and for very thick iron the bluntness should be increased in proportion. The value of this lies in the fact that the flame will not melt the blunt edge too easily and burn the metal at that point before the adjacent surface is melted, as would probably be the case if the bottom of the bevel were left thin and sharp.

3.—*Separate Slightly the Two Edges of a Cast Iron Weld.* If the two ends of a cast iron weld are placed closely together there is the possibility of oxides being deposited at the bottom of the vee thereby weakening the weld. This may be avoided by leaving the edges about ⅛ in. apart for the small welds and farther apart for big castings.

4.—*Cast Iron Should Be Heated Slowly to a Dark Red.* It is possible to heat a piece of cast iron so quickly that the grain structure will be weakened. It also is possible to raise the temperature of an iron casting so fast that its chemical composition will be affected enough to change the nature of the metal. An oxyacetylene weld is obtained by fusion, that is the metal is melted so that the two parts of the job may flow together and thus welded by allowing the mass to cool and become solid. Much of the success of this work depends on the proper heating and cooling of the metal, which is not difficult to accomplish and a welder will be well repaid for his efforts in this direction.

A piece of cast iron is composed of flat-sided grains each of which is formed of crystals of intricate and wonderful design. When the metal is heated from the cold to the red hot condition the grains expand due to the separation and

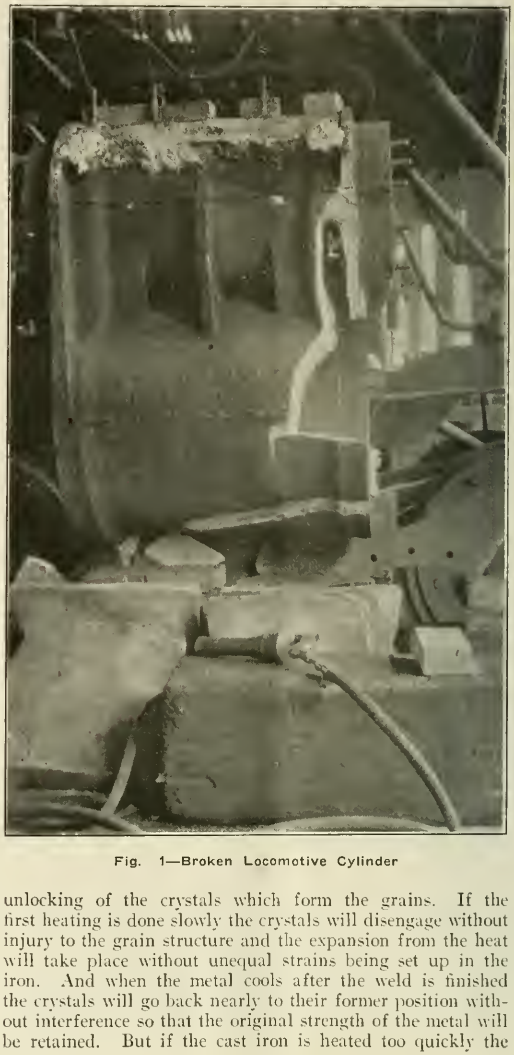


Fig. 1—Broken Locomotive Cylinder

unlocking of the crystals which form the grains. If the first heating is done slowly the crystals will disengage without injury to the grain structure and the expansion from the heat will take place without unequal strains being set up in the iron. And when the metal cools after the weld is finished the crystals will go back nearly to their former position without interference so that the original strength of the metal will be retained. But if the cast iron is heated too quickly the

*Professor of Shop Practice, Stevens Institute of Technology, Advisory Service Engineer Air Reduction Company.

crystals will be torn apart in such a way as to prevent their proper reassembling, and shrinkage cracks will be likely to occur.

The proper way to heat a piece of cast iron is to whirl the flame by circling the torch and to see that the heat is not applied to any one spot long enough to make it red hot before the whole thickness of the metal at the weld feels the expanding effects of the heat.

5.—*Cast Iron Should Be Heated Adjacent to the Weld.* Before applying the flame down in the vee it should be played over the metal on each side of the vee so as to warm it up thoroughly. This will produce a gradual increase of size of grains from the smallest back of the weld in the cold metal up to the largest size grains in the molten metal at the weld. On the other hand if the edges to be welded are heated too quickly there will be a distinct line of weakness between the largest grains of the molten metal and the smallest ones of the cold metal which may develop to be a shrinkage crack or possibly a complete break in the metal. On small welds the oxyacetylene torch will prove to be the most economical means of adjacent heating. On big jobs the casting is likely to require complete preheating, for which other sources of heat would be applicable. The subject of preheating will be treated in a later chapter.

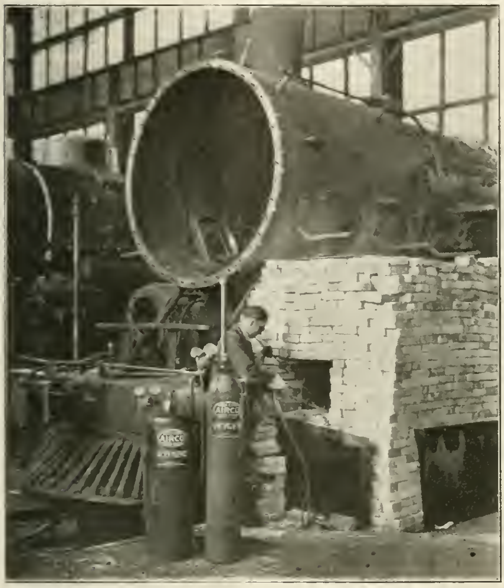


Fig. 2—Broken Locomotive Cylinder Bricked Up for Welding

6.—*A Cast Iron Weld Should Be Thoroughly Fused.* Before the welding rod is melted down in the vee the surface upon which it is to fall should be thoroughly melted well into the metal. By holding the welding rod close to the flame it can be heated up slowly while the flame is bringing the base metal to the molten condition. Then by moving the rod into the flame it will be melted and fused with the molten base metal. The success of a good fusion weld depends mostly on the reuniting of the grains as the metal cools from the molten to the solid condition. If these grains could be brought together again at exactly equal temperature and without any oxides or slag between them, the original natural law of cohesion would be re-established and the metal of the weld would be as strong as the base metal. This of course is also assuming that the welding rod is of proper composition.

A common mistake made in welding cast iron is to fail to have the welding rod and the base metal of the same temperature when melting. To drop thoroughly molten cast iron rod on the hot but still solid surface of the base metal may mean a difference in temperature of the two masses of over 500 deg. F., and good fusion could not possibly result. The filling metal would merely stick to the surface of the base metal and a light hammer blow could break the joint. Precaution should be taken during the making of the entire weld to avoid this pasting of the two metals. A good flux will of course do much to prevent the lack of fusion, but oxyacetylene welders rarely have a good excuse for making a cast iron weld of less than 90 per cent tensile efficiency, and in most cases the strength should be practically 100 per cent.

7.—*Cast Iron Should Not Be Overheated.* If after cast iron is brought to the molten condition the flame of the torch is held too close to the metal for some time the metal might be overheated or burnt. There is no excuse for this. When a piece of cast iron is reduced from the solid to the molten condition the cohesion which holds the grains of the metal together will be reduced from its full amount in the cold metal to almost no cohesion when the metal is liquid. However, there is still sufficient cohesion between the grains to hold the mass together in the liquid state, and merely melting the iron has done it no harm. But if the heat is applied too closely and too long the cohesion will be entirely destroyed, the grains will separate and their surfaces will be coated with an iron oxide scale which will prevent them from reuniting and making a strong piece of metal again. This is burnt iron and is only fit for the scrap pile.

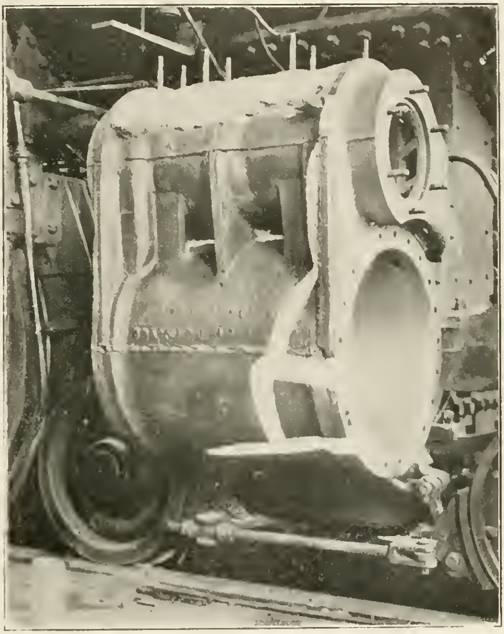


Fig. 3—Locomotive Cylinder Oxyacetylene Welded

Another result of overheating a cast iron weld is that its chemical elements, carbon, silicon, manganese, phosphorus and sulphur, will be burnt out and thereby destroy the natural characteristics of the metal. An oxyacetylene welder will have no difficulty in avoiding the overheating of a cast iron weld if he uses a good flux, keeps the torch flame properly adjusted and learns the appearance of clean molten cast iron as compared with superheated burnt metal.

8.—*Cast Iron Should Be Preheated.* By *preheating* is meant to heat the casting all over to a uniform temperature before starting to weld. This will be absolutely necessary in all castings so shaped that the welded section has not free play to expand and later to contract without setting up strains in adjacent parts of the casting or warping it. On the heaviest welds it is best to build fire bricks up around the job, leaving sufficient space to allow the preheating flames to circulate and heat the casting uniformly. No mortar is necessary. The bricks keep the heat over the casting and confine it there so that the casting will cool very slowly. If the job requires but a small amount of welding the bricks may be omitted and asbestos board used instead with satisfactory results.

The heat for preheating may be satisfactorily obtained from charcoal made of hard wood. Soft wood charcoal may throw off offensive gases. Hard wood charcoal will burn slowly and evenly without smoke or harmful gases, and usually does not require a blast to keep the fire going. It will hold a fire over 40 hours if necessary. Its chief advantage is that it does not burn with long flames to interfere with the welder. In the case of small jobs an oil burner or a gas jet or furnace may be used. A typical cast iron preheating job in railroad practice is a locomotive cylinder, Fig. 1. With its thick and thin walls, bridgings and passages, steam chest and fastenings, it would be impossible to weld the cylinder without preheating it. It should be bricked up carefully, Fig. 2, and iron rods laid inside and across the cylinder at the center of its diameter could form a grate for the charcoal fire.

Preheating of cast iron accomplishes three things:

(a) The uniform expansion of the metal so that there may be uniform contraction including the welded area, and thus avoid shrinkage cracks after the weld cools.

(b) The uniform relieving of all unequal strains which may have been set up in the casting when it was made in the foundry. Many castings contain these locked-up stresses which often are not discovered until long after the casting has been in service and it receives an unusual strain. Then it is surprising how easily it breaks.

(c) The uniform retention of the carbon contents of the iron. Cast iron contains carbon in two states, graphitic and combined. Graphitic carbon softens cast iron and makes it machinable, while combined carbon strengthens cast iron and makes it hard. The proper proportioning of these carbons determines the use of the casting in practice. It is quite possible to change the relative amounts of the carbons by the way it is allowed to cool from the liquid to the solid state.

For example, the casting of a locomotive cylinder will contain say graphitic carbon about 2.75 per cent and combined carbon about .75 per cent. Now if the cylinder were to be welded with the oxyacetylene torch and it was not covered or preheated, when the red hot weld was completed it would cool very quickly in the air, which would cause the carbon to change so as to reverse the relation say to the extent of about .75 per cent graphitic carbon and 2.75 per cent combined carbon, thus leaving the casting so hard that it could not be tooled. The slow cooling after preheating prevents this transformation of the carbon. A good rule to follow is always to cool cast iron as slowly as possible after welding.

The temperature to which cast iron should be preheated varies somewhat with the shape of the casting. If the casting is of nearly uniform thickness throughout it should not be heated higher than about 600 deg. F., which is the point where the surface of the casting still appears black and not at all red. If the casting has thick and thin parts it will be necessary to heat the whole casting to a dark red. Cast iron should never be preheated above a dark red. To go beyond that temperature, which is from 800 to 900 deg. F., would be liable to distort the casting by its own weight.

Cast-Iron Anvil Block Demonstrates Value in Blacksmith Shop

There are few railroad men, particularly in the blacksmith shops, who have not at one time or another experienced difficulties with wooden anvil blocks. If a solid wood anvil block is properly set and the anvil securely fastened in place the block will doubtless have a relatively long life but it is not always easy to fasten the anvil rigidly and unless the block is set with unusual care it will not afford a solid foundation. These difficulties are entirely overcome by the

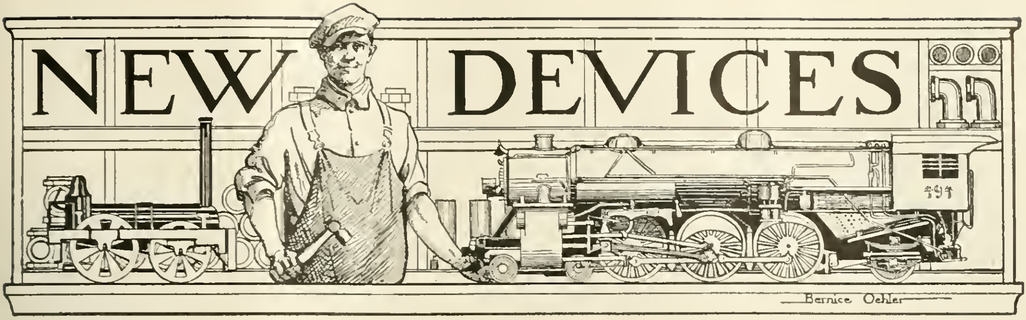
Durable Cast-Iron Anvil Block Used on the Chesapeake & Ohio

use of the cast-iron anvil block illustrated which is being used successfully in the Chesapeake & Ohio blacksmith shop at Huntington, W. Va. The block is provided with a substantial flanged base, having a wide bearing on the floor, and the effective method of fastening the anvil to the block is plainly shown in the illustration. Tightening the nuts on the studs will evidently draw the clamping irons and anvil firmly to the block.

Thermit Weld Collar Inspection

One fact more responsible perhaps than any other for retarding the progress of welding is that when a weld is made it is impossible to determine without destroying it what strength is definitely assured and safe to allow. An examination of the surfaces of welds does not reveal this and certain well-known technical societies and associations interested in the possibilities of welding have greatly restricted the allowable application.

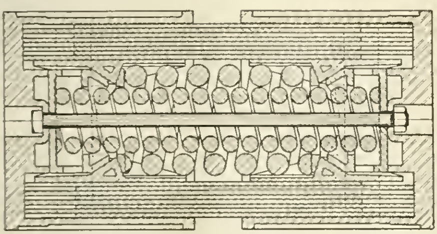
A thermit weld, however, by reason of its collar allows a careful inspection and drawing of accurate conclusions as to strength. An examination internally of the collar can be made without affecting the strength of the weld, the unsound welds being found and condemned. In practice this examination is made by gouging deep grooves in the thermit steel collars parallel with the axis of the piece, these grooves reaching almost to the original section itself. Two such grooves on the four sides of a thermit weld have been found to be sufficient. If these grooves are observed to be free and clean from blow hole defects, the inspector may be absolutely assured that the weld itself is sound.



Hall Multiplate Friction Draft Gear

AFTER many experiments and tests to develop a draft gear with the maximum resistance to wear, high capacity, a moderate and positive release, sturdy in construction, simple to manufacture, and easily handled on application and repairs to rolling stock, the Hall Draft Gear Corporation, Watervliet, N. Y., has placed on the market the Hall multiplate friction draft gear.

A friction draft gear of proper design and manufacture should meet the following conditions: The resistance to wear should exceed the life of the equipment to which the draft gear is applied. The high resistance should build up uniformly without sticking and jumping so as to keep the sill stresses at a minimum for the shocks absorbed. The release should be moderate and positive so as not to return more shock than necessary to the rolling stock, but at the same time insure a positive release in order that the draft gear will be ready for operation at any position of the coupler. Sturdy construction is necessary if the draft gear is to give continuous service without repairs, as there is always more or less liability of rough handling of rolling stock. The first cost should be kept down to the minimum; this likewise applies to application and repairs. The draft gear should be a self-contained unit, as application is much simplified if there are no bothersome loose pieces.



Cross Section Showing Working Parts of the Gear

It is a well-established fact that friction tends to increase uniformly with the pressure up to the point at which the surfaces in contact begin to seize and abrasion starts. If the friction pressure is low enough there will be practically no wear and if any occurs, the surfaces will be smooth and uniform.

If the friction pressure is too high, scoring, irregular wearing and rapid breaking down of the friction surfaces takes place, which greatly reduces the capacity and life of the draft gear.

Steel in sliding contact without lubrication will show abraded surfaces at approximately 800 lb. per sq. in. frictional pressure. This will be more or less depending on the hardness of the surfaces; therefore, in order to obtain a high capacity draft gear, using low friction pressure per square inch, it is necessary to have an extremely large friction area. This has been accomplished in the Hall multiplate gear by using soft spring steel plates in multiple.

The Class H draft gear, 9 in. by 12¾ in. by 24⅝ in., illustrated, has 2,300 sq. in. of friction surface and a maximum pressure of 250 lb. per sq. in. setting up friction. This gives a mechanical combination which shows very little wear, high capacity and smooth action.

The cross-sectional drawing of the draft gear shows the arrangement of the wedges, wedge plates, springs, friction plates and housings. This draft gear is a self-contained unit without followers or loose pieces. It is symmetrical with respect to all axes and cannot be applied improperly. The standard draft gear is 9 in. by 12¾ in. by 24⅝ in.; special draft gears 9 in. by 12¾ in. by 18½ in., 8½ in. by 12¾ in. by 15½ in. and 12¾ in. by 15 in. by 24⅝ in., are built to interchange with existing sill pockets. The latter size is for 100 ton and heavier equipment, the spring capacity having been doubled and the friction area greatly increased in order to give approximately double the capacity of the standard draft gear.

The Hall Multiple Friction Draft Gear Is a Self-Contained Unit

The draft gear casing may be described as two identical cast steel housings with open ends towards each other, separated 2¾ in., or whatever travel the draft gear is designed and set up for. The friction plates are rolled steel of 0.60 to 0.70 per cent carbon content, alternately arranged to move in unison with the housings due to contact at one end of each plate. The weight of the standard gear is 470 lb.

Frictional resistance is created by pressure applied on these friction plates when the draft gear housings are forced towards each other. This pressure is applied by a wedge at each end of the draft gear which moves with the housing, forcing a pair of wedge plates against the friction plates, the amount of this pressure being determined by the pressure of the friction spring, which compresses as the draft gear is closed. The inner spring shown is the release spring, while the outer spring is the friction spring.

As soon as the buffing or pulling load on the housing terminates, the release spring forces the wedges out of contact with the wedge plates, thereby relieving the pressure on the friction plates. The friction spring then moves the housings, friction plates, draft gear attachments and coupler back to position. The release spring is also arranged to work in unison with the friction spring on release.

Due to both ends of the friction spring acting against a pair of wedge plates at each end of the draft gear, and both pairs of wedge plates being forced against the same friction plates, the arrangement allows a comparatively small capacity friction spring to be used in order to obtain a high friction resistance in this draft gear. The lateral pressure, tending to burst the housing, is comparatively small, due to the multiplicity of the friction plates and the small wedging pressures necessary for a high capacity.

In buffing or in pulling, the force is transmitted to the draft gear housings, tending to force one housing against the other. The resistance to this movement is offered by the internal or frictional parts of the draft gear up to the resistance capacity of the gear. With a force beyond this capacity the draft gear housings come in contact and resist further applied forces. The general design of these housings permits making the parts of sufficient strength to protect the frictional elements of the draft gear from damage, and at the same time to resist high buffing or pulling forces which may occur in the handling of rolling stock. The cross-sectional area of the casing is 23 sq. in. and the solid contact area 30 sq. in.

The draft gear is practically weather proof with all wedge arrangements well away from the central opening and can be applied to cars or locomotives with any design of draft yoke or draft attachments that provides a draft gear pocket of the standard dimensions or various existing draft gear pocket dimensions.

The results of tests of the H-2 gear under the A.R.A. 9,000 lb. drop test machine are shown in one of the drawings. A free fall of 30 in. or a total fall of 32¾ in. was required to close the gear. The work done was 24,500 ft. lb. and the work absorbed 23,000 ft. lb.

Car impact tests of the H-2 gear were also made on the Symington tests plant at Rochester, N. Y., using the same 143,000 lb. cars and equipment used by the United States

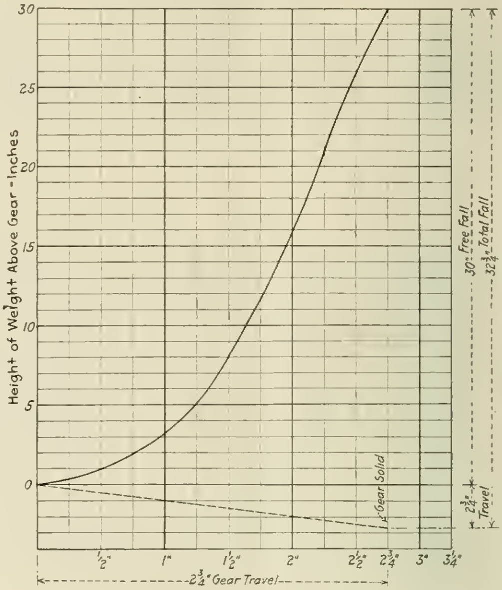


Diagram of Drop Tests of Hall H-2 Gear

Railroad Administration, so that comparison could be made with published data. The closing speed was found to be 5.23 m.p.h. Slow speed, solid speed and over-solid speed trials were made to study the draft gear action under various conditions. The gear showed favorable results as regards car movements, velocities, energy absorbed, smoothness of action and sill stresses set up.

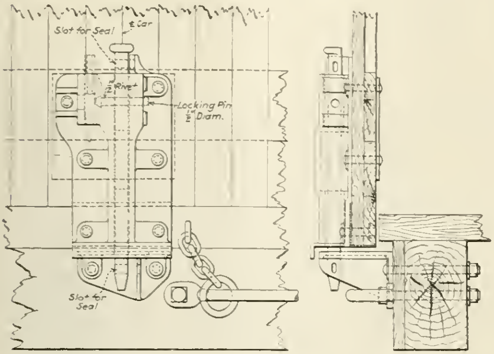
A New Type of Anti-Burglar Car Door Fastener

Immense quantities of valuable freight are being shipped on the railroads with no other protection from theft than a flimsy car seal. Occasionally padlocks are used to secure the doors, but these can usually be pried off with a small bar and offer little additional protection. Considerable losses are sustained from theft of valuable freight. Recently a freight train on an important main line was stopped by bandits who broke into every car and searched it for valuable shipments. It happened that the bandits stopped the wrong train and the loss was small but the incident emphasizes the fact that ordinary methods of securing car doors offer no obstacles to theft. Because of the frequent loss of valuable shipments, some railroads have placed armed guards on trains. Other roads have spiked with heavy nails the doors of cars containing valuable merchandise. If the nails are driven in to the head, they cause delay in opening the cars and injury to the door. If allowed to protrude, they are easily removed and offer little resistance to thieves.

The Delaware, Lackawanna and Western for some time followed the practice of nailing doors on merchandise cars but on account of the inconvenience and expense for repairs, J. C. Fritts, master car builder, designed a type of door lock which provides such effective protection that the railroad now dispenses with the service of train riders.

This fixture which is both simple and effective is illustrated in the drawing. It takes the place of locks and handles and does away with the necessity for special opening and closing devices. The usual locking fixtures at the side of the doors are replaced by a special fixture placed at the center of the bottom edge of the door. The door guides and stops at the bottom of the door are eliminated and a short chain attached to a horizontal rod keeps the door from swinging out more than a limited distance.

The principal feature of the door is the bottom door fastening which is shown in detail in the drawing. The lock consists of a heavy locking bolt about one inch square working in a housing attached to the car door. The lower end of the locking bolt engages a bracket attached to the side sill and the bolt can be sealed either through the bracket or through a lug at the top of the housing. Near the top of the locking bolt is a 9/16 in. transverse hole which registers the corresponding holes in the housing. When it is desired to lock the door securely a 1/2 in. cold rivet



A Simple Door Fixture Which is Effective in Preventing Theft

is inserted through the housing and locking bolt. The head may be held in place by inserting a cold chisel, brake shoe key or any piece of iron of about the same size into the lugs on the housing while the opposite end is upset with a hammer to prevent its removal. It is then necessary to cut the rivet with a chisel before the door can be opened.

Anyone attempting to remove the rivet would make so much disturbance as to attract attention and if an attempt was made to enter the car at night, it would be necessary to use a light which would probably betray the presence of the thief.

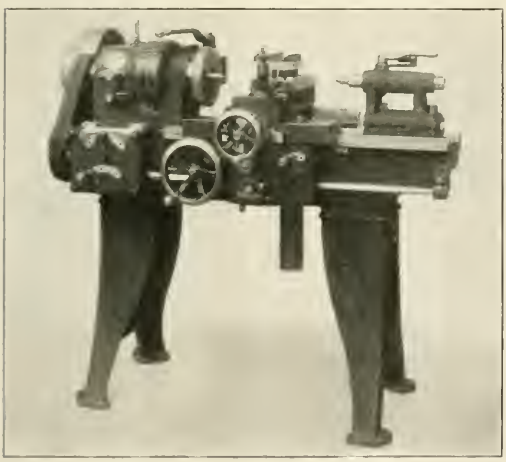
In addition to the anti-burglar feature, this fixture provides for locking the door in a slightly open position. This is useful for securing ventilation when handling certain commodities and is also a distinct advantage in facilitating checking empty cars in yards.

The chain door stop is advantageous in insuring that the door can be opened readily. In case the door posts are sprung or loads shifted against the door, it can be swung out to clear the obstruction, preventing damage which results from forcing doors open.

An important advantage of this fastening is its simplicity and cheapness. It requires but 22 bolts per car while the ordinary fixtures require from 48 to 60. The total cost is considerably less than one-half of the usual type of door fixtures which include guides and corner brackets. Moreover, the whole door mechanism and side of the car are much less expensive to maintain after its application because there is no damage to either door or sheathing in forcing the doors open and closed as is in many instances the case with the ordinary fixtures.

High Duty Lathe for Small Diameter Turning

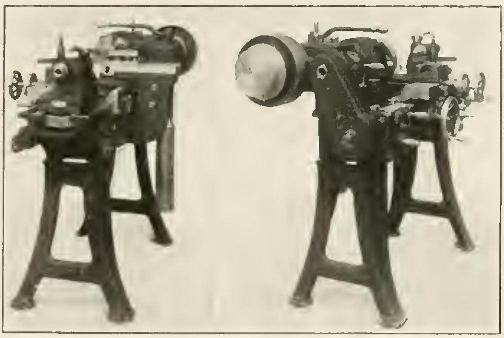
A NEW manufacturing lathe has been developed by the R. K. LeBlond Machine Tool Company, Cincinnati, Ohio, designed for the small diameter turning and facing jobs encountered in manufacturing work. The essential features of the regular line of LeBlond heavy duty lathes are included in this machine such as selective speed, flooded lubrication, heavy duty bed, one-piece box section apron with



R. K. Le Blond 11-In. High Duty Lathe

positive feed clutch, heavy duty carriage and lever-operated quick-acting tail stock. Six speed changes are provided through sliding gears from a constant speed driving pulley. The spindle is of liberal proportions, running in taper bronze bearings adjustable for wear. Ball thrust bearings are provided, the entire mechanism being enclosed in a heavily ribbed oil tight casting. All gears and bearings are thus continuously flooded with oil. Two speed change levers control the six speeds and the starting lever applies a friction brake on the spindle as soon as the driving clutch is released. The spindle is provided with a large hole for passing work through it or mounting draw-in or expansion chucks, either hand or air-operated. This feature is valuable, permitting the manufacture of parts from bar stock.

The lathe is made with a plain block rest and No. 1 single screw tool post with collar and elevating wedge. On speci-



End Views Showing Facing Attachment and Pulley Drive

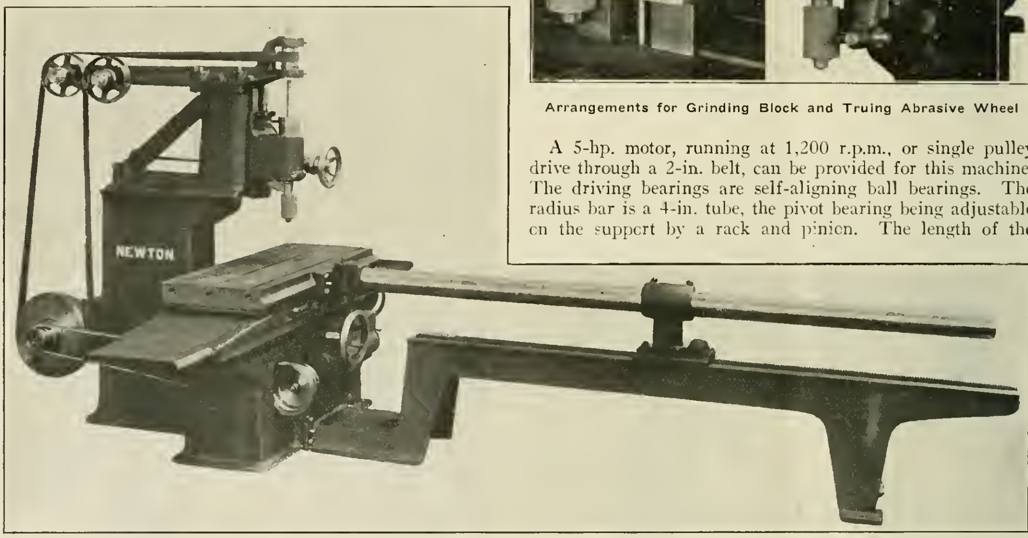
fication a turret tool post can be provided. Nine changes of feed may be obtained by the simple manipulation of two change levers. The bottom lever compounds the range obtainable with the top lever, giving a quick change of feed for roughing and finishing cuts without the necessity of gradually stepping the feed up through gear combinations. The box is driven direct from the spindle by means of a roller sprocket chain adjustable for tension. The lever-operated, quick-acting tail stock is a recent improvement arranged to permit the quick removal and replacing of work with a single movement of the operating handle.

For work requiring facing or grooving operations a facing attachment can be supplied, enabling these operations to be performed at the same time as turning. The application of the facing attachment converts the 11 in. rapid production lathe into a semi-automatic lathe performing turning and facing operations at the same time and covering a field of smaller and lighter work than can be handled on the LeBlond Multi Cut lathes. The facing attachment is mounted on a substantial bracket bolted to a planed pad on the rear of the bed and adjustable to any desired position along the bed. A simple cast-iron form plate is bolted to and travels with the carriage. A roller on the facing attachment engages this form plate and transmits the motion through a rack and pinion to the facing slide which is set towards the center of the lathe on a broad, dovetailed slide. As the carriage is brought back along the bed to the starting position the facing attachment is also brought back automatically by the weight illustrated. This lathe has a capacity to turn work up to 13¾ in. in diameter by 18½ in. long. The facing attachment will face 2½ in. on a side. Six spindle speeds are provided ranging from 50 to 250 r.p.m. Nine feeds can be obtained from .008 to .092 in. per revolution of the spindle.

Radius Link and Link Block Grinder

A NEW radius-grinding machine, particularly adapted for grinding locomotive links and link blocks, has been developed by the Newton Machine Tool Works, Inc., Philadelphia, Pa., being shown in the illustrations.

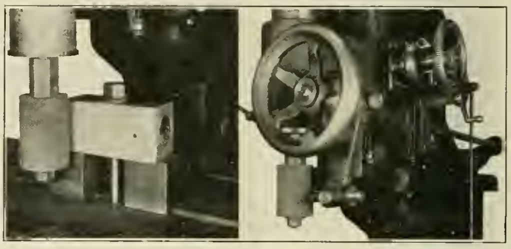
The table of this machine has hand adjustment and is reciprocated automatically by dogs. Three speeds of 5 ft. 3 in., 7 ft. 10 in. and 10 ft. 6 in. per min. are available. Arrangement is made to permit operation of the vertical feed to the wheel and remove pressure during reversal. The slide carrying the table is fitted at either end with cast-iron shields so that the bearing is never uncovered. The spindle of this machine has a taper end for the arbor fit, being provided with ball bearings. The driving pulley is carried on separate ball bearings so there is no thrust on the spindle bearings other than that of rotation.



General View of Newton Link Grinder Featured by Rigidity, Strength and Productive Capacity

The spindle sleeve has a 3-in. adjustment in the slide. The spindle slide is counter-weighted and provided with hand adjustment, oscillating motion for using wide-face wheels and an intermittent feeding motion for narrow-face wheels, the latter motion being reversible by a rachet box.

The spindle head is adjustable on the upright for setting the depth of cut and has sufficient movement to permit of grinding blocks as well as links. This motion is brought to a convenient position for the operator. The wheel truing device is conveniently mounted so that the motion of the spindle slide is available for truing the wheel and the fixture can be readily swung out of position when not in use.

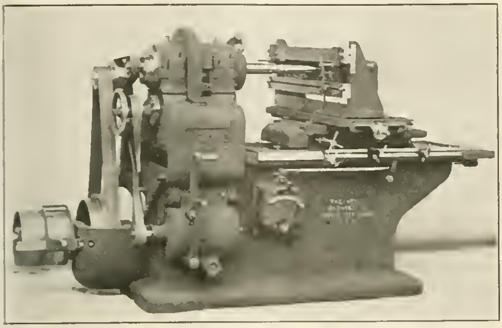


Arrangements for Grinding Block and Truing Abrasive Wheel

A 5-hp. motor, running at 1,200 r.p.m., or single pulley drive through a 2-in. belt, can be provided for this machine. The driving bearings are self-aligning ball bearings. The radius bar is a 4-in. tube, the pivot bearing being adjustable on the support by a rack and pinion. The length of the radius is indicated by a scale. The minimum radius available is 18 in. and the maximum, 100 in. The recommended speed of the spindle is 6,000 r.p.m. The wheel spindle has horizontal adjustments of 6 in. for different widths of work. The table is 18 in. wide by 42 in. long, the maximum table stroke being 30 in. and the minimum, 2 in. It is said that when grinding a link 3 in. wide with .025 in. of metal removed from each side and 5 min. required to set up the job, the total time for grinding is 40 min. New and old links of this size require a total time of one hour.

Wide Speed and Feed Range for Grinder Table

PERHAPS the most distinctive feature of the redesigned internal grinding machine, made by the Heald Machine Company, Worcester, Mass., is the hydraulic drive for the main table operated by oil. By the use of this drive any desired speed from nothing up to a maximum may



Heald No. 50 Internal Grinder with Hydraulic Table Drive

be instantly obtained. This feature of the machine is simple in design, silent in operation and has a minimum of parts to get out of order. The operator can reverse the table at any desired point without shock or noise. The main driving shaft on the rear of this machine runs on ball bearings taking the power directly from the main line without a countershaft. The main table is heavy and wide, being provided with ample wearing surfaces. It is of sufficient length to fully protect the ways from grit and dirt.

The cross slide table gives crosswise adjustment of 28 in. to the work. The feed screw has a graduated dial reading in thousandths of an inch. Adjustable dogs are provided for indicating large dimensions, as when traveling from hole to hole. Vertical adjustment of the cross slide table is provided to the amount of 5/16 in., secured by means of two inclined slides located between the cross slide table and the main

The grinding head and feeding arrangement for the eccentric are similar in design to that used on previous Heald grinders except that they are heavier. The grinding spindle is driven from the main drive shaft through a flexible idler which maintains uniform belt tension at all times. The depth of cut is obtained by a feed mechanism on the right-hand end of the rotating head, operated either by a knob when small adjustment is required, or by a small crank when large adjustments are to be made. For varied work of large size a special spindle, either 15 in. or 18 in. in length handling large wheels and known as the Railroad Type 10 spindle is provided. The speeds of the standard grinding wheels are from 4,500 to 4,950 surface feet per min. The recommended speed of the tight and loose pulleys is 750 r.p.m. A 5-hp. motor, operating at 1,000 to 1,200 r.p.m. is recommended.

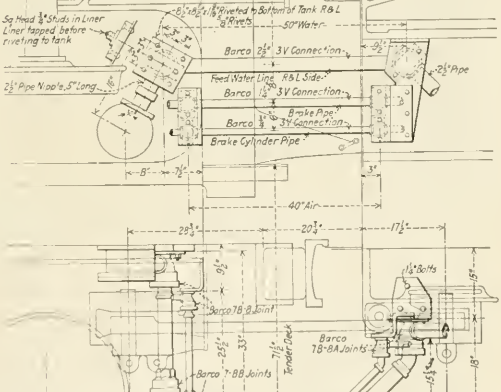
Metallic Locomotive Feed Water Connections

THE first application of flexible metallic connections to the feed water line between the engine and tender were applied in a single large pipe line on the center line of the locomotive, through which both injectors were fed. This type of connection met with some objection because of the possibility that a failure of this connection would completely cut off the feed water supply and cause an engine failure. The drawing shows an application of flexible Barco joints to the feed water line which provides a separate connection for each injector, this arrangement having been developed recently by the Barco Manufacturing Company, Chicago, Ill.

These connections are supported by a plate riveted to the bottom of the tank, to which the upper Barco joint is attached by means of two studs. A short nipple connects the joint with the tank well. By thus applying the connection directly to the tank instead of to the tender frame the possibility of leakage developing as the result of any slight shifting of the tank on the tender frame is eliminated, and the connection is raised well above the rail. The terminal joint on the locomotive end of the connection is secured to the deck in a similar manner, with a pipe connection leading from the joint to the strainer box at lower end of the injector feed pipe.

As is indicated on the drawing, the feed water connection is carried well into a line only about 25 in. from the center line of the locomotive.

Connections of this type have been in service on six Consolidation type locomotives on the Bangor and Aroostook for several months during the past winter, during which time the locomotives have averaged about 30,000 miles with no maintenance required to the feed water line. Under the severe climatic conditions prevailing during the winter months on this line, which require almost constant use of the heaters when the injectors are not working, it is estimated that the same service would have required at least one and probably two renewals of the ordinary hose connections. In addition to the reduction in the cost of maintenance



Application of Barco Flexible Metallic Connections to the Feed Water Line Between Engine and Tender

the pipe connections also insure against injector failures caused by the collapse of loose hose linings.

Self-Supporting Corrugated Steel Freight Car Roof

A NEW design of freight car roof of the heavy gage, all-metal type, has been placed on the market by the Sharon Pressed Steel Company, Sharon, Pa. The roof is made of pressed sheets, continuous for the entire

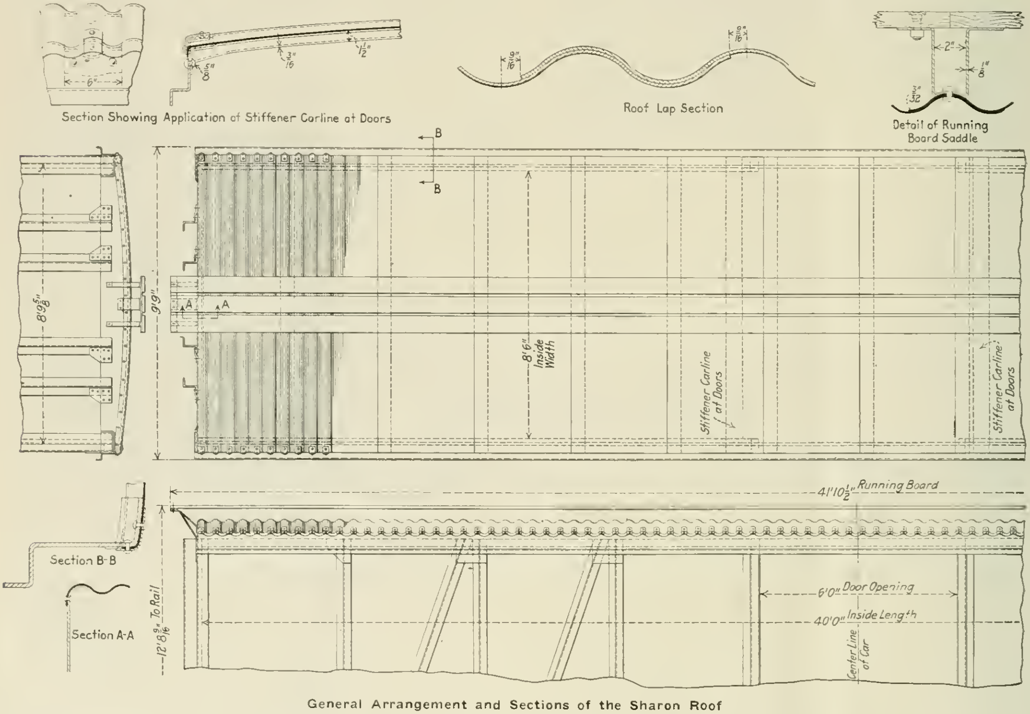
Sharon Pressed Steel Roof as Applied to the Car

width of the car. The sheets are of 14 gage steel, black or galvanized, and 20 to 40 in. wide, the length being made to suit the distance over the eaves. Each sheet has corrugations 1¼ in. deep and 5 in. between centers, extending transversely across the car. These corrugations act as stiffeners and give sufficient strength to support the roof without the use of ridge poles, carlines or purlines, so these parts are omitted except for one carline at each side of the door opening to stiffen the car frame.

The pressed steel sheets are laid with an overlap of one corrugation at each end. They are attached at the sides of the car to a pressed side plate, being riveted with short angle clips outside the sheet, as shown in the drawing. The side plate is of 3/16 in. or ¼ in. material and is made continuous from end to end of the car. The design can be adapted to any type of car construction. A side plate of this type is approximately four times as strong as the 5/16 in. by 4 in. by 4 in. angle commonly used for this part, and is also lighter by about 120 lb. per car. The special end fascia used with the roof is of one piece, pressed to engage the end roof sheet, and riveted to the side plates. The running board is supported by light pressed steel saddles.

The roof complete weighs about 70 lb. per foot of car length. Each 40 in. sheet of 14 gage steel when securely fastened at the side plate will carry the following loads concentrated at the center or eaves: For cars 9 ft. wide, 940 lb.; for cars 9 ft. 6 in. wide, 890 lb., and for cars 10 ft. wide, 845 lb. The tensile strength to resist spreading at the sides is 40,000 lb. per sheet. The roof has sufficient play to take care of weaving of the car frame due to uneven track or unbalanced loading. The surface provides a firm foothold in case it is necessary for trainmen to walk at the side of the roof. The overlapping sheets make a watertight construction. No leakage was found even when the roof was tested with a heavy stream from a hose. In case a sheet needs to be replaced, it is only necessary to remove the rivets along each side, cut four rivets in the overlapping sheet and four in the clips.

For new cars this roof can be assembled at the manufacturer's plant and shipped as one piece ready for application to the car frame. When used for repairs the roof is applied in sections and, if desired, can be furnished with sheets of 22 gage steel put over the existing carlines and purlines.



General Arrangement and Sections of the Sharon Roof

GENERAL NEWS

Samuel Gompers, president of the American Federation of Labor, was re-elected without opposition at the recent convention in Cincinnati, Ohio. It was his forty-first election to that office. Portland, Oregon, was chosen as the place for the next convention, which will be held in October, 1923.

Citizens of Palestine, Tex., are agitated over the expected removal of the International & Great Northern's shops from that city, and several heated conferences have been held between citizens and officers of the city, the citizens being determined to contest the contemplated removal. In behalf of bondholders a suit has been filed in the federal district court against the city of Palestine and the citizens, to enjoin them from interfering with the road's removal plans.

Swiss Turbine Locomotive Tests

A few days ago the line from Zurich to Sargans was the scene of tests made by the Swiss Federal Railways of a turbine locomotive manufactured by the firm of Escher, Wyss & Co., Zurich. The results with regard to water and coal consumption are reported as being good.

Tool Foremen's Convention

The convention of the American Railway Tool Foremen's Association will be held at the Hotel Sherman, Chicago, September 5-8, at the same time that the International Railway General Foremen's Association meets. The Supply Association of the American Railway Tool Foremen's Association is arranging to hold a convention and exhibit in connection with this joint meeting.

Argentina Buys German Locomotives

The Argentine State Railways have ordered 50 locomotives from Germany, according to the Wall Street Journal. The Argentine Port Zones Authority has, according to the same publication, opened bids for 130 cars and 10 locomotives. Ninety concerns in the United States, England, Germany and Belgium bid on this business and, since the American bids were the lowest, it is thought that the contracts will come to this country.

Railroad Not Liable as Garnishee for Wages Earned During Federal Control

A railroad company is not liable for wages earned by an employee, while he was employed by the Federal Railroad Administration in operating the company's properties, and such a railroad company cannot be required to respond as garnishee of funds from which such earnings are alleged to be due.—Heuermann v. Huermann (Missouri Pacific, Garnishee) (Mo. App.), 237 S. W. 893.

Supplement No. 2 to the 1921 Rules of Interchange

A supplement to the 1921 Rules of Interchange has been prepared by the Arbitration Committee and the Committee on Prices for Labor and Materials. This supplement, in addition to interpretations of existing rules by the Arbitration Committee, announces the extensions of the effective dates of certain rules which are to become effective during the year 1922; also labor allowances for R. & R. or R. of Transom Draft Gear and Parts, recommended by the Committee on Princes for Labor and Materials.

Minnesota Car Repair Shed Law Declared Invalid

A statute passed by the Minnesota legislature requiring railroads and other concerns who build or repair cars and car trucks to provide shelters for the protection of workmen from inclement weather, was declared null and void in a decision rendered by Federal Judge W. F. Booth at Winona, Minn., on May 15. The decision grants the Chicago & North Western a permanent injunction restraining the Minnesota Railroad & Warehouse Commission and the attorney general of the state from enforcing the statute in question.

Motor Omnibuses on English Railways

The North Eastern Railway is at present conducting experiments with motor omnibuses as a means of improving the services on certain branch lines on which circumstances do not permit an extension of traveling facilities of the usual kind. The omnibuses are of the ordinary road type and are fitted with flanged wheels. As a trial the first omnibus is being run on the line between York and Strensall. If the experiments are satisfactory, it is probable that the railway company will construct special omnibus vehicles for the purpose.

National Safety Council

The eleventh annual Safety Congress of the National Safety Council will be held at Detroit, August 28 to September 1. The meetings will be held in the new Case Technical High School which has just been completed and contains an auditorium which will accommodate more than 3,000 persons. In connection with the convention a large safety exhibit will be held in the hall adjoining the main auditorium.

The Steam Railroad Section of which Isaiah Hale, safety superintendent, Atchison, Topeka & Santa Fe, is chairman, will hold its sessions on August 29 and August 30 at which a number of interesting papers will be presented.

Death of Noted British Mechanical Officer

Norman J. Lockyer, locomotive works manager of the North Eastern Railway at Darlington, England, and one of Britain's best known railway mechanical men, died recently. Mr. Lockyer commenced his apprenticeship with Sir J. Whitworth & Co., Ltd., of Manchester, England, in 1877. Subsequently he served in the works of the Manchester, Sheffield & Lincolnshire Railway at Gorton until 1882, when he was employed by the running department. In 1885 he joined the staff of Sir A. M. Rendel, being employed in superintending the manufacture of locomotives for the Indian State and other railways. In 1896 he was appointed manager of the works of Sharp, Stewart & Co., Ltd., of Glasgow, the locomotive builders, and in 1899 he became works manager of the Gateshead Locomotive works of the North Eastern Railway. He was transferred to the Darlington works in 1909. He was the inventor of a number of devices for use on locomotives and in railway shops, one of the best known of his locomotive invention being called the "Lockyer" double-beat regulator valve.

Pennsylvania Women's Aid

The Women's Aid of the Pennsylvania Railroad System is conducting a campaign to increase its membership among the families of the 17,000 employees in the Northwestern Region. The Women's Aid aims to organize the women of the families connected with the Pennsylvania System in order that they may know one another and, when occasion arises, render aid and sympathy in such manner as may be most helpful. It has now more than 50,000 members. The wives, mothers, sisters and daughters of Pennsylvania employees and all women employees are eligible for membership. The dues are uniformly 25 cents a year. The badge is a small pin inscribed "P. S. Women's Aid." Mrs. W. W. Atterbury is director of the Aid for the System, and Mrs. J. G. Rodgers is associate director for the Northwestern Region. The six operating divisions in the Northwestern Region have been organized under the following superintendents: Chicago Terminal, Mrs. W. H. Scriven; Fort Wayne, Mrs. T. A. Roberts; Logansport, Mrs. B. H. Hudson; Toledo, Mrs. J. B. Hutchinson, Jr.; Grand Rapids, Miss Hilda Jones; Mackinaw, Mrs. R. E. Casey.

Adjustment of Brake Power on Tank Cars

Request has been received from a majority of the owners and operators of tank cars for an extension of the effective date for complying with the provisions of Circular S. III-11 of the Mechanical Division of the A. R. A., issued May 15, 1919, and the Tank Car Specifications for the Adjustment of Brake Power on Existing Cars. It is stated that this request is due to the general business conditions prevailing for some time and also to the fact that so many of the cars were scattered throughout the country, many of them having been stored on railroad sidings, making it difficult, if not impracticable, for the owners to complete the work in the time limit was set, which was July 1, 1921.

This request has been granted by the General Committee and the effective date for complying with the requirement of the Tank Car Specifications in the matter of Adjustment of Brake Power on existing tank cars is extended to July 1, 1923.

Fuel Savings on the Pere Marquette

A letter by Frank H. Alfred, president and general manager of the Pere Marquette, addressed to all employees who have to do with the handling and consumption of fuel, calls attention to the excellent fuel performance obtained on that road during the month of April. Passenger, freight and switching records for that month show an improvement over March, 1922, and also a better showing than in the same month of 1921. The fuel performance in these periods was as follows:

	April, 1922	March, 1922	April, 1921
Passenger service			
Average car miles per ton of coal.....	117.30	109.00	111.10
Freight service			
Pounds of coal per 1,000 gross ton miles	144.00	148.87	187.64
Switching service			
Average miles per ton...............	14.19	13.47	14.21

The increase in the average car miles per ton for April, 1922, over March, 1922, is 7.61 per cent, and over April of last year, 5.58 per cent. In freight service the record shows a 3.29 per cent better performance in April than in March of this year and a 23.26 per cent better showing than for April of last year, this being in part due to the better quality of coal used.

Labor Board Decisions

PAY OF FOREMEN WHILE GANG IS LAID OFF.—A case arose on the Buffalo, Rochester & Pittsburgh in connection with an extra gang that was laid off one day each week, the foreman contending that he was exempt from deductions from his monthly pay on this account. The decision of the board is that if the foreman is compensated on a monthly basis for all service rendered, including time worked in excess of the regular working hours or days assigned, he should receive not less than the monthly rate so established, provided he was ready and available. If on the other hand the foreman is compensated on the monthly basis but is paid overtime for work performed after eight hours and for all work performed on Sundays and holidays, no valid claim can be made for time lost under the provisions of Section 8, Article V, of the agreement.—*Decision No. 896.*

SHEET METAL WORKERS IN M. W. DEPARTMENT INCLUDED IN SHOP CRAFTS.—The Federated Shop Crafts brought before the Labor Board the cases of two employees in the maintenance of way department of the Northern Pacific who were working under the master carpenter, contending that these men should be classified as sheet metal workers and should be represented by the Federated Shop Crafts. Both men were rated as bridge carpenters, one doing tinner's work and the other pipe work in connection with water service. The road contended that these employees performed other mechanic's work as it was assigned to them from day to day. The Labor Board ruled that these men are sheet metal workers in the sense in which this term is commonly understood, and that they come properly under the jurisdiction of the Railway Employees' Department of the Federated Shop Crafts. Dissenting opinions were filed by J. H. Elliott and Horace Baker. In the dissenting opinions it is pointed out that these men have been employed in the bridge and building department for several years. The fact was also emphasized that the character of the work there and of that done in the locomotive department are entirely different and that the line of demarcation between employment in these departments has long been kept distinct. In their opinion the ruling of the Labor Board will create confusion between the work of the two departments.—*Decision 946 and 947.*

General Foremen's Convention

The International Railway General Foreman's Association has issued the following announcement of its 1922 meeting:

"The General Foreman's convention, scheduled at Chicago for September 5, 6, 7 and 8, 1922, affords an opportunity for a period of intensive instruction that no general foreman or his superior officer can consistently disregard.

"Held annually at a nearly central point in the United States and at a time of the year that is the most favorable for the average railway shop supervisor to absent himself from his duties, the attendance will comprise a class of energetic, earnest workers who will put vim into their meetings and return to their tasks broadened and advanced in their ideas.

"Insofar as the foreman has been the subject for a great many printed articles showing his acts to be commendable or otherwise, as the spirit of the writer impelled his ideas, it brings out this thought: Is the foreman to blame for his lack of knowledge or his apparent inability to keep step with the rapid progress of the railway mechanical department? If due consideration is given to the fact that four years of constant training is necessary to produce a passable mechanic, we would say that the foreman who rarely sees any shop except the one in which he is employed and meets no mechanical men other than his daily associates, is not to be censured but rather to be praised for what he does accomplish, and that the time spent at an annual convention or meeting yields large returns.

"Numerous men holding responsible positions today attribute their success and value to their employer largely to the broadening influence gained by attendance at business sessions. Each railway general foreman as a matter of benefit to the stockholders by whom he is employed, his superior officers, and himself should not only be permitted but required to attend the convention of the International Railway General Foreman's Association."

Meetings and Conventions

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

AIR-BRAKE ASSOCIATION.—F. M. Nellis, Room 3014, 165 Broadway, New York City. 1923 annual convention; Denver, first Tuesday in May.

AMERICAN RAILROAD MASTER TINNERS', COPPERSMITHS' AND PIPEFITTERS' ASSOCIATION.—C. Borcherdt, 202 North Hamlin Ave., Chicago.

AMERICAN RAILWAY ASSOCIATION, DIVISION V—MECHANICAL.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

DIVISION V—EQUIPMENT PAINTING DIVISION.—V. R. Hawthorne, Chicago.

DIVISION V.—PURCHASE AND STORES.—J. P. Murphy, N. Y. C., Collinwood, Ohio.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—R. D. Fletcher, 1145 E. Marquette Road, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, A. F. Stuebing, 2201 Woolworth Building, New York.

AMERICAN SOCIETY FOR TESTING MATERIALS.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY FOR STEEL TREATING.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention and exposition postponed until October 2-7, 1922, Detroit, Mich.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

CANADIAN RAILWAY CLUB.—W. A. Booth, 53 Rushbrook St., Montreal, Que. Regular meeting second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Meeting second Monday in month, except June, July and August, New Morrison Hotel, Chicago, Ill.

CAR FOREMEN'S ASSOCIATION OF ST. LOUIS.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo.

CENTRAL RAILWAY CLUB.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Meeting second Thursday in January, March, May, September and November, Hotel Iroquois, Buffalo, N. Y.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill. Annual convention August 22-24, Chicago.

CINCINNATI RAILWAY CLUB.—W. C. Cooder, Union Central building, Cincinnati, Ohio. Regular meetings second Tuesday, February, May, September and November.

DIXIE AIR BRAKE CLUB.—E. F. O'Connor, 10 West Grace St., Richmond, Va.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich. Convention Hotel Sherman, Chicago, August 15, 16 and 17.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 W. Wabasha Ave., Winona, Minn. Annual convention September 5-8, 1922.

MASTER BOILERMAKERS' ASSOCIATION.—Harry D. Vought, 26 Cortlandt St., New York, N. Y.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Regular meetings second Tuesday each month except June, July, August and September, Copley Plaza Hotel.
New York Railroad Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Regular meetings third Friday of each month, except June, July and August, at 29 West Thirty-ninth street, New York.
Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.
Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Regular meetings second Thursday of each month in San Francisco and Oakland, Cal., alternate.
Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Regular meetings fourth Thursday in each month, except June, July and August, at Fort Pitt Hotel, Pittsburgh, Pa.
St Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo. Regular meetings second Friday each month, except June, July and August.
Traveling Engineers' Association.—W. O. Thompson, 1177 East Ninety-eighth street, Cleveland, Ohio.
Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Regular meetings third Monday of each month, except June, July and August.

Locomotive Orders

The New York Central has ordered 100 locomotive boosters from the Franklin Railway Supply Company.

The Southern Pacific has ordered 55 locomotive boosters from the Franklin Railway Supply Company.

The New York, Chicago & St. Louis has ordered 14 locomotives from the Lima Locomotive Works.

The Southern Railway has ordered 15 Mikado type locomotives from the American Locomotive Company.

Freight Car Orders

The Pere Marquette has ordered 500 box cars from the Pressed Steel Car Company.

The Baltimore & Ohio has ordered 1,000 box car bodies from the Standard Steel Car Company.

The New York, Chicago & St. Louis has ordered 400 refrigerator cars from the Merchants' Despatch.

The Tennessee Central has ordered 350 gondola cars from the Western Steel Car & Foundry Company.

The Grand Trunk has ordered 250 refrigerator cars from the National Steel Car Corporation, Hamilton, Ont.

The Belt Railway of Chicago has ordered 100 hopper cars from the Western Steel Car & Foundry Company.

The Missouri, Kansas & Texas has ordered 200 refrigerator cars from the American Car & Foundry Company.

The Chile Exploration Company, New York City, has ordered 50 steel ore cars from the Pressed Steel Car Company.

The Florida East Coast has ordered 175 refrigerator cars from the Mount Vernon Car Manufacturing Company.

The Fort Smith & Western has ordered 125 steel center constructions from the Western Steel Car & Foundry Company.

The Atlantic Coast Line has ordered 700 box cars of 40 tons' capacity from the Standard Tank Car Company, Sharon, Pa.

The New York Central has ordered about 975, 55-ton all steel hopper car bodies from the American Car & Foundry Company.

The Florida East Coast has ordered 30 tank cars of 10,000 gal. capacity from the General American Tank Car Corporation.

The Buffalo & Susquehanna has ordered 200 hopper car bodies of 55 tons' capacity from the Standard Steel Car Company.

The New York, Chicago & St. Louis has ordered 1,000 automobile box cars from the Illinois Car & Manufacturing Company.

The New York, Chicago & St. Louis has ordered 100 steel center constructions from the Illinois Car & Manufacturing Company.

The Chesapeake & Ohio has ordered 500 ventilated box cars of 40 tons' capacity, from the Newport News Shipbuilding & Dry Dock Company.

The Missouri, Kansas & Texas has placed an order with the General American Car Company for 200 refrigerator cars of 40 tons' capacity.

The Union Refrigerator Transit Company, Milwaukee, Wis., has ordered 350 refrigerator cars from the American Car & Foundry Company.

The Roxana Petroleum Corporation, St. Louis, Mo., has ordered 25 insulated tank cars of 40 tons' capacity from the General American Tank Car Corporation. The cars will hold 8,000 gal.

The Chesapeake & Ohio has arranged for the purchase of 300, 40-ton box cars in addition to the 1,400 already ordered as noted in the May issue of the Railway Mechanical Engineer.

The Seaboard Air Line has ordered 900 steel underframe ventilated box cars of 40 tons' capacity from the Pressed Steel Car Company and 100 phosphate cars of 50 tons' capacity from the Magor Car Corporation.

The Northern Pacific has ordered 250 ballast cars from the Roger Ballast Car Company. The company has also placed an order for 1,000 automobile box cars and 250 stock cars with the General American Car Company.

The Atchison, Topeka & Santa Fe has ordered 2,000 steel-underframe, double-sheathed box cars of 40 tons' capacity, as follows: From the Pullman Company, 1,000 cars; from the American Car & Foundry Company, 500 cars; and from the Standard Steel Car Company, 500 cars.

The Wabash has ordered 2050 composite gondola car bodies of 50 tons' capacity from the General American Car Company, and 750 steel underframe automobile cars, 40 ft. in length and 40 tons' capacity, from the American Car & Foundry Company and 750 from the Pullman Company.

The Baltimore & Ohio has ordered 1,000, 70-ton low-side gondola cars from the Cambria Steel Company, and will have repairs made to 1,000 gondola cars and 1,000 hopper cars at the shops of the Pressed Steel Car Company; also to 1,000 coke cars at the shops of the Standard Steel Car Company.

The New York Central has ordered 1,106 self clearing hopper cars of 55 tons' capacity from the American Car & Foundry Company, 18 low side gondolo cars of 70 tons' capacity from the Standard Steel Car Company and 49 high side gondola cars of 50 tons' capacity from the Buffalo Steel Car Company.

Freight Car Repairs

The Baltimore & Ohio is having repairs made to 25 refrigerator cars at the shops of the Standard Steel Car Company and to 25 at the shops of the American Car & Foundry Company, and 25 coke cars at the shops of the Koppel Car Repair Company.

The Erie has awarded contracts for the repair of the following cars: 1,000 box and 100 refrigerator cars to the Standard Steel Car Company; 1,500 to the Illinois Car Company; 1,000 to the Buffalo Steel Car Company; 1,000 to the Youngstown Steel Car Company, and 500 to the Western Steel Car & Foundry Company.

The Illinois Central has contracted with the Streator Car Company for repairs to 1,300 automobile box cars; with the Interstate Car Company for 500 box cars; with the Illinois Car Company for 300 steel general service cars; with the Ryan Car Company for 600 steel general service cars, and with the Pullman Company for 800 box cars. The company will also repair 500 cars in its Burnside shops.

Passenger Car Orders

The Missouri, Kansas & Texas has ordered 30 steel passenger coaches from the American Car & Foundry Company.

St. Louis-San Francisco has ordered 6 steel chair cars and 8 steel coaches from the American Car & Foundry Company.

The Atlantic Coast Line has ordered 20 express cars and 10 coaches from the Bethlehem Shipbuilding Corporation, Harlan Plant.

Machinery and Tools

The Long Island is inquiring for 2 axle lathes, a wheel press and some other machines.

The Detroit United Railway has ordered a 36-in. lathe from the Niles-Bement-Pond Company.

The Boston & Albany is inquiring for a 90-inch wheel lathe, also for a box facing and boring machine.

The Wheeling & Lake Erie has ordered one 48-in. car wheel borer from the Niles-Bement-Pond Company.

The Southern Pacific has ordered a 15-ton crane with 75 ft. span from the Niles-Bement-Pond Company.

The Southern Pacific has ordered a 200-ton overhead traveling crane from the Niles-Bement-Pond Company.

The Delaware & Hudson has ordered a 42-in. center drive car wheel lathe from the Niles-Bement-Pond Company.

The War Department is offering for sale a large list of commodities, including machine tools, shop equipment and supplies.

THE CAMBRIA & INDIANA has ordered a 79-in. driving wheel lathe and a thirty-six-inch planer from the Niles-Bement-Pond Company.

THE SOUTHERN PACIFIC has ordered a 200-ton locomotive lifting crane of 77 ft. span, and a 15-ton overhead crane of 75 ft. span, from the Niles-Bement-Pond Company.

THE UNION PACIFIC has prepared a machine inquiry list consisting of 73 items which are as follows: 22 lathes of various types, 15 grinders of various types, 4 boring bars, 4 drills, 3 boring mills, 2 drill presses, 2 shapers, 2 forcing presses, 2 pneumatic flanging machines, 1 boring and turning machine, 1 disk sander, 1 flange clamp, 1 punch and shear, 1 riveting machine, 1 hammer, 1 boring machine, 1 centering machine, 1 slip roll forming machine, 1 pipe folder, 1 pneumatic flanging clamp, 1 pipe cutting and threading machine and 1 cutting off machine.

THE CHICAGO, BURLINGTON & QUINCY has issued a new machinery inquiry for its Denver shops covering 117 items which include 31 lathes of various types, 19 grinders of various types, 12 drills, 6 hammers, 5 presses, 5 crank shapers, 5 boring mills, 4 grindstones, 3 planers, 2 slotters, 2 turret screw machines, 2 bar iron shears, 2 combination punch and shears, 2 milling machines, 2 head bolt cutters, 2 pipe threading machines, 1 single end punch, 1 bolt centering machine, 1 bending roll, 1 pneumatic flanging machine, 1 pneumatic flanging clamp, 1 sheet metal cutter, 1 drill press, 1 forging machine, 1 staybolt and crownstay machine, 1 pipe bending machine and 1 horizontal boring machine.

Shop Construction

ERIE.—This company has awarded a contract for an extension to its shops at Hornell, N. Y., to the Bates & Rogers Construction Company.

WABASH.—This company has awarded a contract to C. W. Gindle, Chicago, for the construction of a reclamation plant at Decatur, Illinois.

CHICAGO & NORTH WESTERN.—This company has awarded a contract to C. W. Gindle, Chicago, for the rebuilding in the near future of its 12-stall engine house at Ashland, Wis.

WESTERN MARYLAND.—This company has awarded a contract to the M. A. Long Company, Baltimore, for the erection of a 100 ft. by 300 ft. Mallet locomotive repair shop at Port Covington, Baltimore. The shop will be fully equipped with cranes and other machinery.

ATCHISON, TOPEKA & SANTA FE.—This company has authorized the construction of a new boiler and tank shop at Albuquerque, N. M., to cost approximately $400,000; also the construction of boiler washing plants at Amarillo, Texas, and Winoka.

KANSAS CITY SOUTHERN.—This company is now preparing plans for and expects to undertake in the near future with its own forces, improvements to its shop at Pittsburg, Kan., which will consist principally of erecting 160-ft. and 110-ft. extensions to the present structure to provide facilities respectively for additional erecting space and for a blacksmith shop, and a 64-ft. extension to the present transfer table. The building will have a concrete foundation, brick walls with wire glass in metal sash, and composition roofing supported on steel trusses. Each of the six bays in the extensions to the erecting shop will be provided with engine pits to be served by a 10-ton and a 250-ton traveling crane. The work will cost approximately $200,000.

Bad Order Cars

The Car Service Division of the American Railway Association reported 327,704 bad order cars, or 14½ per cent, for the two weeks ending May 1. On June 1 the percentage of bad-order cars was 15 as compared with 14.7 on May 15.

Freight Car Loading

According to the reports of the Car Service Division of the American Railway Association, freight car loading during the week ended May 13 continued to increase. The total, 777,359 cars was 26,173 more than the loading for the corresponding week of 1921 and an increase of 23,000 as compared with the week before.

For the weeks ended May 20, 27 and June 10, the totals were 792,459, 821,121 and 846,002 cars. For the corresponding weeks of last year 770,991, 795,335 and 787,283 loaded cars were reported.

PERSONAL MENTION

GENERAL

S. B. RILEY has been appointed superintendent of motive power of the Western Maryland with headquarters at Hagerstown, Md., succeeding G. F. Wieseckel, resigned.

J. P. ROQUEMORE, acting superintendent of motive power of the International & Great Northern since May 9, and prior to that mechanical engineer of the same company, has been appointed superintendent of motive power. L. E. Temple has been appointed mechanical engineer.

PURCHASING AND STORES

B. W. GRIFFITH has been appointed general storekeeper of the Michigan Central with headquarters at Detroit, Mich., succeeding G. T. Dunn, resigned.

A. H. LARET has been appointed assistant to the vice-president and chief purchasing officer of the St. Louis-San Francisco with headquarters at St. Louis, Mo.

G. H. PINION has been appointed purchasing agent of the Trans-Mississippi Terminal with headquarters at Dallas, Texas, succeeding L. M. Sullivan, deceased.

C. R. PAINTER has been appointed assistant to the general purchasing agent of the New York, New Haven & Hartford with headquarters at New Haven, Conn., succeeding B. L. Northam, resigned.

R. J. AUL, storekeeper of the Indiana Harbor Belt, with headquarters at Gibson, Ind., has been appointed to serve also as storekeeper of the Chicago River & Indiana and the Chicago Junction.

J. E. BOLLINGER, secretary to the manager of purchases of the American Short Line Railroad Association, has been appointed assistant to the manager of purchases with headquarters at Washington, D. C.

W. MCMASTER, purchasing agent of the Indiana Harbor Belt, with headquarters at Chicago, has been appointed purchasing agent also of the Chicago River & Indiana and the Chicago Junction, with headquarters at Chicago, in which capacity he succeeds S. Salter, heretofore purchasing agent of the Chicago Junction.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

N. C. FERGUSON has resumed duty as road foreman of engines of the Dauphin Division of the Canadian National, with headquarters at Dauphin, Man., succeeding P. Henze.

G. L. FLINT has been appointed road foreman of engines of the Portland division of the Southern Pacific, with headquarters at Portland, Ore., succeeding E. Stroud, promoted.

P. HENZE has been appointed acting road foreman of engines of the Canadian National, with headquarters at Prince Albert, Sask., succeeding J. G. Norquay who has been granted a leave of absence.

F. C. SIMPSON, master mechanic of the Southern with headquarters at Bristol, Va., has been transferred in a similar capacity to Knoxville, Tenn. M. D. Stewart succeeds Mr. Simpson at Bristol.

M. L. ZYDER, roundhouse foreman of the Indiana Harbor Belt, has been promoted to assistant master mechanic at Gibson, to succeed A. B. Fromm, promoted to master mechanic to succeed C. B. Nelson.

What is described as probably the thickest seam of black coal discovered in any part of the world is being developed at Blair Athol, in Queensland. The maximum thickness, as far as can be ascertained, is 93 ft. The amount of coal in the field is estimated at 258,000,000 tons.

OBITUARY

I. B. Lesh, general superintendent of the Railway Materials Company, Chicago, with headquarters at Toledo, Ohio, died in that city on May 22.

William C. Arp, retired superintendent of motive power of the Vandalia, died at his home in Terre Haute, Ind., on June 16 at the age of 74 years after having been engaged in railway service for 48 years.

Edward A. Williams, at one time general mechanical superintendent of the Erie, died at his home in Glen Ridge, N. J., on April 29. Mr. Williams was born at Wiscasset, Me., on October 4, 1848. He attended public school at Milwaukee, Wis., and learned the machinist trade in the Milwaukee shops of the Chicago, Milwaukee & St. Paul. From 1877 to 1880 he was roundhouse foreman for this road at Prairie du Chien, Wis., and thereafter, until 1886, general foreman at Wells, Minn. From 1886 to 1890 he was assistant general master mechanic at Milwaukee. Then, until 1893, he was master mechanic of the Minneapolis, St. Paul & Sault Ste. Marie with headquarters at Minneapolis. He was then promoted to mechanical superintendent, which position he left in 1901 to become superintendent of rolling stock of the Canadian Pacific with headquarters at Montreal. In 1904 and 1905 he was assistant general manager of the Erie and in November, 1905, became general mechanical superintendent, in which position he served until the time of his retirement in 1907.

E. A. Williams

E. F. Needham, formerly superintendent of motive power of the Wabash, died on May 18 in Boston, Mass. Mr. Needham was born at Batavia, Ohio, on December 25, 1864, and entered railway service in 1880 as a repair track laborer on the Wabash at Butler, Ind. Shortly thereafter he became a boilermaker apprentice at the Fort Wayne, Ind., shops, and at the conclusion of his apprenticeship in 1894, was promoted to foreman of the boiler shops at Fort Wayne. He was transferred to Springfield, Ill., as boiler foreman in January, 1899, was advanced to assistant master mechanic with headquarters at Decatur, Ill., on December, 1901, and held this position at Decatur and, after April, 1902, at Ashley, Ind., until October, 1902, when he was promoted to master mechanic with headquarters at Fort Wayne, Ind., having supervision over the Detroit, Peru and Buffalo divisions. He was transferred to Springfield, Ill., as master mechanic in charge of the Decatur and Springfield divisions in March, 1906, and on September 1, 1907, became superintendent of motive power, a position he held until June 1, 1920, when he resigned on account of ill health.

E. F. Needham

Work is progressing on the extension of the Canadian Pacific line from Kipawa to Les Quinze, at the further end of Lake Temiskaming, 800 men being employed. The line penetrates a fine agricultural area.

SUPPLY TRADE NOTES

A. L. Pearson, secretary of Mudge & Co., Chicago, has been appointed assistant to the president in addition to his secretarial duties.

J. D. Rogers, who has been representing the Baldwin Locomotive Works in South Africa, has been appointed manager of the company's office at Calcutta, Ind.

F. S. Wilcoxen, formerly system fuel supervisor of the Chicago Great Western, has joined the service department of the Edna Brass Mfg. Company, Cincinnati, Ohio.

G. H. Kilborn has been appointed road foreman of engines of the Portland division of the Southern Pacific, with headquarters at Roseburg, Ore., succeeding G. L. Flint.

The Austin Company, Cleveland, Ohio, has been given a contract to put up a one-story building, 120 ft. by 400 ft., at Hammond, Ind., for the Standard Steel Car Company.

N. R. Seidle has resigned as assistant general manager of the Charles G. Heggie Company, Joliet, Ill., to become works manager of the General Boilers Company, Waukegan, Ill.

Newcomb Carlton, president of the Western Union Telegraph Company, has been elected a director of the United States Rubber Company, New York, to succeed Col. Samuel P. Colt, deceased.

A. D. Halpern, who has been associated with the Philadelphia sales staff of the Combustion Engineering Corporation, New York, for some time, has now become a member of its New York sales force.

Harry B. Snyder, who recently returned from the foreign branch service of the Baldwin Locomotive Works, has been appointed assistant to the president of the Pilliod Company, 30 Church street, New York City.

The Carborundum Company, Niagara Falls, N. Y., has appointed the American Abrasive Metals Company, 50 Church street, New York, to act as United States sales representative for the Carborundum anti-slip tile.

J. W. McCabe has been appointed manager of the St. Louis branch of the Chicago Pneumatic Tool Company. Mr. McCabe has been connected with that company for 20 years and has recently returned from a three years' business trip around the world.

The National Bronze & Aluminum Foundry Company, Cleveland, Ohio, is building an addition of 150 ft. to its new plant at East Eighty-eighth street and Laisy avenue, and is in the market for a few molding machines and some miscellaneous foundry equipment.

Charles M. Schwab, chairman of the board of directors of the Bethlehem Steel Corporation, has been elected chairman of the board, also of the Chicago Pneumatic Tool Company, New York, to succeed John R. McGinley, who resigned as chairman but who remains as a director of the company.

The Black & Decker Manufacturing Company, Baltimore, Md., has established a new Detroit office in the General Motors building in that city. C. G. Odell, assistant to the president of this company, will make this office his headquarters, in addition to which it will provide headquarters for the local Detroit representative.

The Fibre Conduit Company, Orangeburg, N. Y., has acquired the plant of the American Fibre Conduit Corporation, at Fulton, N. Y., and the conduit manufacturing business of the Johns-Mansville, Incorporated, at Lockport, N. Y., and has appointed Johns-Mansville, Incorporated, New York, as sales agent for its products.

Frank Phalen, manager of sales of the New York district for the Republic Iron & Steel Co., for the past 15 years, has resigned to associate himself with his brother Charles G. Phalen in the firm of Phalen & Co., 342 Madison avenue, New York City. This firm handles railway equipment and specialties, also iron and steel products.

The United Alloy Steel Corporation, Canton, Ohio, recently bought the Canton Sheet Steel plant. The plant will have a capacity of around 60,000 tons of ingots a month. This company's products now include common and alloy steel, blooms, slabs, billets, plates, bars, rods, sheets and anti-corrosive Toncan iron.

O. H. Dallman, formerly with the Vanadium Alloy Steel Company, Latrobe, Pa., and the mechanical department of the Pennsylvania Railroad at its Fifty-fifth street shops, Chicago, has joined the sales force of the Independent Pneumatic Tool Company, Chicago.

Joseph H. Perry, Jr., has been appointed Philadelphia representative of the Edgewater Steel Company, Pittsburgh, Pa. Mr. Perry will have his office in the Finance building. He was for a number of years with the engineering department of the Pennsylvania Railroad at Pittsburgh. M. Roy Jackson, who was formerly vice-president in charge of the Philadelphia office, has resigned.

A. R. Ludlow, vice-president in charge of sales of the Air Reduction Company, Incorporated, New York, has been elected first vice-president; M. W. Randall, secretary, has been elected vice-president and secretary; Herman Van Fleet, chief engineer, has been elected vice-president and operating manager and Dr. F. J. Metzger has been elected vice-president in charge of research and development.

The E. H. Welker Company, Inc., 222 W. Larned street, Detroit, Mich., will in the future represent the George Oldham & Son Company, Baltimore, Md., in the state of Michigan and the city of Toledo, Ohio, and J. A. Meredith will represent this company in the Pittsburgh district with office at 2138 Oliver building. Both the Detroit and Pittsburgh offices will be factory branches and will carry in stock a complete line of the company's pneumatic equipment.

Wesley W. Burden, formerly with the Bird-Archer Company as chief mechanical engineer and assistant to the president, has resigned to become vice-president and treasurer of the Wilbur G. Hudson Corporation, engineers and constructors, with offices at 50 Church street, New York. This company specializes in coal, coke, ash, and ore handling systems, steel, timber and reinforced concrete structures, railroad shops, roundhouses, terminals, and railroad coaling stations.

Ralph Templeton, for several years manager of the Whitman & Barnes Manufacturing Company's New York office and store, has assumed an important position in the company's executive offices in Akron, Ohio. Mr. Templeton entered the employ of the Whitman & Barnes organization in 1898 and has served it in various capacities continuously since that time. He was at first in the Akron office, then Detroit representative, and since 1910 manager of its New York store.

J. M. Kryl, president of the Kryl Bridge & Crane Works, Chicago, and W. H. Eichelman, until recently chief engineer of the Hamler Boiler & Tank Company, Chicago, have formed a partnership under the name of Kryl & Eichelman at 2906 West Twenty-sixth street, Chicago. Both men are graduate engineers of considerable experience in fabricating steel plate and structural iron with present facilities for handling water tanks, oil tanks, stacks, process kettles of all kinds for chemical equipment, ornamental iron and structural steel.

Harry M. Wey has been appointed manager of the Chicago district for the Pittsburgh Testing Laboratory, Pittsburgh, Pa. Mr. Wey's office is at 1560 Monadnock block. He entered the service of the Pennsylvania Railroad in 1900 in the office of the superintendent of motive power at Columbus, Ohio. Later he served in the motive power departments of the Illinois Central and the Atchison, Topeka & Santa Fe. He was again employed in the mechanical department of the Pennsylvania, Lines west of Pittsburgh, from 1905 until 1909 when he entered the sales department of the U. S. Metallic Packing Company.

C. E. Meyer has been placed in charge of railway sales of the railroad department recently organized by the Parish & Bingham Corporation, Cleveland, Ohio. This new department has been formed for the purpose of manufacturing pressed steel car parts and other railway specialties. P. O. Krehbiel, a former engineer of the same corporation, has been appointed chief engineer of the railroad department. Mr. Meyer started in the railway supply business in 1911 with the National Malleable Castings Company at Cleveland. He left the employ of that company in February, 1913, to enter the stores department of the Damascus Brake Beam Company, Cleveland. With the exception of eighteen months in the military service in this country and in France, he has been in the continuous service of the latter company in its purchasing, operating and sales departments until his recent appointment as above noted.

The Pittsburgh Testing Laboratory, Pittsburgh, Pa., has opened a sales office with a complete inspection bureau, at 1864 Railway Exchange building, St. Louis, Mo., and has appointed Colonel N. C. Hoyles as district manager. He is a graduate of Queens University, and took a post-graduate course at the University of Toronto. In 1908 he entered the service of this company as an inspector at its Birmingham office and in 1912 was promoted to manager of that office. Two years later he was transferred to the Vancouver office; and at the breaking out of the war, he entered the service of the Canadian Army, serving with the British Pioneer Engineers Corps in France. He received decorations from both the French and British governments, and upon his release from the Army in 1919, he was appointed assistant sales manager at Cleveland. Since that time he has been consecutively assistant sales manager at New York and manager at Cincinnati, until his appointment to the new position above mentioned.

At a meeting of the board of directors of the Joliet Railway Supply Company held in Chicago last week, Burton Mudge and Fred A. Poor were elected directors. Burton Mudge was elected president to succeed Frederick L. Sivyer, who remains as a director. Messrs. Mudge and Poor have acquired a controlling interest in this company, but Mr. Sivyer and his associates and the Northwestern Malleable Iron Company will continue to hold a substantial interest in the company and will be represented on its board. Mr. Mudge states that this is a preliminary step in the reorganization of the business and in the enlargement of the personnel and facilities of the company to handle properly its growing business. He adds that there will be no change in the direct management of the business, James H. Slawson, first vice-president, continuing as heretofore in charge of manufacturing and all other departments, and Charles A. Carscadin, vice-president in charge of sales. The company owns and operates a steel fabricating plant in Chicago where it manufactures car truck bolsters and brake beams. Its general offices are in the Railway Exchange, Chicago.

J. M. Duncan, whose selection as general sales manager of the Detroit Steel Casting Company, with headquarters at Detroit, Mich., was announced in the June issue of the *Railway Mechanical Engineer*, was born at Toronto, Canada, on February 22, 1888. Mr. Duncan entered the railway supply field on November 27, 1905, in the employ of the Detroit Steel Casting Company. He was later made "follow-up engineer" of this company, in which position he personally followed every important shipment to its destination to see how the castings were applied, and to ascertain whether more satisfactory results could be obtained by closer co-operation between the management and the user. He was serving in this capacity at the time of his recent promotion to general sales manager

J. M. Duncan

William H. Eager, since 1918 first vice-president of the Whitman & Barnes Manufacturing Company, Akron, Ohio, has been elected president to succeed A. D. Armitage, who resigned on June 7, in order to give more of his time to his duties as vice-president and general manager of the J. H. Williams Company, Brooklyn, N. Y., with executive offices in Buffalo. Mr. armitage still remains a member of the Whitman & Barnes board of directors. Mr. Eager is a graduate of the Massachusetts Institute of Technology, and for the past 16 years has been with the Whitman & Barnes Manufacturing Company, having joined the organization as assistant superintendent of its Chicago factory, later becoming works manager and in 1908 he was elected treasurer. In the early part of 1909 he was transferred to Akron, two years later he was appointed sales manager, and in 1918 was elected first vice-president. Frank W. Oliver has been appointed eastern sales manager of the Whitman & Barnes Manufacturing Company, with headquarters at 64 Reade street, New York City. Mr. Oliver has been connected with the drill and reamer industry continuously for 23 years.

Philip L. Maury has been elected a vice-president of the Detroit Graphite Company with headquarters at Detroit, Mich. He will have direct charge of all activities of the company pertaining to its paint and varnish business with railroads. Mr. Maury was born in Denver, Colo., on October 5, 1884. After leaving school he entered the paint business and has been connected with that industry ever since, having served for many years with the Sherwin-Williams Company as manager of railway and industrial sales, which position he leaves to take up his new duties with the Detroit Graphite Company. During the war he was in charge of the government activities of the Sherwin-Williams Company and was closely identified with the work of the War Service Committee of the Paint Manufacturers' Association.


P. L. Maury

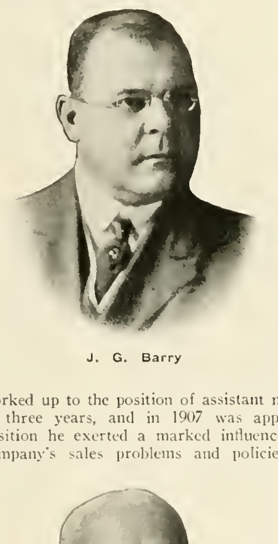
Elliott E. Nash, vice-president and general manager of the Minneapolis & St. Louis, with headquarters at Minneapolis, Minn., has resigned to become western representative of the American Locomotive Company, with headquarters at Chicago. Mr. Nash was born on March 28, 1870, at Hudson, Wisconsin, and entered railway service in June, 1886, with the Chicago, St. Paul, Minneapolis & Omaha, where he served in various clerical capacities until November, 1888, when he became traveling auditor, with headquarters at St. Paul. He was appointed agent in March, 1892, and continued in this capacity at Ashland, Wis., at St. Paul, Minn., and at Minneapolis, until January, 1905, when he was promoted to assistant superintendent at Itasca, Wis., being transferred later to Eau Claire. In May, 1910, he entered the service of the Chicago & North Western at Chicago with a special assignment in the president's office, where he remained until May, 1911, when he was promoted to superintendent at Winona, Minn., where he remained until April, 1912, when he was transferred to Baraboo, Wis. In November, 1913, he was promoted to assistant general superintendent of all lines east of the Missouri river except the Iowa, Minnesota and Dakota divisions, and in October, 1917, he was transferred to the Iowa territory, with headquarters at Boone, Iowa, where he remained until July, 1918, when he was promoted to assistant to the federal manager, which position he held until March, 1920, when he became general manager of the Minneapolis & St. Louis with headquarters at Minneapolis, Minn. He was promoted to vice president and general manager of this company on May 31, 1921.


E. E. Nash

The Paige & Jones Chemical Company, New York, manufacturers of materials for treating boiler feed water, has opened a general sales office at 417 South Dearborn street, Chicago. Lucius A. Fritze, until recently vice-president and general sales manager of the Borromite Company, who is a practical chemist and has had an extended experience with various phases of feed water treatment, has become associated with the Paige & Jones Chemical Company as vice-president and general sales manager, with headquarters at Chicago, and Robert O. Friend, formerly water and mechanical engineer of the Borromite Company, who is experienced in designing and building water softening plants, has been appointed vice-president and supervising engineer with headquarters at Hammond, Ind., of the Paige & Jones Chemical Company. The other officers of the company are: Fred O. Paige, president; Charles P. Wolfe, vice-president and treasurer, both at New York; Fred O. Paige, Jr., secretary and works manager, Hammond, Ind. The executive offices of the company are at 248 Fulton street, New York, and the technical department works are at Hammond. C. B. Flint will continue as sales manager of the railroad department, with headquarters at New York.

General Electric Elects Two New Vice-Presidents

J. G. Barry, sales manager of the General Electric Company since 1917, and manager of its railway department for many years, and A. H. Jackson of the law department, were recently elected vice-presidents of the company at a meeting of the board of directors.


J. G. Barry

Mr. Barry has been connected with the General Electric and Thomson-Houston Companies for 32 years and is 52 years old. He was first employed in the production department of the Thomson-Houston Company in Lynn, in 1890. A year later he was transferred to the construction department of the Boston office and in 1894 entered the railway department at Schenectady, following the organization of the General Electric Company. Mr. Barry worked up to the position of assistant manager of this department in three years, and in 1907 was appointed manager in which position he exerted a marked influence on many aspects of the company's sales problems and policies. His success as manager of the railway department, one of the most important divisions of the G-E organization, led to his appointment in 1917 as general sales manager and his present promotion to vice-president.


A. H. Jackson

Mr. Jackson has been head of the law department of the General Electric Company for several years. He was born in Schenectady in 1864 and was educated in the public schools there. In 1886 he was graduated from Union College and two years later received the degree of LL.D. from the Albany Law School. He first practised law with his father, Judge Samuel W. Jackson, and remained with him until 1902, except for three years which he spent with the firm of Chanler, Maxwell and Philip in New York. Mr. Jackson was first employed at the General Electric Company in the law department in December, 1902.

John F. Schurch, vice-president of the T. H. Symington Company, with office at St. Paul, Minn., has left that company and has been elected a vice-president of Manning, Maxwell & Moore, Inc., New York. He will be in charge of sales in the middle west and west, with headquarters at Chicago, 27-29 North Jefferson street. Mr. Schurch was graduated from the University of Minnesota in 1893. He entered the service of the Minneapolis, St. Paul & Sault Ste. Marie the same year, serving consecutively in the office of the auditor and of the general superintendent and in the transportation department, resigning in 1905 after having attained the position of chief clerk to the vice-president. From 1905 until 1914 he was associated with the Railway Materials Company of Chicago. In February, 1914, he was elected vice-president of the Damascus Brake Beam Company with office in Cleveland, Ohio, and in June, 1914, he was elected president of the same company, which position he resigned the same year and was elected vice-president in executive charge under President T. H. Symington, of the Symington Company. Mr. Schurch was president of the Railway Supply Manufacturers' Association, which had in charge the exhibits at Atlantic City in connection with the meetings last month of Division V—Mechanical, and VI—Purchases and Stores, A. R. A.

J. F. Schurch

Changes in Baldwin Personnel

Several changes in the official personnel of the Baldwin Locomotive Works were made recently; J. P. Sykes, vice-president in charge of manufacture, has been appointed senior vice-president in charge of plant and manufacture; C. A. Bourgeois, works manager, has been appointed vice-president in charge of manufacture; J. L. Vauclain, in the plant and equipment department, has been appointed vice-president in charge of plant and equipment. Harry Glaenzer, chief mechanical engineer, has been appointed vice-president in charge of engineering to succeed Kenneth Rushton, deceased, and W. A. Russell, purchasing agent, has been appointed vice-president in charge of purchases.

Federal Trade Commission Opposes Steel Merger

The Federal Trade Commission has issued a formal complaint against the Bethlehem Steel Corporation and the Lackawanna Steel Company charging that the merger of the two companies will constitute an unfair method of competition in that it contains a dangerous tendency unduly to hinder competition and restrain commerce.

New Merger of Three Steel Companies

Announcement is made of the adoption of a plan by which the properties of the Midvale Steel & Ordnance Company, the Republic Iron & Steel Company, and the Inland Steel Company will be unified in the ownership of the Midvale Steel Company, whose name will be changed to the North American Steel Company, or some other appropriate name. The terms of the plan are as follows: All existing obligations of the three companies are to be assumed by the unified company. Existing preferred and common stocks will be changed into preferred and common stocks of the unified company. The new preferred stock is to have a par value of $100 per share, is to be 7 per cent cumulative, is to be redeemable at $115 per share and accrued dividends and is to be convertible for twelve years into new common stock at the rate of five shares of new common for four shares of new preferred. The common stock is to be without par value.

All assets of the three companies are to be owned by the unified company, except the Nicetown plant (the armor-making, ordnance and forging plant) of the Midvale Steel Company, which is to be transferred to a separate company with a capital of 500,000 shares without par value.

TRADE PUBLICATIONS

Vises.—The Charles Parker Company, Meriden, Conn., has issued catalogue No. 57, also three-fold circulars showing its line of vises and their many features in complete detail.

Pneumatic Tools.—Master pneumatic tools and their various parts are listed and illustrated in a catalogue of spare parts prices recently issued by William H. Keller, Inc., Grand Haven, Mich.

Resistance Thermometry.—The Brown Instrument Company, Philadelphia, Pa., has published a new resistance thermometer catalogue which explains the theory of resistance thermometry, the various types of instruments which are made and the merits of each type.

Pig Iron.—The Bethlehem Steel Company, Bethlehem, Pa., has issued an interesting, illustrated booklet of 28 pages describing Mayari pig iron, a low phosphorus and low sulphur iron, containing also nickel, chromium and small percentages of titanium and vanadium. Analysis specifications of castings made with Mayari iron for special purposes are also included.

Automatic Appliances.—The Imperial flange oiler, automatic grease plug and drain valve and valve system are described and shown in detail in cross-sectional views in catalogue No. 1 recently issued by the Imperial Steam Appliance Company, Seattle, Wash. "Don'ts" referring to the grease cup and questions relative to the automatic drain system are interesting features of the catalogue.

Industrial Furnaces.—The Surface Combustion Company, New York, is issuing a series of bulletins, Nos. 3-D, 5, 6, 7, 8, 16, 17, 18 and 24, pertaining to low-pressure air-gas inspirators, oven furnaces for the heat treatment of both carbon and high speed steel, pot-hardening furnaces, soft metal furnaces, galvanizing baths, shipyard furnaces, rivet heaters, small forges and laboratory furnaces for high temperatures, respectively.

Welded Flexible Staybolts.—A pamphlet outlining the reason why locomotive users should change from the threaded to the welded flexible staybolt sleeve in their boilers has been sent out by the Flannery Bolt Company, Pittsburgh, Pa. The answer given in the booklet is that the latter is stronger, will not leak, does not require the care in application, will not crystallize and can be used to replace threaded sleeves or rigid bolts.

Boiler Feed Water Regulator.—"Regulating Boiler Feed Water" is the title of a booklet which has recently been published by the Northern Equipment Company, Erie, Pa. The subject has been treated in an entirely new way, the object being to cover boiler feed water regulation completely and yet very briefly. To accomplish this purpose, free use has been made of a graphical method of presentation: charts showing the effect of feed water regulation on water input, steam output, feed water temperatures, etc.; also other charts, photographs, etc.

Boiler Tube Corrosion.—Three authoritative articles on the subject of boiler tube corrosion, each of which is written from the particular and definite viewpoint of either the locomotive, the stationary, or the marine engineer, have been selected and incorporated as the basis of Bulletin No. 4-C issued by the National Tube Company, Pittsburgh, Pa. The combined information in the bulletin, which is entitled, "Preventing Corrosion of Boiler Tubes," gives the more important data available on the problems involved and, taken individually, each article reflects the main accomplishments of research in their respective fields.

Staybolts and Staybolt Sleeves.—The American Locomotive Company, New York, has recently issued catalogue No. 10,050-A describing its new line of staybolts and staybolt sleeves. These include reduced body flexible bolts, reduced body rigid bolts, tapered end crown stays and Alco welded sleeves and caps. The staybolt sleeves are made with square ends seating on the sheet, tapered ends to fit into the holes reamed in the sheet and a flush type in which the sleeve has a very slight projection above the sheet. Special hexagon caps have been designed for these sleeves which permit easy application or removal and keep the projections beyond the outer sheet at a minimum.

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Three-Cylinder Locomotives

European railroads have been using three-cylinder, single-expansion locomotives for many years and the type has been quite popular in several countries. Moreover, a study of the locomotives of advanced design which have been brought out recently in England, France and Germany shows an increasing tendency toward the use of three cylinders. One of the locomotives of this type, described in this issue, contains a number of features of more than usual interest. Hitherto there has been comparatively little consideration given to three-cylinder locomotives in this country and but few have been built. Some of the reasons why European locomotives differ from those used in America are more restricted clearances and track conditions which do not admit of as high an axle load as is employed here. While three-cylinder locomotives are not quite as simple a piece of machinery as the common type with only two cylinders, they offer certain clearly defined advantages. They are better balanced; therefore, are less severe in the strains set up in track and bridges and run with greater smoothness. The turning torque is more uniform and it is consequently practical to use a lower factor of adhesion. As there are six instead of four exhausts per revolution, the draft on the fire is more even and the tendency is toward better combustion. These are points which are being given increasing consideration and will probably lead to the building of some three-cylinder locomotives in this country in the near future.

Training Shop Foremen

When higher mechanical department officers can detach themselves long enough from a consideration of labor problems, they discuss the need of a greater number of trained shop men and especially foremen. One of the most practical plans which we have yet seen for training railway shop foremen is described on another page of this issue. The author, Hugo Diemer of La Salle Extension University, has been a shop superintendent and industrial engineer and has some interesting comments to make on railroad shop mechanics and foremen who have come under his observation. Acknowledging the resourcefulness of the average shop foreman, he warns against a tendency to be satisfied with makeshifts which might be satisfactory in an emergency, but which would be time-consuming and costly for continuous production work. He points out most forcefully the value of trained foremen and outlines the development of foreman training courses, describing in a general way a typical course.

Without attempting to steal the author's thunder, we may say that he recommends the conference method (with home study) of training foremen under the direction of group leaders. Obviously, capable group leaders must first be obtained and these men can then transmit to the foreman an idea of their function in industry and the best methods of fulfilling their duties—namely, to fill the gap between management and workers, translate company policies, direct men tactfully but firmly and be executive leaders in the true sense of the word. Referring to the great possibilities of foreman training, the author says in the last paragraph of the article, "Those who are active in the movement and who have had an opportunity to observe and measure its results, feel confident that ultimately it will prove as important as scientific management in bringing about greater industrial efficiency and in maintaining America's industrial supremacy." How long will it take the railroads to realize the benefits that can be secured from such training?

Departmental Co-operation Is Needed

The natural tendency in any large organization, such as that of a railroad system, is for the various departments to become self-centered. As contact with other departments is lost, the work is carried on with less and less knowledge or consideration of the problems or needs of those outside of the particular department even though there may be no interdepartmental jealousies. As an illustration, the engineering department not only has jurisdiction over tracks, yards and stations, but also over the design of bridges, shops and terminals. Engineering knowledge is required for the design of either a bridge or a shop building to secure adequate strength and economy in the use of structural materials. There is, however, a vast difference between the after use to which the two are put. If the bridge is of ample strength, is properly erected and is kept protected by paint against corrosion, it meets all requirements. An error of judgment in the design of a bridge may slightly increase the first cost and consequently add to the fixed charges for capital but a mistake in the layout of a shop or engine terminal may result in a considerable and unnecessary addition to the cost of operation which goes on year after year as long as the building remains in use or until alterations are made to help the situation. In too many instances important shop buildings are designed without sufficient investigation in regard to the exact way in which they are to be used. After preliminary plans have been drawn up the details of the project should be gone over carefully with the mechanical department, and by the mechanical department is meant not only the superintendent of motive power but also the subordinate officers who will be called upon to operate the shop after it has been built. The men who spend their time in a shop and are responsible in a large measure for the operating costs should realize better than anyone else the effects which even minor changes in arrangement may have upon the question whether the plant will be a convenient and economical one. Manufacturing concerns, which as a rule are obliged to consider all operating costs far more rigidly than is the case at present on a railroad, are at an advantage when it comes to the question of shop design and equipment. All departments are usually located at one point and the heads come in daily contact with those in other departments. There may be a plant engineer but he usually reports to the chief engineer who has charge of the design of the plant as well as of the product. The works manager or superintendent is also in close contact with the chief engineer and all parties work out together the various problems in connection with the design of a shop building or addition. With the increasing demand for a reduction in railroad operating costs it is important that greater consideration be given to shop layouts and that the engineering and mechanical departments work together on the problems arising from the growing or changing demands for rolling stock handling and maintenance.

College Men in Railroad Work

The question of the college man in railroad work is an old one but is still a vital issue both for the man and for the railroad. The leading motive power officers on some of the largest systems have evidently considered that there was a need for such men and that there were places where the knowledge obtained from a college training, after having been supplemented by a period of practical experience, could be used with advantage to the road. This is evident from the fact that considerable time and thought has been given to mapping out special apprenticeship courses covering two or more years which would give young men a broad and varied experience in the numerous phases of railroad motive power work. A large proportion of men when they leave college appreciate the fact that they are lacking in practical experience, which can be obtained only in the field of activity which they select for their life work, but probably few if any put on overalls and do the varied work in shop, roundhouse and on the road, from stripping a locomotive to firing, with the intention of becoming a skilled machinist or of indefinitely performing manual labor. Any young man who completes a term as a special apprentice shows that he is at least interested in what he is doing, is not afraid of hard work and is not deterred by a low rate of pay. A less promising young man would have taken a job as a draftsman or sought some other position where the pay would have been greater, the work pleasanter and the future prospects at least as good. There are undoubtedly instances of men who have started in railroad work and who have shown later on that they were better suited to other fields of activity. However, far too many have started and after serving for a number of years have found that there was apparently little prospect of advancement in the railroad field and after making a change have been highly successful in manufacturing or other work. Many a valuable man has been lost to the railroads from an indifference to his future after his training has been completed. If he was worth training he must have some value other than as a mechanic. To train a man and then fail to realize anything from the effort and expense of furnishing such a training is a wasteful procedure, discouraging to the man and a hindrance to the future progress of the mechanical department.

More Drop Forging Work Needed

One feature of blacksmith shop work not emphasized as much as its importance warrants is drop forging. Only a comparatively few railroad blacksmith shops are equipped with drop hammers and trimming dies and where this equipment is installed it is usually insufficient to meet the needs. One of the most interesting practices at the Reading locomotive shops, described elsewhere in this issue, is the drop hammer work in the blacksmith department. The experience shows that with drop hammers of the proper capacity and trimming dies to remove the flash, drop forging offers an efficient, quantity-production method of making many small parts used in locomotive and car repair work. In most cases one operator can insert the blanks in the furnace, form the parts under the drop hammer and remove the flash under the trimming dies, the labor cost being thus reduced to a minimum. The forgings are formed rapidly and after enough have been made to pay for the cost of the dies, the unit cost for each forging is greatly reduced, representing a considerable saving over the cost of buying or manufacturing by other methods. In addition, the fact that the metal is worked under the drop hammers results in improved quality forgings which are less likely to fail in service than are castings.

As specific examples of the drop forging work at Reading shops, the dies and methods of drop forging heavy 2¼-in. to 3-in. hexagon nuts and column guides for freight car truck bolsters are noteworthy. Other drop forged parts include guide blocks, eccentric rod jaws, cylinder cock jaws, hose clamps, etc. A further advantage results from manufacturing these parts locally under the drop hammers in that they may be secured on short notice, thus avoiding the delayed deliveries which frequently occur when forgings are purchased from outside manufacturers. Considering the many advantages of drop forging, it should be introduced far more extensively in railroad shop practice than is now the case.

Back Shop and Roundhouse Co-operation

One effective way of expediting locomotive running repair work is by a closer co-operation of the shop and roundhouse supervisory forces. In spite of the fact that back shop and roundhouse men work in the same department under the jurisdiction of the same mechanical superintendent, or superintendent of motive power, there is usually more or less rivalry and sometimes antagonism between the two groups. The roundhouse foremen are directly on the firing line. They feel that their needs are of paramount importance and often are none too tactful in demanding material and parts from the back shops. The shop supervision on the other hand, often with practically no roundhouse experience, does not appreciate the extremities caused by lack of material or repair parts at terminals and often feels, therefore, that roundhouse foremen have an exaggerated opinion of their own importance.

One valuable result of the present strike of the shop crafts has been the fact that in many cases mechanical department foremen, by conference and otherwise, have been brought in closer contact with each other and have a better understanding of mutual problems. In a specific case, one back shop was closed as a result of the strike and the entire shop supervision sent to an important nearby terminal to help out. These men had an excellent opportunity to observe at first hand the resourcefulness of the roundhouse foremen in turning locomotives under difficulties. The way locomotives were held up for lack of material and the real emergency created by a broken side rod or crosshead was brought home to these shop foremen in a forceful manner. Almost to a man they returned to their shop with a better understanding of roundhouse needs and a determination to pay more prompt attention in the future to communications from that source.

Master mechanics and roundhouse foremen on the other hand can greatly assist the back shop forces and incidentally themselves by giving closer attention to work reports, making sure that these reports are accurate and explaining any weaknesses developed by locomotives. In this way defects can be corrected and will not be overlooked when locomotives go to the back shops for heavy repairs. Another practice not followed as generally as seems desirable is to let the shop supervision know in advance what will be needed in the way of new material or machine parts on locomotives soon due for a shopping. For example, if the cylinder bushings on a certain locomotive are almost down to the limit and will not stand another reboring, the shop forces should be advised so that new bushings can be rough machined before the locomotive comes to the shop. If locomotives ride hard, reverse with difficulty, or pick up speed slowly, these facts should be reported to the shop forces who often will be able to correct the defects by a little extra attention. Good results all around will follow a closer co-operation of the back shop and roundhouse supervisory forces.

Be Prepared for Car Orders

One of the surprising conditions met with in railroad operation is the sudden and often unexplainable changes in traffic. Thus a road which recently was short of box cars and planned to build a large number found before construction was started that it had a surplus of that class of equipment and numerous demands for flat cars that could not be supplied. Although many of the parts for the box cars had been made, the road considered working over all the material for use in flat cars, as it seemed likely that the increased net earnings by having these cars in service promptly would more than make up for the higher cost of construction.

This incident explains why the mechanical department is so often called upon to prepare designs and specifications for cars on short notice. When confronted with the prospect of losing traffic if equipment cannot be furnished, the higher executives are likely to disregard the desirability of making a thorough study of the design before cars are built. Hastily drawn plans have been the direct cause of much unnecessary expense for maintenance, and the only way to insure that new cars when acquired will be a credit to the mechanical department is to keep designs of each type constantly under way. Those who are directly responsible for the design should be given every opportunity to study conditions in shops and yards. They will discover many reasons why cars fail and why they are expensive to maintain that would never be suspected by a man who stayed in the drafting room. Few cars designed today can be criticized as lacking in strength in the essential parts, but it is also important that cars should be as light as they can consistently be made, easy to repair and well protected against corrosion. Few cars meet all these requirements.

It is interesting to lay out a new design and then to analyze each feature critically, applying the experience with existing types and trying to eliminate their defects. A comparison of the final result with the original will usually show a surprising number of changes and will convince anyone of the necessity of giving long and painstaking attention to every new design.

What Is "Ordinary Handling"?

The last of the so-called combination defects were eliminated from the interchange rules in 1918, and in the 1918 code owners were held responsible for all damages except those due to certain specified causes for which responsibility obviously lies with the handling line. That extensive combinations of sill defects were not to be considered in themselves evidence of unfair usage irrespective of the conditions under which they developed, was made even clearer by the interpretation added to Rule 43 in the 1919 code. But the note which replaced the interpretation under this rule in 1920 and an arbitration decision since rendered have completely reversed this position, placing the burden of proof on the handling line if fair usage is claimed in connection with extensive underframe damage.

The application of the present rule hinges on what constitutes the "ordinary handling" of which the delivering line must present positive evidence if it is to shift the responsibility for the cost of repairs to the owning road. The fact that when fair usage is claimed there is usually little evidence on which to base such a claim other than the absence of such conditions as derailment, cornering, sideswiping, etc., in effect defines this term as that handling which will not cause "damage to more than five longitudinal sills on wooden underframe cars, more than four longitudinal sills on composite wooden and steel underframe cars, more than three longitudinal steel sills on steel or steel underframe cars and both steel center members on tank cars with two longitudinal sills only." In other words, what constitutes abusive treatment depends on the condition and the strength of the design of the cars handled.

For many cars now in service operating conditions on the road as well as in both flat switching and hump yards make ordinary handling, as thus defined, impossible. It is true, of course, that if no check is placed on the severity of the operating stresses to which cars are subjected, it will be impossible to develop designs of sufficient strength to withstand them, and it might be argued that placing the liability for damages on the handling line would tend to check carelessness in switching and handling trains. But the responsibility for damage to lading and to home cars when on the home line should accomplish all that can be expected in this direction, while overprotection of the interests of the owner tends strongly to perpetuate worn out equipment and inadequate designs.

This, no doubt, is understood by the Arbitration Committee, but before holding that body responsible let it be remembered that it can go no farther in modifying the intent of the rules than the consensus of opinion of the representative membership of the American Railway Association will permit. What is necessary, then, if pressure is to be exerted effectively against undue protection of the car owner, is an active and co-ordinated interest in the modification of this rule by all roads principally affected as handling lines. The *Railway Mechanical Engineer* ventures the opinion that a careful study of the situation will demonstrate that the interests of the handling lines in this matter outweigh those of the owning lines, and that the interests of the roads as a whole would be better served by a return to the 1919 rule.

Some Comments on Internal Grinding

Practically all the advantages of external cylindrical and flat surface grinding, emphasized many times in these columns, hold with equal force for internal cylindrical grinding. Internal grinders are now made of sufficient power to remove metal rapidly, leaving holes which may have almost any desired degree of accuracy and greater smoothness than can be obtained by any other method. The possible uses of internal grinding machines in railroad shops are too numerous to describe in detail but a few typical examples may be mentioned for the benefit of shop men unfamiliar with the machines.

One of the most extensive uses of internal grinders is for truing worn holes in side rods and valve motion work. These holes often become out of round and rough in service, it being difficult if not impossible to get a satisfactory fit for new bushings to be applied. Internal grinding presents the best method of truing these holes and getting a smooth surface. A boring machine could be used but the grinder does the job more quickly and takes off only enough metal to true the holes. Another extensive use of the small internal grinding machine is for truing the holes in case-hardened valve motion bushings. These bushings are usually made in quantity on turret lathes or automatics, then being case-hardened and pressed into the valve motion parts, such as links, eccentric rods, combination lever, lift shaft, etc. The process of case-hardening almost invariably changes the size of the bushing holes slightly, often distorts them and leaves a rough surface due to scale. The bushings are hard so that they cannot be reamed or filed and the only satisfactory way of truing the holes and bringing them accurately to size is by grinding. The appearance of bushings after grinding will convince any skeptic that, on the ground of smoothness alone and consequently better bearing qualities, these bushings should be ground.

As described in a previous issue of the *Railway Mechanical Engineer* a prominent Eastern railroad has for some time followed the practice of standardizing valve motion pins and bushings, manufacturing them in quantity from bar stock on automatic machines. The bushings are standardized in graded sizes, the pin fits in the bushings being ground before it is known on which locomotive they will be applied. Sufficient stock is left on the taper bearings of the pins and the outside diameters of the bushings so that these fits can be made quickly at the time of application. This work would be absolutely impossible without the use of internal grinding machines and the railroads owe a greater debt than is commonly appreciated to the manufacturers of this type of machine. Large amounts of time and money have been spent in developing the machine and bringing it to a point where it can efficiently perform almost any internal grinding job.

Another valuable use of the internal grinder in railroad shops is for truing the main piston bushings in triple valves and other air brake operating valves. The internal grinder is particularly adapted for this operation because of the great accuracy required. It is generally recognized that parts of the air brake equipment including the valves must be machined and fitted with greater accuracy than is needed in general locomotive repair work. Air will leak through a small hole and it does not require much of a leak at a critical point to render air brake valves inoperative. The fit of the main piston ring in a triple valve may be mentioned as an example and this ring cannot be sized properly and ground in unless the bushing is almost perfectly round and smooth. Experience has shown the value of internal grinding machines for truing these bushings and reclaiming valves which would otherwise have to be scrapped or returned to the manufacturers. The latest improvement in internal cylinder grinders has been the hydraulic arrangement for traversing and reversing the table absolutely without shock. These machines should be a valuable addition to any shop on account of the convenience of operation, the accuracy and smooth quality of the work performed, and above all the saving in the cost of repairs which can be effected by their use.

Weight of Passenger Cars

FOR a long period almost every passing year has seen a slow but steady increase in the weight of passenger cars; this increase has not been accompanied by a corresponding increase in carrying capacity. In freight car design there also has been a marked increase in weight and size but the ratio of dead weight to carrying capacity has never been lost sight of; in fact, the aim has ever been to obtain a higher proportion of revenue load. In passenger car design the points given most consideration are those which have added to the comfort of the passengers or have appealed to their æsthetic sensibilities. Coupled to this has been an effort to secure maximum strength to withstand damage from collision or derailment. Designs have clearly shown the influence of the Pullman car. Railroad officers seem to have given little heed, however, to the fact that it is expensive to haul cars that weigh more than necessary—the Pullman Company does not have to furnish the locomotives to haul its cars and naturally can afford to ignore weight to a much greater degree than the railroads.

The extent to which weight has mounted should be appreciated when we find sleeping cars weighing over 7,000 lb. for each berth. Moreover, a dead weight of 2,000 lb. per passenger seat is by no means unusual for modern all-steel day coaches. For strictly suburban traffic the weight is less but even here 1,200 lb. per passenger seat is better than the average.

Another striking change which has been brought about by the increased weight of passenger cars has been the radical modifications in the design and type of locomotives which are used to haul heavy passenger trains. Not many years ago the Atlantic type locomotive began to be displaced by the Pacific type. It seemed for a time as though the latter type would meet all requirements for an indefinite period, but Pacific type locomotives steadily increased in size until they weighed some 270,000 lb. for the engine alone and reached 2,500 hp. and a tractive effort of over 40,000 lb. This was not sufficient, however, and now we find the Pacific type being superseded by the Mountain type in many places. Locomotives of the last type now weigh over 350,000 lb., are rated at more than 3,000 hp. and develop a tractive effort of nearly 60,000 lb. Looking back for a brief period of less than 30 years, we find important trunk lines then building for heavy, fast passenger service an American type locomotive weighing less than 125,000 lb., with 19 in. by 24 in. cylinders, 20,000 lb. tractive effort and 1,100 hp. This is quite a contrast when compared with some of the locomotives ordered recently.

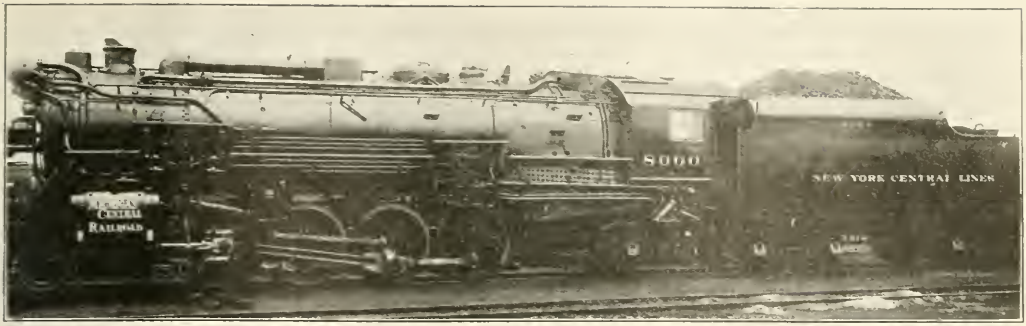
The modern builders of gasoline rail motor cars appear to realize the need of holding the dead weight to a minimum far more clearly than do many of the railroad officers with whom they have to deal. In fact the motor car men frankly state that the reason for the failure of older designs of such cars to meet expectations was largely due to their heavy weight brought about by attempts to carry out railroad demands. If the operating economies desired are to be realized the weight of these cars must not exceed that which can be handled by engines already developed for highway trucks. Thus we find such cars seating 35 persons and weighing less than 25,000 lb. or about 670 lb. per passenger seat.

It would seem to be time not only to call a halt to the increase in passenger car weight, but to study seriously the problem of reducing the weight of such cars. A far-reaching lesson might well be learned from the attempts of motor car designers to limit the weight of their cars. Future designers looking back to our present practices in passenger cars will undoubtedly consider them crude, wasteful and decidedly lacking in the application of engineering.

New Books

OPERATING ENGINEER'S CATECHISM OF STEAM ENGINEERING. *By Michael H. Gornston, 428 pages, 4½ in. by 7½ in., bound in leather. Published by D. Van Nostrand Company, New York.*

This book is of special interest and service to younger operating engineers and students. It contains 1,300 questions and answers which, as a rule, are clearly and concisely stated. Its form will appeal particularly to those who are not accustomed to concentrated study and is, for this reason, rather elementary in its treatment of the different subjects. The author is a steam engineer in the department of education of the City of New York and in writing the book evidently had in mind the engineer who wished to prepare himself for such examinations as are required for civil service positions, municipal or state. The book, however, will also be of use in the library of older and more experienced engineers, for reference purposes. Among the subjects discussed are heat, steam, combustion, boilers, engines and condensers, together with chapters on the practical management of boilers, engines and auxiliary machinery. Pumping machinery, steam heating, stokers and also pulleys and belting are included. The book is well printed and of convenient size although it would have been improved by the use of more illustrations. An excellent index of 32 pages adds considerably to its value.



Many Radical Changes Have Been Made in the Construction of This Locomotive

A Remarkable Mikado on the Michigan Central

Maximum Power Per Unit of Weight and Utmost Efficiency in Use of Fuel Keynotes of Design

FOR the past month the Michigan Central has been operating a Mikado type locomotive built by the Lima Locomotive Works, which incorporates many new features of design. On account of the unusual character of this new motive power the railroad has not heretofore made public any of the details of its construction. The following general description has now been given out by the New York Central Lines:

The Front of the Locomotive Presents a Striking Appearance

An extraordinary locomotive "No. 8000," which is expected to prove a most important contribution to motive power progress, has just been put in service on the Michigan Central. In numerous details of its design and construction it is radically different from any locomotive previously built and in general appearance it presents striking departures from the familiar features of the ordinary locomotive.

The locomotive was planned and constructed under the personal direction of President A. H. Smith of the New York Central Lines, who specified the several most important main accomplishments to be sought by the new design and made provision for the use of every up-to-date improvement of proved worth, brought to the last degree of refinement for economy and efficiency. The engine contains features never before incorporated in any locomotive.

Locomotive 8000 in its preliminary tests and subsequent daily service hauling heavy trains between Detroit and Toledo, has performed in a way highly satisfactory to the New York Central officials and the builders. In its initial road test, it hauled 100 heavily laden coal cars and later easily pulled a train of 140 cars containing more than 9,000 tons of coal, indicating a capacity of more than 150 cars and load in excess of 12,000 tons.

Locomotive 8000 is considered the last word in efficiency and economy in freight motive power. The principal advantages which it is expected to demonstrate are:

(1) For its weight, it will deliver more power than any other locomotive in the world.

(2) It will develop more power per ton of coal consumed than any locomotive ever built.

(3) It will prove a locomotive easier to operate and repair than its predecessors, this making for quick turnarounds and safety.

Locomotive 8000 was designed and built to expedite the movement of heavy fast freight trains. With an increase in weight of less than two per cent as compared with the heaviest Mikados in service on the Michigan Central, No. 8000 has an increase of nearly eight per cent in tractive power derived from the forward cylinders and an increase of over 26 per cent when the booster is cut in.

The designers of this locomotive in addition to securing the greatest possible tractive effort with a minimum weight at which strength would not be sacrificed, incorporated the best known practices and devices for securing economy in the use of fuel and water. A type E superheater has been applied which produces a higher temperature of steam than the superheaters in general use.

On Locomotive 8000 a maximum tractive effort of 74,500 lb. is obtainable. Of this figure 11,000 lb. are delivered by the booster, the remaining 63,500 lb. being obtained from the main cylinders.

Refinements in design and the use of alloy of steel and hollow axles and crank-pins have made it possible to eliminate a great amount of weight ordinarily necessary. The weight of the locomotive, exclusive of tender, is 334,000 lb. The tender, which has a capacity of 10,000 gallons of water and 16 tons of coal, weighs 199,700 lb. The boiler carries 200 lb. per square inch steam pressure. The main cylinders are 28 in. in diameter, with 30 in. stroke. The diameter of the driving wheels is 63 in.

On this locomotive for the first time superheated steam is used to operate the air pump, feed-water pump, booster engine and headlight turbo-generator.

The locomotive is equipped with the Superheater Company's feed-water heater. The heater is located at the front of the engine, above the headlight and near the top of the boiler, on a level above the top of the tank so as to give the condensate pipe line plenty of fall to return the condensed water to the filter on the rear of the tender. The feed-water pump is mounted on the left side of the boiler back of the smokebox.

Another important departure from standard railway practice is the feature of superheating the steam before it reaches the main throttle. In locomotive 8000 the steam from the boiler passes through the steam dome into the dry pipe and thence to the superheater units, the dry pipe, which is outside of the boiler, being connected at the forward end direct to the superheater.

Before the steam leaves the dome it is passed through a separator which collects any water that may be carried in the steam, the water being automatically returned to the boiler, which, together with the taking of steam from the highest possible point of boiler, insures absolutely dry steam. From the superheated steam passages in the header, the superheated steam is conveyed to the throttle, located in a throttle box, at the top of the smoke-box and just forward of the stack, another unusual departure from existing designs and practice which was necessary in order to permit the use of superheated steam for the auxiliaries.

Careful attention has been given to the application of devices to facilitate handling the locomotive by the enginemen, the special equipment consisting of the precision power reverse gear, an Elvin stoker and a power grate shaker. The interior arrangement of the cab is such that the engineer and fireman perform the necessary duties in connection with the operation of the engine with minimum of movement from their positions on either side of the cab, the physical effort of each being practically nil. Even the blowing of the whistle is pneumatically controlled, an air valve being located near the side of the cab and immediately in front of the engineer.

As is customary on the Michigan Central, the engine is equipped with a water scoop, which eliminates stops and consequent delays for taking water.

Before being put into service the engine was inspected by President Smith, Vice-President E. D. Bronner and General Manager Henry Shearer of the Michigan Central.

Locomotive 8000 has more than lived up to expectations in the short time it has been in service. When it has been in service a sufficient length of time dynamometer tests will be taken and results very definitely determined.

The Calculation of Elliptic Springs

Formulas and Tables for the Rapid Determination of Capacity and Deflexion

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In order to facilitate the calculation of capacity and deflection of elliptic and semi-elliptic springs in railroad work, the formulas herewith given have been reduced to their simplest form. These formulas are supplemented by tables in order to make quick work of calculations of this type of springs. No attempt will be made to derive or prove the authenticity of the formulas except in an elementary way.

All elliptic springs are calculated as semi-elliptic, the capacity being the same and the deflection double that of a semi-elliptic spring.

The following symbols are used in the formulas:

M = Bending moment.

P = Safe working load at center of one plate at fiber stress of 80,000 lb. per sq. in.

l = Length of span of spring.

I = Moment of inertia of a rectangular section (each plate).

S = Unit stress, 80,000 lb. per sq. in.

c = Distance between center of gravity and extreme fibre of a section of a plate.

b = Width of plate.

h = Thickness of plate.

n = Number of plates.

W = Total capacity of spring.

f = Deflection.

p = Load on one end of spring.

$L = \text{Half of span} = \frac{l}{2}$

E = Modulus of elasticity = 30,000,000.

K = Constant (See formula 3).

Capacity

For calculating capacity, a semi-elliptic spring may be taken as a simple beam supported at both ends with a concentrated load at the center. Assuming the spring to consist of one plate, the bending moment at the center is

$$M = \frac{P\,l}{4} = \frac{S\,I}{c}$$

which is the standard formula for this type of beam. Substituting the following

$$I = \frac{b\,h^3}{12},\ c = \frac{h}{2} \text{ and } S = 80{,}000$$

the formula becomes $\frac{P\,l}{4} = \frac{80{,}000\,b\,h^3}{6\,h}$

and solving $P = \frac{80{,}000 \times 4 \times b\,h^2}{6\,l} = \frac{53{,}333\,b\,h^2}{l}$

which is the capacity of one plate.

Assuming (b = 1 in.) the formula becomes

$$P = \frac{53{,}333\,h^2}{l} \quad \dots\dots\dots\dots (1)$$

This is the standard formula for the capacity of one plate, one inch wide. Then the total capacity of the spring is

$$W = P\,b\,n \quad \dots\dots\dots\dots (2)$$

Values of "P" are given in Table I, calculated by means of formula (1).

Example 1.—Required the capacity of a semi-elliptic spring having fourteen 5-in. by ½-in. plates, 36-in. span.

In Table I, in column for ½-in. plates and line for 36-in. span we find value of P = 372. Then

$$W = P\,b\,n = 372 \times 5 \times 14 = 26{,}040 \text{ lb.}$$

A full elliptic spring composed of two of these semi-elliptic springs would have the same capacity, i. e., 26,040 lb.

Deflection

Though a semi-elliptic spring is considered as a simple beam supported at each end with a concentrated load at the center for calculating the capacity, the same does not hold true for the deflection.

From experiments it has been determined that the deflection follows the formula for a cantilever beam of uniform strength which is

$$f = \frac{6\,p\,L^3}{E\,n\,b\,h^3}$$

This holds true when all the plates are evenly graduated and there is only one plate of the full length of the spring.

However, in railroad work, it is customary to make one-fourth of the number of plates of full length, in which case the formula has been reduced by experiments to

$$f = \frac{5.44\ p\ L^3}{E\ n\ b\ h^3}$$

(Kent's Mechanical Engineer's Handbook, 9th Edition, page 417)

$$\text{or} \qquad f = \frac{5.44\ p\ l^3}{8\ E\,n\,b\,h^3}$$

Substituting $E = 30{,}000{,}000$ and $p = \frac{P}{2}$

$$f = \frac{.000{,}000{,}011{,}34\ P\ l^3}{n\ b\ h^3}$$

Analyzing this formula, it will be seen that for any one plate and span the deflection varies in direct proportion to the load and inversely with the number of plates. In order to simplify calculations, this deflection formula has been divided into two factors, as follows:

$$f = \frac{.000{,}000{,}011{,}34\ l^3}{b\ h^3} \ / \ \frac{P}{n}$$

The first factor is constant for the same plate and span, and for simplifying the formula it has been designated as "K," hence

$$K = \frac{.000{,}000{,}011{,}34\ l^3}{b\ h^3} \ \ldots\ldots\ (3)$$

$$\text{and} \qquad f = \frac{K\ P}{n} \ \ldots\ldots\ldots\ (4)$$

Values of "K" are given in Table 2 on page 440.

The deflection added to the working height gives the free height of the spring.

Example 2.—Find the deflection of spring given in Example 1 when loaded to 24,000 lb.

In Table 2, in column under 5-in. by ½-in. plate and line for 36-in. span, we find K = .00084, then

$$= \frac{K\ P}{n} = \frac{.00084 \times 24000}{14} = 1.442\text{-in., say } 1\ 7/16\text{-in.}$$

Should this spring be loaded to capacity, 26,040 lb., the deflection under this load may be found in Table 1 in column under ½-in. plate and line for 36-in. span, namely 1.58 in.

A full elliptic spring composed of two semi-elliptic springs as mentioned in Example 2, would have twice the deflection of one semi-elliptic spring, or 2⅞ in.

In Tables 1 and 2, figures above the upper heavy line and below the lower heavy line are not considered safe and springs of those dimensions should be avoided.

If springs are desired with stresses other than 80,000 lb. per sq. in., for which the tables have been worked up, the capacity and deflection may be worked up by above method and tables and multiply the answer by the ratio of the stress desired to 80,000 lb.

Example 3.—Same spring as Example 1, only capacity wanted at 90,000 lb.

Capacity at 80,000 lb. stress = 26,040 lb.

$$\text{Capacity at 90,000 lb. stress} = 26{,}040 \times \frac{90{,}000}{80{,}000} = 29{,}295 \text{ lb}$$

The deflection of this spring with capacity load would be

$$f = 1.58 \times \frac{90{,}000}{80{,}000} = 1.78 \text{ in.}$$

The above formulas and tables only apply to carbon steel springs and will not give correct answers for springs made from special alloy steels.

TABLE I—SEMI-ELLIPTIC SPRINGS—VALUES OF "P" AND DEFLECTIONS UNDER CAPACITY LOAD

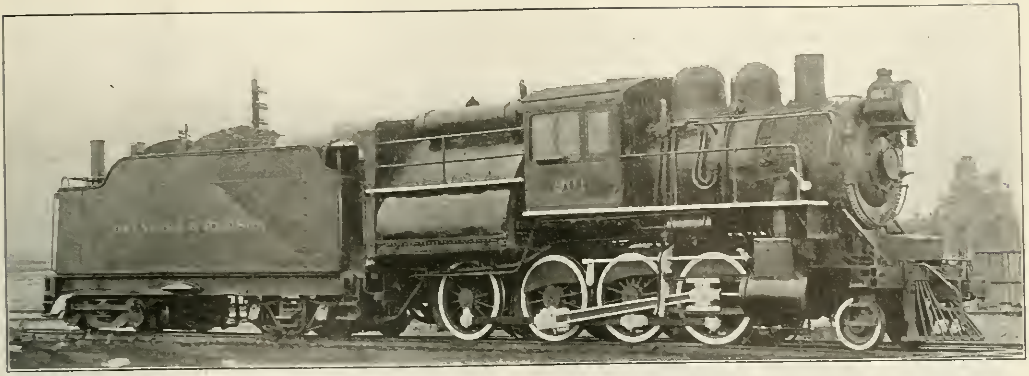
Length Between Centers	One Plate 1 Inch Wide — ¼ in. Load	¼ in. Defl.	5/16 in. Load	5/16 in. Defl.	11/32 in. Load	11/32 in. Defl.	⅜ in. Load	⅜ in. Defl.	13/32 in. Load	13/32 in. Defl.	7/16 in. Load	7/16 in. Defl.	15/32 in. Load	15/32 in. Defl.	½ in. Load	½ in. Defl.	17/32 in. Load	17/32 in. Defl.	9/16 in. Load	9/16 in. Defl.	⅝ in. Load	⅝ in. Defl.
20	167	.98	260	.78	315	.71	375	.65	442	.60	510	.56	587	.52	667	.49	757	.46	844	.44	1,042	.39
22	152	1.19	235	.95	286	.86	341	.79	403	.73	464	.67	534	.63	606	.59	687	.56	767	.53	947	.47
24	139	1.41	217	1.13	263	1.03	312	.94	368	.86	425	.80	488	.75	556	.71	632	.66	703	.63	868	.56
26	128	1.66	200	1.32	243	1.21	288	1.10	340	1.00	393	.95	452	.89	513	.83	583	.78	649	.74	801	.66
28	119	1.92	186	1.53	225	1.40	268	1.28	316	1.18	365	1.10	419	1.02	476	.96	541	.90	602	.85	744	.76
29	115	2.05	180	1.65	217	1.50	259	1.37	305	1.26	352	1.18	405	1.10	460	1.03	523	.97	582	.92	719	.82
30	111	2.20	173	1.76	210	1.60	250	1.47	295	1.35	341	1.26	391	1.17	444	1.10	505	1.04	562	.98	694	.88
32	104	2.50	163	2.00	197	1.82	234	1.67	276	1.54	319	1.43	367	1.34	416	1.25	474	1.18	527	1.11	651	1.00
33	101	2.66	159	2.13	191	1.94	228	1.78	268	1.64	311	1.52	355	1.42	405	1.33	459	1.25	514	1.18	633	1.06
34	98	2.83	153	2.26	185	2.06	220	1.88	260	1.74	301	1.62	345	1.51	392	1.41	446	1.33	496	1.26	613	1.13
35	95	3.00	149	2.40	180	2.18	215	2.00	253	1.84	293	1.71	335	1.60	381	1.50	433	1.41	485	1.33	597	1.20
36	92	3.17	144	2.53	175	2.31	208	2.12	246	1.95	284	1.81	326	1.69	372	1.58	421	1.49	469	1.41	579	1.27
38	88	3.53	137	2.78	166	2.57	197	2.35	233	2.17	269	2.03	309	1.89	350	1.76	399	1.66	444	1.56	548	1.41
39	85	3.72	134	2.98	162	2.71	193	2.48	227	2.29	263	2.13	301	1.99	343	1.86	389	1.75	436	1.65	536	1.49
40	83	3.92	130	3.13	158	2.85	187	2.60	221	2.41	255	2.24	293	2.09	333	1.95	379	1.84	421	1.73	521	1.56
42	79	4.32	124	3.45	150	3.14	178	2.87	211	2.65	243	2.47	280	2.31	317	2.16	361	2.03	401	1.91	496	1.73
43	78	4.50	122	3 62	147	3.29	175	3.02	206	2.78	238	2.58	273	2.41	311	2.26	352	2.12	395	2.01	487	1.81
44	76	4.74	118	3.79	143	3.45	170	3.15	201	2.91	232	2.71	267	2.53	303	2.37	345	2.22	383	2.10	473	1.89
46	72	5.18	113	4.14	137	3.76	163	3.45	192	3.18	222	2.96	255	2.76	290	2.58	330	2.43	366	2.29	453	2.07
48	69	5.65	109	4.51	131	4.11	156	3.75	184	3.46	213	3.22	245	3.01	277	2.82	315	2.65	351	2.50	434	2.25
49	68	5.89	107	4.69	129	4.28	153	3.91	181	3.61	209	3.36	240	3.13	273	2.94	309	2.76	346	2.61	427	2.34
50	66	6.12	104	4.89	126	4.45	150	4.07	177	3.76	204	3.49	235	3.26	266	3.06	303	2.88	337	2.71	416	2.44
52	64	6.62	100	5.28	121	4.82	144	4.40	170	4.06	197	3.78	226	3.52	256	3.30	291	3.10	324	2.93	400	2.64
54	62	7.12	97	5.70	117	5.19	139	4.75	164	4.39	189	4.08	217	3.81	247	3.57	281	3.36	312	3.16	385	2.85
56	59	7.66	93	6.14	113	5.58	134	5.11	158	4.71	182	4.38	210	4.09	238	3.83	271	3.60	301	3.40	372	3.06
58	57	8.24	90	6.60	109	6.00	129	5.50	153	5.05	176	4.71	202	4.40	230	4.12	261	3.87	291	3.65	359	3.28
60	55	8.80	87	7.05	105	6.31	125	5.87	147	5.41	170	5.04	196	4.70	222	4.40	253	4.14	281	3.91	347	3.52
62	54	9.40	84	7.53	102	6.85	121	6.26	143	5.79	165	5.37	189	5.02	215	4.70	245	4.42	272	4.18	336	3.75
64	52	10.00	81	8.00	98	7.29	117	6.68	138	6.15	160	5.72	183	5.35	208	5.00	237	4.70	264	4.45	325	4.00
66	50	10.69	79	8.52	96	7.76	114	1.09	134	6.55	155	6.09	178	5.69	202	5.32	230	5.00	256	4.74	315	4.25
68	49	11.31	77	9.05	93	8.24	112	7.53	130	6.95	150	6.45	173	6.04	196	5.65	223	5.31	248	5.02	306	4.52

TABLE 11—SEMI-ELLIPTIC SPRINGS—CONSTANTS FOR FIGURING DEFLECTIONS—VALUES OF "K"

Length between centers	2½ in. by 11/32 in.	3 in. by ¼ in.	3 in. by 5/16 in.	3 in. by 11/32 in.	3 in. by ⅜ in.	3 in. by 7/16 in.	3 in. by ½ in.	3¼ in. by 5/16 in.	3¼ in. by 11/32 in.	3¼ in. by ⅜ in.	3¼ in. by 7/16 in.	3¼ in. by ½ in.	Length between centers
20	.00089	.00024	.00096	.00074	.00057	.00036	.00024	.00091	.00068	.00053	.00033	.00022	20
22	.00118	.00025	.00131	.00098	.00076	.00048	.00032	.00121	.00091	.00070	.00044	.00030	22
24	.00154	.00033	.00171	.00128	.00099	.00062	.00041	.00157	.00118	.00091	.00057	.00038	24
26	.00195	.00042	.00216	.00163	.00125	.00079	.00053	.00200	.00150	.00116	.00073	.00049	26
28	.00244	.00053	.00270	.00203	.00156	.00099	.00066	.00250	.00187	.00145	.00091	.00061	28
29	.00271	.00059	.00301	.00226	.00174	.00109	.00073	.00277	.00208	.00160	.00101	.00068	29
30	.00301	.00065	.00331	.00250	.00193	.00121	.00081	.00307	.00230	.00178	.00112	.00075	30
32	.00365	.00079	.00404	.00303	.00234	.00147	.00098	.00372	.00279	.00216	.00136	.00091	32
33	.00399	.00086	.00443	.00332	.00256	.00161	.00108	.00408	.00306	.00236	.00149	.00100	33
34	.00438	.00095	.00485	.00364	.00291	.00177	.00118	.00447	.00335	.00259	.00163	.00109	34
35	.00476	.00103	.00528	.00398	.00306	.00192	.00129	.00486	.00365	.00282	.00177	.00119	35
36	.00519	.00112	.00576	.00434	.00333	.00210	.00140	.00531	.00398	.00307	.00193	.00129	36
38	.00610	.00132	.00675	.00507	.00392	.00246	.00164	.00624	.00467	.00361	.00227	.00152	38
39	.00660	.00143	.00730	.00548	.00424	.00266	.00178	.00675	.00505	.00390	.00246	.00164	39
40	.00712	.00154	.00789	.00592	.00457	.00282	.00192	.00727	.00546	.00422	.00265	.00177	40
42	.00825	.00179	.00911	.00688	.00529	.00333	.00222	.00842	.00632	.00488	.00307	.00206	42
43	.00883	.00189	.00980	.00735	.00568	.00357	.00238	.00904	.00678	.00524	.00329	.00221	43
44	.00948	.00205	.01050	.00790	.00609	.00383	.00256	.00970	.00726	.00561	.00353	.00236	44
46	.01080	.00232	.01200	.00910	.00695	.00437	.00292	.01108	.00830	.00640	.00404	.00261	46
48	.01231	.00266	.01361	.01025	.00790	.00497	.00332	.01258	.00944	.00728	.00458	.00306	48
49	.01370	.00283	.01450	.01088	.00840	.00528	.00352	.01338	.01000	.00774	.00487	.00327	49
50	.01390	.00301	.01540	.01159	.00894	.00562	.00375	.01421	.01068	.00823	.00518	.00347	50
52	.01563	.00338	.01730	.01304	.01004	.00631	.00422	.01600	.01200	.00925	.00584	.00390	52
54	.01752	.00379	.01941	.01460	.01124	.00706	.00472	.01791	.01343	.01039	.00653	.00436	54
56	.01951	.00422	.02160	.01630	.01252	.00789	.00527	.01996	.01499	.01156	.00728	.00487	56
58	.02173	.00470	.02410	.01810	.01396	.00878	.00585	.02220	.01668	.01287	.00809	.00541	58
60	.02400	.00520	.02660	.02010	.01542	.00970	.00648	.02459	.01842	.01421	.00895	.00599	60
62	.02660	.00575	.02880	.02213	.01703	.01071	.00715	.02715	.02035	.01570	.00990	.00660	62
64	.02820	.00633	.03237	.02430	.01872	.01178	.00786	.02982	.02236	.01723	.01088	.00726	64
66	.03200	.00691	.03540	.02661	.02054	.01290	.00862	.03270	.02450	.01890	.01191	.00797	66
68	.03500	.00758	03880	.02920	.02246	.01412	.00945	.03580	.02684	.02073	.01306	.00872	68

Length between centers	3½ in. by 5/16 in.	3½ in. by 11/32 in.	3½ in. by ⅜ in.	3½ in. by 7/16 in.	3½ in. by ½ in.	4 in. by 5/16 in.	4 in. by 11/32 in.	4 in. by ⅜ in.	4 in. by 13/32 in.	4 in. by 7/16 in.	4 in. by 15/32 in.	4 in. by ½ in.	Length between centers
20	.00088	.00063	.00049	.00031	.00021	.00074	.00056	.00043	.00037	.00027	.00022	.00018	20
22	.00113	.00084	.00065	.00041	.00027	.00099	.00074	.00057	.00049	.00036	.00029	.00024	22
24	.00146	.00110	.00085	.00053	.00036	.00128	.00096	.00074	.00064	.00047	.00038	.00031	24
26	.00185	.00139	.00107	.00068	.00045	.00162	.00122	.00094	.00081	.00059	.00048	.00039	26
28	.00232	.00174	.00134	.00085	.00057	.00203	.00152	.00118	.00102	.00074	.00060	.00049	28
29	.00257	.00193	.00149	.00094	.00063	.00225	.00169	.00131	.00112	.00082	.00067	.00054	29
30	.00285	.00214	.00165	.00104	.00070	.00250	.00187	.00145	.00125	.00091	.00074	.00061	30
32	.00345	.00260	.00200	.00126	.00084	.00303	.00227	.00175	.00152	.00110	.00090	.00074	32
33	.00379	.00285	.00219	.00138	.00092	.00332	.00249	.00192	.00166	.00121	.00099	.00081	33
34	.00415	.00312	.00240	.00157	.00103	.00364	.00273	.00211	.00182	.00132	.00108	.00089	34
35	.00452	.00340	.00262	.00165	.00111	.00397	.00297	.00229	.00198	.00144	.00118	.00097	35
36	.00492	.00370	.00285	.00179	.00120	.00432	.00324	.00250	.00216	.00157	.00128	.00105	36
38	.00578	.00435	.00335	.00211	.00142	.00507	.00380	.00293	.00254	.00184	.00151	.00123	38
39	.00626	.00470	.00362	.00228	.00153	.00549	.00412	.00317	.00274	.00199	.00163	.00134	39
40	.00675	.00507	.00391	.00246	.00165	.00592	.00444	.00342	.00296	.00215	.00175	.00144	40
42	.00783	.00588	.00453	.00285	.00191	.00686	.00514	.00397	.00342	.00249	.00203	.00167	42
43	.00840	.00630	.00486	.00306	.00205	.00735	.00552	.00427	.00368	.00268	.00218	.00179	43
44	.00900	.00675	.00520	.00328	.00219	.00788	.00591	.00456	.00394	.00286	.00234	.00192	44
46	.01028	.00771	.00594	.00374	.00251	.00900	.00675	.00521	.00450	.00327	.00267	.00220	46
48	.01168	.00876	.00675	.00425	.00285	.01022	.00767	.00592	.00512	.00372	.00303	.00249	48
49	.01241	.00932	.00718	.00452	.00303	.01089	.00815	.00630	.00545	.00396	.00323	.00265	49
50	.01320	.00991	.00765	.00480	.00322	.01158	.00867	.00670	.00579	.00421	.00343	.00282	50
52	.01485	.01114	.00860	.00540	.00363	.01302	.00975	.00753	.00651	.00474	.00386	.00317	52
54	.01665	.01249	.00962	.00605	.00406	.01458	.01093	.00844	.00730	.00530	.00432	.00355	54
56	.01855	.01391	.01072	.00675	.00454	.01626	.01220	.00940	.00815	.00590	.00482	.00396	56
58	.02060	.01548	.01192	.00750	.00504	.01807	.01353	.01047	.00904	.00656	.00535	.00440	58
60	.02280	.01712	.01320	.00830	.00558	.02000	.01500	.01158	.01000	.00727	.00594	.00487	60
62	.02500	.01891	.01458	.00915	.00615	.02207	.01652	.01280	01102	.00802	.00655	.00538	62
64	.02763	.02080	.01600	.01010	.00675	.02426	.01820	.01406	.01212	.00882	.00719	.00591	64
66	.03036	.02280	.01757	.01104	.00741	.02660	.01996	.01540	.01330	.00968	.00789	.00648	66
68	.03321	.02495	.01920	.01210	.00812	.02910	.02182	.01684	.01456	.01060	.00865	.00710	68

Length between centers	4 in. by 17/32 in.	4½ in. by 5/16 in.	4½ in. by ⅜ in.	4½ in. by 7/16 in.	4½ in. by ½ in.	5 in. by ⅜ in.	5 in. by 7/16 in.	5 in. by ½ in.	6 in. by 5/16 in.	6 in. by ⅜ in.	6 in. by 7/16 in.	6 in. by ½ in.	Length between centers
20	.00015	.00066	.00038	.00024	.00016	.00034	.00021	.00014	.00049	.00028	.00017	.00012	20
22	.00020	.00087	.00051	.00032	.00021	.00045	.00028	.00019	.00066	.00038	.00023	.00016	22
24	.00026	.00114	.00065	.00041	.00027	.00059	.00037	.00025	.00085	.00049	.00031	.00020	24
26	.00033	.00144	.00083	.00052	.00035	.00075	.00047	.00031	.00108	.00062	.00039	.00026	26
28	.00041	.00180	.00104	.00065	.00043	.00094	.00059	.00039	.00135	.00078	.00049	.00033	28
29	.00046	.00199	.00116	.00073	.00049	.00102	.00066	.00044	.00150	.00086	.00054	.00037	29
30	.00051	.00222	.00128	.00081	.00054	.00115	.00072	.00049	.00166	.00096	.00060	.00040	30
32	.00062	.00268	.00156	.00098	.00066	.00140	.00088	.00059	.00202	.00115	.00073	.00049	32
33	.00068	.00295	.00171	.00107	.00072	.00154	.00097	.00065	.00221	.00128	.00081	.00054	33
34	.00074	.00322	.00187	.00118	.00078	.00168	.00105	.00071	.00242	.00141	.00091	.00059	34
35	.00081	.00351	.00203	.00128	.00086	.00184	.00115	.00077	.00264	.00153	.00096	.00064	35
36	.00088	.00383	.00222	.00139	.00093	.00199	.00126	.00084	.00288	.00166	.00104	.00070	36
38	.00104	.00449	.00260	.00164	.00110	.00234	.00147	.00096	.00338	.00195	.00123	.00082	38
39	.00112	.00486	.00282	.00178	.00119	.00254	.00159	.00107	.00366	.00212	.00133	.00089	39
40	.00121	.00525	.00304	.00192	.00128	.00272	.00172	.00115	.00394	.00228	.00143	.00096	40
42	.00140	.00608	.00352	.00222	.00147	.00317	.00199	.00134	.00456	.00264	.00166	.00111	42
43	.00150	.00652	.00378	.00238	.00159	.00341	.00214	.00144	.00490	.00284	.00178	.00119	43
44	.00161	.00699	.00405	.00255	.00170	.00364	.00229	.00154	.00525	.00304	.00191	.00128	44
46	.00183	.00798	.00462	.00280	.00194	.00415	.00262	.00175	.00600	.00346	.00218	.00146	46
48	.00208	.00906	.00526	.00330	.00220	.00473	.00298	.00199	.00681	.00385	.00248	.00166	48
49	.00222	.00965	.00559	.00352	.00236	.00504	.00317	.00212	.00725	.00420	.00264	.00177	49
50	.00236	.01025	.00595	.00374	.00250	.00535	.00336	.00225	.00771	.00446	.00280	.00187	50
52	.00265	.01152	.00668	.00420	.00281	.00602	.00377	.00253	.00866	.00501	.00314	.00211	52
54	.00296	.01291	.00749	.00470	.00316	.00673	.00424	.00284	.00972	.00563	.00353	.00236	54
56	.00331	.01440	.00835	.00525	.00351	.00750	.00474	.00319	.01081	.00625	.00394	.00264	56
58	.00368	.01602	.00928	.00584	.00391	.00830	.00526	.00352	.01203	.00695	.00437	.00293	58
60	.00407	.01771	.01028	.00645	.00432	.00921	.00581	.00389	.01330	.00770	.00485	.00324	60
62	.00450	.01960	.01132	.00713	.00463	.01021	.00641	.00430	.01470	.00851	.00534	.00327	62
64	.00492	.02148	.01242	.00782	.00525	.01120	.00705	.00473	.01615	.00935	.00588	.00395	64
66	.00541	.02360	.01363	.00860	.00575	.01228	.00772	.00517	.01770	.01022	.00645	.00432	66
68	.00594	.02582	.01492	.00938	.00631	.01346	.00846	.00567	.01940	.01121	.00705	.00473	68



Superheated Consolidation Locomotive to Which the Tender Booster Has Been Applied

Booster for Tender Trucks Developed on D. & H.

Utilizing Tender to Increase Tractive Power Enables Locomotives to Haul Heavier Trains

DURING the past two years there has been developed on the Delaware & Hudson a booster designed for application on the tender trucks. The basic principles underlying this development were: First, to utilize as a source of revenue tractive power at moderate speed the excess boiler capacity, the volume of which is increased materially by the use of superheated steam. Second, to convert the tender weight, unused as a motive agent, into a means of obtaining additional tractive power, the amount of increase depending on the speed and whether the application is made on one or both tender trucks. Third, to obtain more nearly constant tractive force at the tender draw bar during successive revolutions of the locomotive. The development of the tender truck booster has now progressed sufficiently to prove that these objectives have been attained.

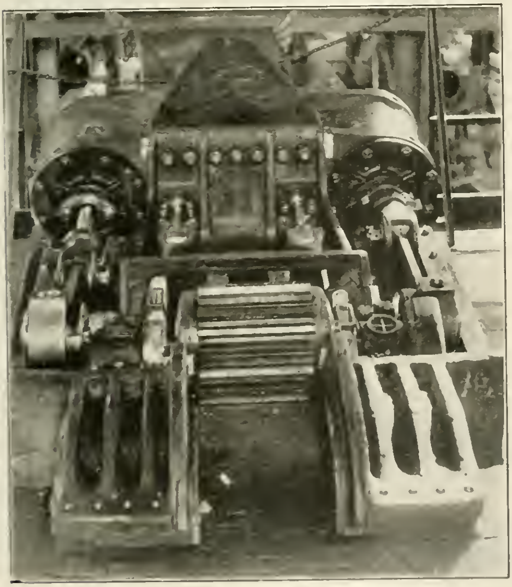


Fig. 1—Booster Engine Assembled In Shop

The tender booster, which has been patented jointly by J. A. McGrew, general superintendent of equipment and way and J. T. Loree, general manager, comprises a four-wheel truck fitted with side rods and a reciprocating steam engine, arranged to drive one of the axles. The engine which supplies the motive force for the booster is shown in Fig. 1.

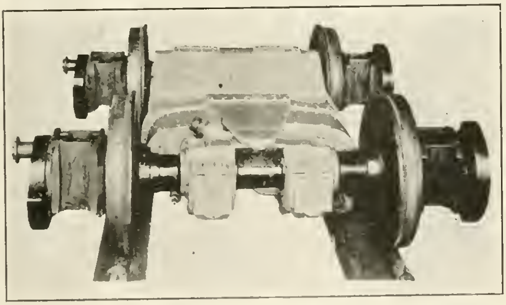


Fig. 2—Booster Truck Before Frame Has Been Applied

It is a simple two cylinder engine with 10-in. by 10-in. cylinders. On the main shaft of the booster engine is a pinion and on one of the tender truck axles is a large gear. Intermediate between them is a gear arranged to be thrown into mesh between the pinion and the large gear by a bell crank operated by a piston impelled by the superheated steam forming the motive agent for operating the booster cylinders. In Fig. 2 the engine is shown mounted on the axles before the frame has been put in place. The two bearings shown in the foreground of Fig. 1 span the geared axle and the opposite end of the frame casting rests on springs supported by journal boxes on the other axle, giving a three point support. A view of the completed truck as applied under the tender is shown in Fig. 3.

The steam supply for the booster is taken directly from the steam pipes of the locomotive. Admission of steam to the booster is controlled by an air-operated valve in the main steam line, as shown in Fig. 4. Operation of the booster is governed by an independent air valve in the cab, thus in no manner interfering with the engineman in his method of running the locomotive, enabling him to use or cut out the booster at will as road conditions may indicate to be desirable. The booster cannot be started except when the main throttle is open and if the locomotive is shut off the booster

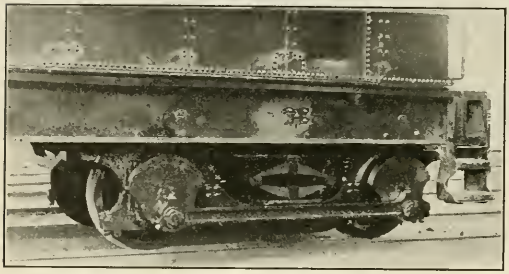


Fig. 3—Completed Truck as Applied Under Tender

is automatically thrown out of gear. Barco joints are fitted in the steam pipe between the locomotive and the tender to give the necessary flexibility at this point.

The steam on its way to the engine entrains the booster engine transmission gears. The fact that superheated steam in the locomotive steam pipe is simultaneously the motive agent of the booster and the controlling power effecting the meshing of the gears, produces practically perfect synchronization of effort of the locomotive and booster engines and also provides an elastic cushion for disengagement should excessive stresses be set up within the gears. The steam from the booster is exhausted direct, without pipe couplings, into a simple feed water heater located in the tender tank. The gear ratio between the booster engine shaft and the tender axle is 1 to 4.25, and the wheels are 33 in. in diameter. The rated tractive effort with 210 lb. steam pressure, based on the formula commonly used for locomotives, is 12,200 lb.

The locomotive to which the booster has been applied is shown in the photograph at the beginning of this article. It is of the Consolidation type, the weight of the locomotive being 207,150 lb. and the rated tractive power 42,100 lb.

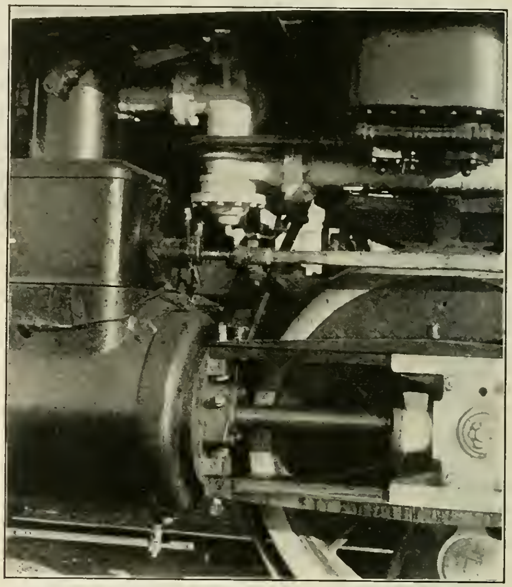


Fig. 4—Steam Pipe to Booster and Air Operated Valve

developing a maximum draw bar pull of 36,000 lb. on level track. The weight of the tender when empty is 58,800 and when loaded 120,800 lb.

To determine the results that can be obtained in actual service from locomotives equipped with the booster, tests

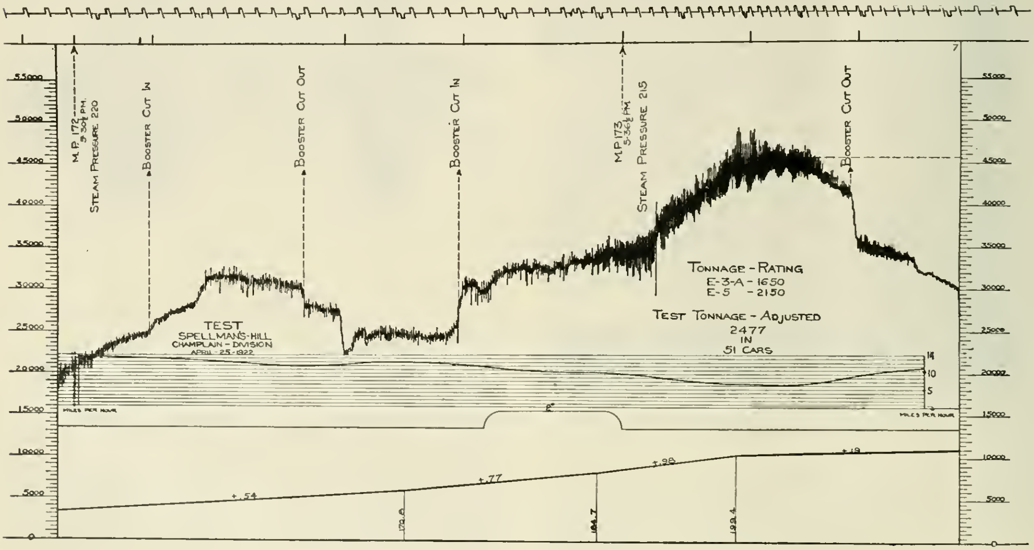


Fig. 5—Dynamometer Chart Showing Operation of Booster on a Ruling Grade

were made over the Pennsylvania, Susquehanna and Champlain divisions. A photograph taken from the dynamometer chart on the controlling grade on the Champlain division is shown in Fig. 5. The increase in tractive power due to the booster is clearly shown in the draw bar pull curve. The standard rating for this class of locomotive, without the booster, on this division is 1,650 adjusted tons, while the tonnage of the test train was 2,477 adjusted tons in 51 cars, an increase of 48 per cent.

An analysis of the various tests conducted with the booster developed the following principles:

When superheated steam is used as the motive agent in the booster, and advantage is taken of the opportunity thus afforded for using steam expansively in the locomotive cylinders, no difficulty is experienced in maintaining practically constant steam pressure.

The use of steam for the gear operating cylinders as well as for supplying power to the locomotive and booster

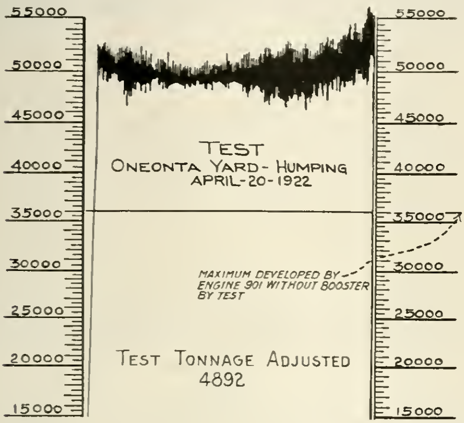


Fig. 6—Chart of Tractive Effort of Locomotive with Booster Pushing Over a Hump

cylinders, gives a complete synchronization of effort between the primary and secondary engines.

The results of the tests also clearly demonstrate the following operating advantages resulting from the booster application:

The tonnage which the locomotive can haul is increased; abnormal stresses on draft gears and equipment are decreased, and more prompt and constant acceleration is effected. Tire wear and rail wear, due to slipping of the locomotive driving wheels, are decreased. The average speed over grades is increased and grades may be equalized without a very heavy capital expenditure. The booster makes it possible to haul increased tonnage over divisions where the trainload is now limited by the weight of locomotives which the bridges can safely carry. The location of the booster is such that no delay in turning of power need be occasioned by repairs. The addition of the geared power unit on the tender permits of using a lower factor of adhesion in locomotive design. The booster also effects a saving in fuel by reducing the time required for movement over the division, and by making it possible for a smaller locomotive to do the work of a larger type.

The Central Railway Club, Buffalo, owing to the current labor troubles, has postponed until further notice its outing scheduled to take place on the last Thursday in August. The next regular meeting will be held on September 14, at 8 p. m. (standard time) at the Hotel Iroquois.

Locomotive Feed Water Heaters*

In order that definite information might be obtained as to the operation and maintenance of the Locomotive Feed Water Heaters, a questionnaire was compiled and sent to the presidents of 137 railroads in the United States and Canada. Answers were received from 78 of these roads, 20 roads having feed water heaters.

In 1920 there were seven roads using feed water heaters. There are now 28 American roads with five types of heaters on order or in service. The number of the different types of heaters in use or on order are as follows:

The Superheater Company's feed water heater	93
Worthington feed water heater	136
Weir feed water heater	1
Simplex-Blake-Knowles feed water heater	3
Local type	1
Total heaters applied or on order	234

The advisability of extending the use of locomotive feed water heaters is strongly recommended by five railroads; the other roads consider that the process of development is yet in the experimental stage and are waiting until further tests show that the economy derived will justify their use.

The application of feed water heaters has not been limited to any single class of power or service. The largest locomotive equipped with a feed water heater is a Mallet type of 107,961 lb. tractive effort, while the smallest is an American type of 24,000 lb. tractive effort. Other types of locomotives to which feed water heaters have been applied are Mikado, Pacific, Consolidation, Mountain and locomotives in suburban service. These locomotives operate in both passenger and freight service on mountainous and rolling territory. Both coal and oil are used for fuel.

One of the most important considerations in the selection of the type of feed water heater to be used, is the character of the water in the territory through which the locomotive is to operate. In bad water districts, the open type heater seems to be preferred, as the scale deposits on the tubes of the closed type heater retard the heat transmitted and reduce the efficiency of the heater, and there would be less danger of boiler trouble from oil due to the frequent washouts. No road has reported trouble from oil from the feed water in the boiler. Roads where the boiler washout period averages 30 days generally prefer the closed type of feed water heater.

Three roads have reduced the size of the exhaust nozzles on application of feed water heaters and one road has enlarged the nozzle. The reduction in the size of the nozzle is done in order to offset the loss in superheat temperature which occurs when a feed water heater is applied to a locomotive. This is not considered advisable, as the reduction of the size of the nozzle increases the back pressure, which will probably offset any saving that would be effected by the increased superheat.

There has been no difference reported in the amount of boiler scale in boilers equipped with feed water heaters over the other engines.

The open type heater has in all cases gone from shopping to shopping without cleaning, regardless of the water conditions. While going through the shop the scale deposit is scraped from the inside of the heater, no acid or cleaning solution being used.

In good water territory, the closed type of heater is cleaned each time the locomotive is shopped. The usual method of doing this is to dip the tube nest into a lye vat to remove any oily deposit which may have formed on the outside of the tubes. In districts where the water conditions necessitate more frequent cleaning, the deposit is either washed out by flushing the heater with water or, if the scale is not soluble, a dilute solution of muriatic acid is pumped through the heater for a short time and then water is pumped

*Abstract of a paper presented before the International Railway Fuel Association, Chicago, May, 1922.

through to clean out the acid. The strength of the acid varies from 20 to 33⅓ per cent, depending on the nature of the scale.

The highest cost of cleaning the feed water heater is $170.00 per year, both labor and material, and the lowest cost is $2.31. In one case the heater is cleaned by the use of dilute muriatic acid; the other, by a basic solution. An average of the cost data submitted by all the roads for cleaning by the acid process is $62.19 per heater per year, which includes both labor and material.

The cost of other maintenance of the heater proper per year is practically nothing on both the open and closed types. Where weak acid solutions are used, none of the heaters cleaned show any signs of deterioration due to the use of the acid. The territory in which locomotives equipped with feed water heaters operate, includes the greatest range of climatic conditions possible. No serious difficulty has been encountered with any of the feed water heater systems freezing up. Drain valves and telltale pipes have frozen up, but these have given no further trouble after lagging.

Failures of the heater proper while in service have occurred, due to tubes bursting or becoming loose in the tube sheet, heater heads cracking with the closed type of heater, and a crack developed in the cylinder near the discharge valve on the open type of heater. The brass tubes in the closed heater have been replaced by copper tubes, which are more ductile than the brass and a better joint can be made when the tubes fasten into the header. Some trouble has been experienced with the boiler checks pounding out or breaking off with the use of feed water heater equipment. This has been largely overcome by using larger boiler checks with reduced lift.

The boiler feed pump has given good service with all types of heaters. The most common defects which have been encountered are the pump piston rod packing leaking, rods wearing, water valve springs breaking, water cylinder scoring, top head pump gasket leaking, abnormal lift of intake and outlet valves, and valves stuck or leaking. The average cost of maintenance per pump, taken from the data submitted, is $55.16 per year, including labor and material.

The cost of maintenance of the feed water heater apparatus complete averages $97.15 per locomotive for labor and material per year. This figure was determined by averaging the maintenance costs submitted by all the roads, regardless of the type of heater used.

As all the locomotives, which are equipped with feed water heaters, have an injector, no engine failures could be attributed to the operation of the feed water heater apparatus, as the injector was used to supply the boiler in case of the failure of the feed water heater.

Where feed water heaters are applied, the enginemen should be personally instructed relative to the operation of the equipment in order that the highest efficiency may be obtained. The feed water heater pump should only be used to supply the boiler when the engine is working steam, as the exhaust steam from the auxiliaries is not sufficient to heat the water hot enough to show a saving, and the introduction of the cold water into the boiler would tend to cause serious strains in the flues and flue sheets. The rule to pump locomotives with feed water heaters only when working steam, is in force on very nearly all the roads.

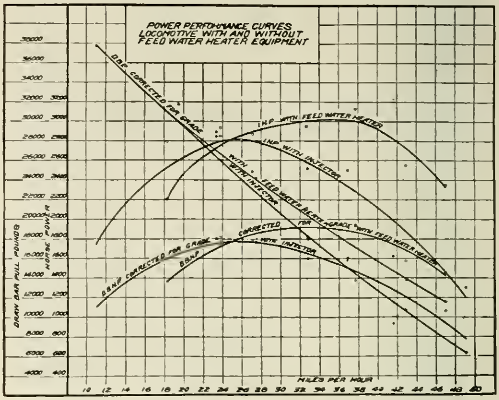
It has been possible to eliminate some water tank stops when the condensate from the feed water heater is returned to the boiler.

On tests made on feed water heater locomotives, the feed water heater shows a saving of between 10 and 16 per cent in fuel, based on the evaporation performance of the locomotive. On two roads where dynamometer car tests had been conducted on feed water heater locomotives, there was a saving of approximately 10 per cent based on fuel consumption per drawbar horsepower. On a thousand ton mile basis, the saving varies from 4 to 11 per cent.

The accompanying power performance chart is based on data taken on dynamometer car tests. It shows that with the feed water heater locomotives, there is an increase of both indicated and drawbar horsepower. This increase in horsepower is due to the back pressure being decreased by diverting about 12 per cent of the exhaust steam from the cylinders to the feed water heater, thus increasing the steaming capacity of the locomotive at high speeds. This increased horsepower will permit an increase in the tonnage rating and average speed of the locomotive.

In its present form the locomotive feed water heater has passed through the experimental stage in this country and the results indicated in this report are typical of what may be anticipated from the application of feed water heaters on other railroads, barring unusual local conditions.

At the present time, the exhaust steam injector as extensively used abroad is being considered as an alternative to the open type of locomotive feed water heater. One American firm is already engaged in the manufacture of this device, and arrangements are being perfected for supplying the railroads in this country with a type of exhaust steam injector that has been successfully used on an extensive scale in England and her colonies.



Results of Dynamometer Tests With and Without Feed Water Heaters

The report was signed by E. E. Chapman, chairman (A. T. & S. F.); J. R. Alexander (Penn.), E. A. Averill (Superheater Company), J. A. Carney (C. B. & Q.), J. N. Lammedee (Worthington Pump & Mchy. Corp.), L. P. Michael (C. & N. W.), Geo. E. Murray (Grand Trunk), C. B. Peck (*Railway Age*), L. G. Plant (Railway Review), G. B. Von Boden (Sou. Pac.), W. H. Winterrowd (Can. Pac.).

Discussion

H. B. Oatley (Superheater Company), called attention to the fact that feedwater heating has been practiced as long as the injector has been used to feed the locomotive boiler, although in the live steam injector the heat is taken direct from the boiler and is not reclaimed. He then referred to the exhaust steam injector, which has been used extensively in England and the British Colonies, and said that from seven to eight pounds of water could be passed from the tank to the boiler for each pound of steam condensed in the injector; the exhaust steam alone at one, three and five pounds pressure being capable of delivering against boiler pressures of 150 lb., 165 lb. and 180 lb. respectively. A small amount of line steam is required to supplement the exhaust steam for delivery against higher pressures. Mr. Oatley suggested that the possibilities of heat reclamation with the exhaust steam injector compare favorably with those of other types of feed water heaters.

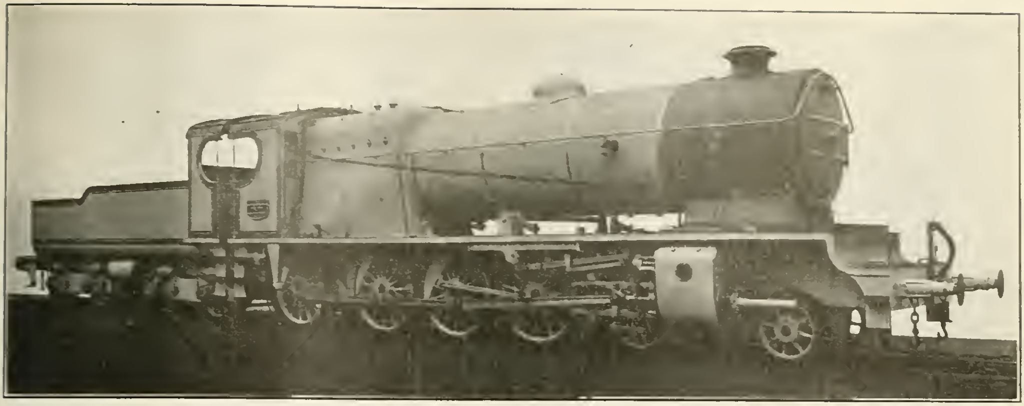


Fig. 1—Three-Cylinder Locomotive Built by Yorkshire Engine Company, Ltd.

Three-Cylinder Locomotive for Spanish Service

Heavy 4-8-0 Type of an Unusually Well-Worked-Out Design with Many Interesting Features

LOCOMOTIVES of the three-cylinder single-expansion type are meeting with increasing favor on British and also on a number of European roads which are noticeable for advanced designs. Engines of this type are being designed for heavy power to be used in either passenger or freight service and are taking the place of compound and four-cylinder simple locomotives.

Spain is a country intersected by a number of mountain ranges which form barriers between many of the principal cities and the seaports. As a result of the relatively sparse population and the high cost of railroad construction due to the mountainous character of the country a large amount of the mileage is of single track and frequently with long and heavy grades. Moreover, the lightness of the bridges and rails does not admit of a high axle load. The two largest railroads are the Madrid, Zaragoza y Alicante and the Norte, each of which has about 2,300 miles of 5 ft. 6 in. gage line. On the former the axle load is limited to 16 metric tons (35,260 lb.) and on the latter to 15.8 metric tons (34,825 lb.). In addition, the maximum allowable running weight over locomotive and tender buffers is 6 metric tons per meter, or 4,035 lb. per foot. The minimum radius of curves around stations is 200 meters (656 ft.).

For many years much more powerful locomotives have been used in Spain than are ordinarily employed on European railroads. A number of these locomotives have been built in the United States as, for example, the lot of 25 four-cylinder balanced compounds of the 4-8-0 type delivered to the Madrid, Zaragoza y Alicante in 1917 by the American Locomotive Company. These were practically duplicates of previous German locomotives, weighed 192,900 lb. for the engine in working order exclusive of the tender and exerted a tractive effort of 35,500 lb. simple and 29,550 lb. compound. In 1920 another lot of 15 locomotives was delivered to the same road. They, however, were of the Pacific type, designed along American lines, had 23 in. by 26 in. cylinders, 65 in. wheels, weighed 188,500 lb. and were proportioned for a tractive force of 28,830 lb.

The Spanish Government recently adopted a high tariff on imported goods with the object of fostering the manufacture in Spain of machinery and other commodities including locomotives. As a result of the inauguration of this protection policy, La Sociedad Espanola de Construcciones Babcock y Wilcox, which has a large new plant at Bilboa, decided to add the building of locomotives to their line of manufacture. An order for a sample locomotive to meet Spanish requirements was consequently placed by them with the Yorkshire Engine Company, Ltd., Meadow Hall Works, Sheffield, England. The locomotive, which is of the three-cylinder, 4-8-0 type, has now been delivered and will be tested out on several Spanish roads.

The weight of the locomotive in working order is 194,400 lb. of which 137,000 lb. are on the drivers and 57,400 lb. on the front truck. The tender, which is carried on two four-wheel trucks, has a capacity of 4,840 gal. of water and seven tons of coal and weighs 112,500 lb. in working order. These figures correspond to a driving axle load of 34,250 lb. and as the length of locomotive and tender over buffers is 76 ft. 2½ in., the weight per running foot is 4,027 lb. or practically the allowable maximum.

As the weight on the drivers is 137,000 lb. and the rated tractive force, calculated on a basis of 85 per cent m.e.p. is 41,950 lb., this gives a ratio of 3.27 to 1, a low figure but apparently entirely practical on account of the even torque produced by the three cylinders with cranks set at 120 deg. In fact the three-cylinder system appears to be the logical solution of the problem of designing a locomotive of high tractive force with restricted axle loadings.

From the table of dimensions, weights and proportions it will be noted that the weight is 92.6 lb. per cylinder horsepower and 114.2 lb. per boiler horsepower which shows good designing in the use of materials.

The boiler horsepower, calculated according to the practice of the American Locomotive Company, is only 1,702 whereas the cylinder horsepower is 2,100. The coal rate per square foot of grate per hour is 136 lb., assuming coal to be of 12,000 B.t.u. value. The boiler capacity is less than would appear to be advisable judging by American experience.

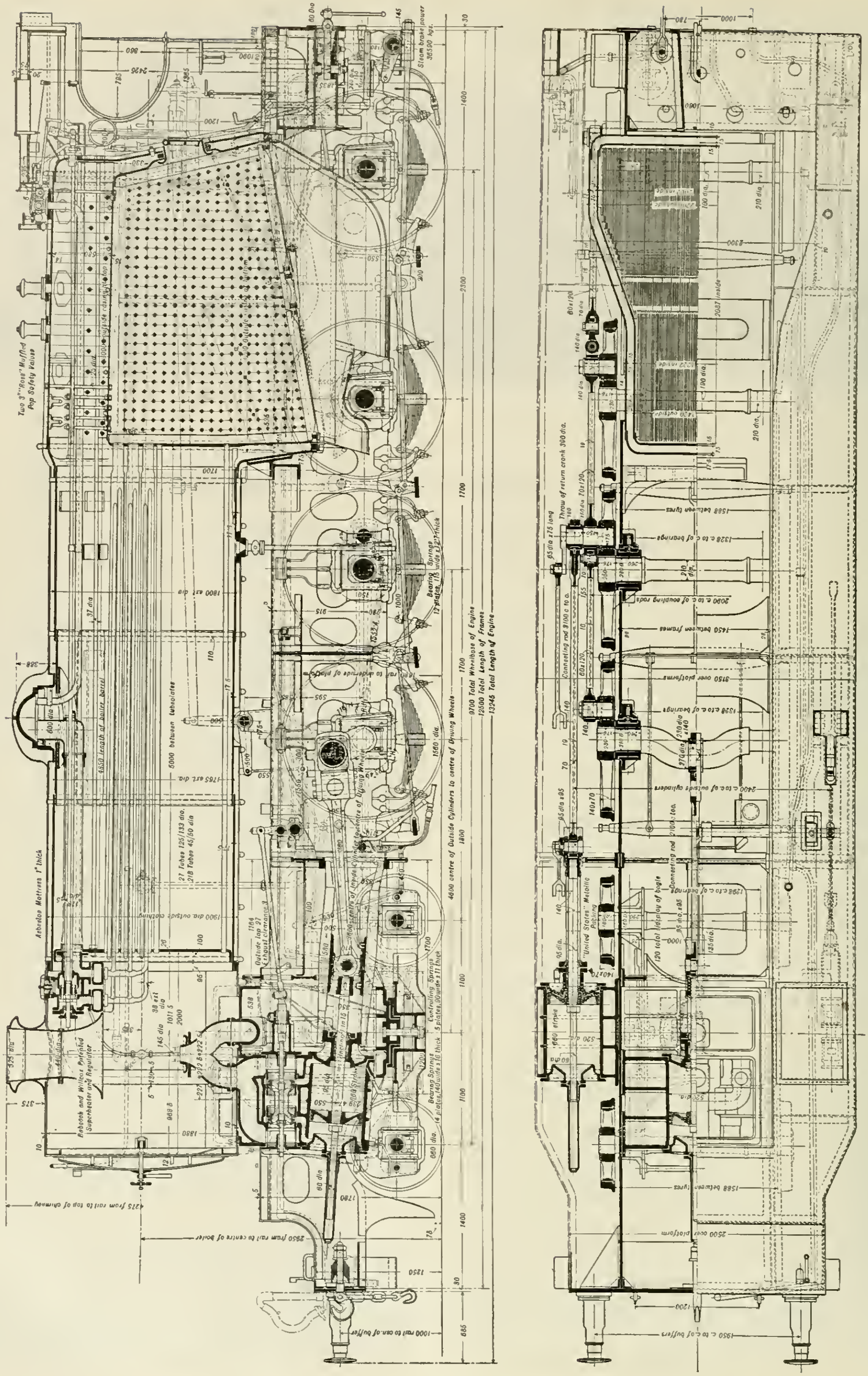


FIG. 2—ELEVATION AND PLAN OF THREE-CYLINDER LOCOMOTIVE FOR SPAIN

All Dimensions are given in Millimeters

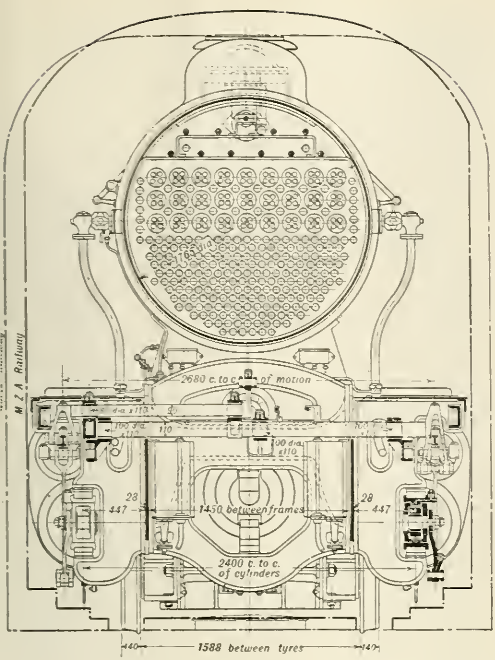


FIG. 3—SECTION THROUGH BOILER

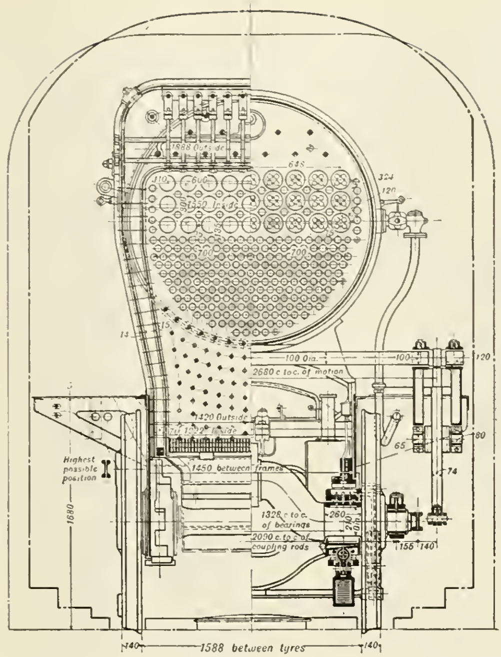


FIG. 4—SECTION THROUGH FIREBOX AND CRANK AXLE

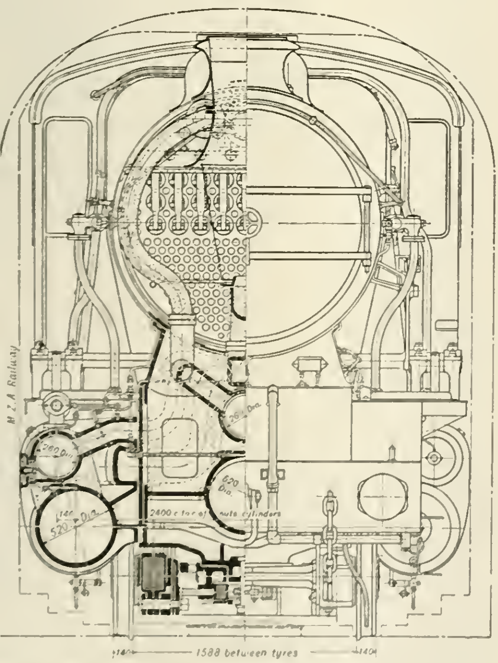


FIG. 5—SECTION AT CYLINDERS AND HALF-FRONT VIEW

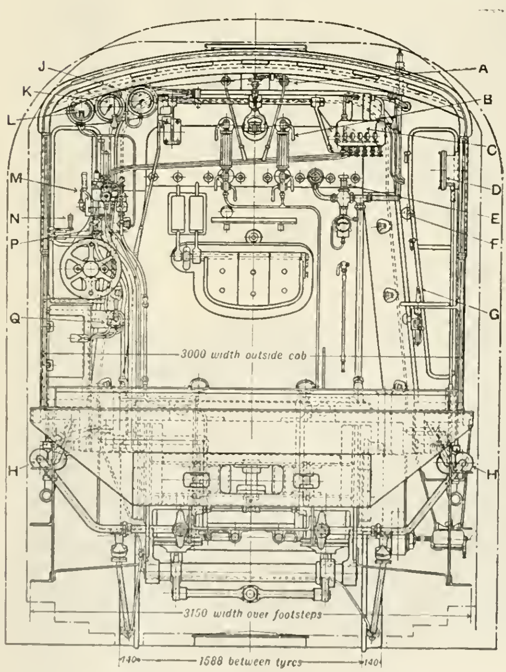


FIG. 6—REAR VIEW AND ARRANGEMENT OF CAB

Moreover the grate area, one square foot for 42 hp., is less than would be used in this country, especially in view of the rather low grade of Spanish coals.

The general design is well shown in the elevation and cross section drawings which are reproduced from the description of the locomotive given in the Engineer, London.

All three cylinders are of the same size; namely, 20½ in. by 26 in. The outside cylinders are horizontal and

Table of Dimensions, Weights and Proportions

	Metric	English
Cylinders, 3 of	520 mm. by 660 mm.	20½ in. by 26 in.
Valve gear	Walschaert type	....
Valves, piston type, size	260 mm.	10¼ in.
Outside lap	27 mm.	1⅝ in.
Exhaust clearance	3 mm.	3/16 in.
Weights in working order:		
On drivers	62,000 kg.	137,000 lb.
On front truck	26,000 kg.	57,400 lb.
Total engine	88,000 kg.	194,400 lb.
Tender	51,000 kg.	112,500 lb.
Wheel base and length:		
Driving	5.700 m.	18 ft. 8⅜ in.
Total engine	9.700 m.	31 ft. 9⅞ in.
Total engine and tender	18.930 m.	62 ft. 1¼ in.
Total length over buffers	23.230 m.	76 ft. 2½ in.
Wheels, diameter outside tires:		
Driving	1.560 m.	61 7/16 in.
Front truck	0.860 m.	33⅞ in.
Tender	1.080 m.	42½ in.
Journals, diameter and length:		
Driving, second	230 mm. by 260 mm.	9 in. by 10¼ in.
Driving, others	210 mm. by 260 mm.	8¼ in. by 10¼ in.
Front truck	160 mm. by 290 mm.	6¼ in. by 11 7/16 in.
Boiler:		
Type	Raised Belpaire	....
Steam pressure	13 kg. sq. c.m.	185 lb.
Diameter, first ring, outside	1.800 m.	70⅞ in.
Firebox, length and width	2.989 m. by 1.222 m. and 2.002 m.	100 in. by 48 in. and 79 in.
Height, grate to crown sheet, back	1,420 mm.	56¼ in.
Height, grate to crown sheet, front	1,980 mm.	77¾ in.
Tubes, number and outside diameter	218—0.050 m.	218—1.97 in.
Flues, number and outside diameter	27—0.133 m.	27—5.23 in.
Length between tube sheets	5.000 m.	16 ft. 4⅞ in.
Tube spacing	20 mm.	25/32 in.
Flue spacing	17 mm.	13/16 in.
Grate type	Orleans	....
Grate area	4.65 sq. m.	50 sq. ft.
Heating surfaces:		
Firebox	18.4 sq. m.	198 sq. ft.
Tubes	171.0 sq. m.	1,840 sq. ft.
Flues	56.8 sq. m.	610 sq. ft.
Total evaporative	246.2 sq. m.	2,648 sq. ft.
Superheating	47.1 sq. m.	507 sq. ft.
Comb. evaporative and superheating	493.3 sq. m.	3,155 sq. ft.
Tender:		
Water capacity	22,000 kg.	4,840 gal.
Fuel capacity	7,000 kg.	7 tons
General data, estimated:		
Rated tractive effort, 85 per cent	18,970 kg.	41,950 lb.
Cylinder horsepower	....	2,100 hp.
Boiler horsepower	....	1,702 hp.
Speed at maximum horsepower	68 km. p. h.	42.2 m.p.h.
Steam required per hour	....	43,680 lb.
Boiler evaporative capacity per hour	....	35,400 lb.
Coal required per hour, total	....	6,825 lb.
Coal, rate per sq. ft. grate per hour	....	136 lb.
Weight proportions:		
Weight on drivers ÷ tractive force	....	3.27
Weight on drivers ÷ total weight engine	....	70.5
Total weight, engine ÷ cylinder horsepower	....	92.6 lb
Total weight, engine ÷ boiler horsepower	....	114.2 lb.
Boiler proportions:		
Boiler horsepower ÷ cylinder horsepower, per cent	....	81
Comb. heating surface ÷ cylinder horsepower	....	1.50
Tractive force ÷ comb. heating surface	....	13.30
Tractive force × dia. drivers ÷ comb. heating surface	....	817
Cylinder horsepower ÷ grate area	....	42
Boiler horsepower ÷ grate area	....	34
Firebox heating surface ÷ grate area	....	3.96
Firebox heating surface ÷ evap. heating surface, per cent	....	7.5
Superheating surface ÷ evap. heating surface, per cent	....	29.2
Tube length ÷ inside diameter	....	111

coupled to the second pair of wheels by main rods 122 in. long. The inside cylinder is set forward of the other cylinders and inclined at 1 in 15, the main rod, which is connected to the forward axle, being 82¾ in. long. This arrangement secures a main rod of reasonable length for the inside cylinder and gives a good distribution of driving stresses on the various axles. Each cylinder is cast separately, the inside cylinder being integral with the smokebox saddle. There are only two steam pipes in the smokebox. Each passage is divided into two, one going to the inside steam chest and the other to the outside steam chest. Exhaust passages are short and direct. A by-pass valve is applied to each cylinder. These valves are entirely automatic in their action, remaining closed as long as there is pressure in the steam chest and opening when steam is shut off or when excessive compression occurs.

Particular attention was taken to secure lightness as well as strength and durability in all moving parts. Pistons are of forged steel, finished all over. Valves are of the hollow piston type with inside admission and have forged steel heads, machined all over and welded to a section of solid drawn tubing. In addition to using channel sections for main and side rods, some of the motion parts are also of channel section.

The crank axle is of circular section, forged in one piece and bent to shape. Driving boxes are of cast steel with phosphor-bronze bearings.

Plate steel frames, 1⅛ in. thick, reflect British practice as does the use of underhung springs, which are equalized in two groups. The front truck has a side play of 2⅜ in. each way and is centered by elliptic springs.

All three valves are driven by two gears of the Walschaert type. The outer valves are connected to the gear in the usual manner. The motion of the inside valve is obtained by means of a rock shaft carried in fixed bearings and driven from one side of the engine. This shaft, which has arms in the ratio of 2 to 1, carries a floating shaft in bearings formed in its short arms. The arms of the floating shaft are of equal length and it is driven from the other side of the engine. The general arrangement has been successfully used on a number of three-cylinder locomotives. This design gives straight line connections and permits the withdrawal of any of the piston valves without interference with the valve gear.

The boiler is of the raised-top Belpaire type with "Orleans" type firebox. The grate surface is 100 in. long, 79 in. wide at the back end, where the grates are raised above the rear drivers, and only 48 in. wide at the front, where the grates slope down between the third pair of drivers. This arrangement gives a good firebox volume with sufficient space between grates and the brick arch without unnecessarily raising the center line of the boiler.

The superheater and regulator or throttle valve are of special design, patented by Babcock and Wilcox. A 7-in. saturated steam pipe is carried from the dome to the cast steel

Index to Cab Fixtures

A—Injector steam cocks
B—Dewrance's water gages
C—Six-feed vacuum lubricator, capacity 6 pts.
D—Hasler speed indicator and recorder.
E—Heintz steam heating valve
F—Blower cock
G—Drop grate handle
HH—Gresham and Craven's No. 10 hot water injectors
J—Steam pressure gage
K—Steinle pyrometer
L—Duplex vacuum gage
M—30/20 Dreadnaught ejector with steam brake valve
N—Leading sanding handle
P—Cylinder cock handle
Q—Steam sanding valve

throttle chamber casting in the smokebox and thence to a forged steel leader from which branches lead to the 27 superheater elements which are of 1½ in. outside diameter. The superheated steam passes to another header connected to the front portion of the throttle chamber casting. The throttle valve is of the hollow piston type and when closed permits the superheated steam to flow through it and pass to the boiler through a small return pipe. This return pipe is open when the steam is shut off from the cylinders and closed when the main throttle valve is opened. By this arrangement dampers and circulating devices are not required. Superheated steam is always instantly available while the expansion of steam in the superheater elements cannot cause the engine to be started unintentionally.

The cab is arranged for left hand operation and the various fixtures are conveniently placed as will be observed from one of the drawings. The accompanying table gives the names of the different devices.

The driver brake rigging is of the equalized type with brake shoes on the front side of all driving wheels and is well designed, although American practice would favor the use of separable brake shoes and heads with shoes applied on the back side of the wheels. The driver brakes are operated by two steam brake cylinders, 9½ in. diameter by 6 in. stroke. The braking power is 36,590 kg. (80,600 lb.) or 59 per cent of the weight on the driving wheels. The locomotive is equipped with Gresham and Craven's "Dreadnaught" ejector for the operation of the vacuum brakes on the tender and train.

The design of this locomotive is of more than ordinary interest and it is hoped that we will be able to secure information in regard to its performance at some future date.

Strength of Welded Pressure Containers*

THE following conclusions were reached as the result of an investigation of pressure tests on electric welded, gas welded and riveted pressure containers, similar to air reservoirs used in railroad service, furnished by the Vilter Manufacturing Company, Milwaukee, Wis. Tension and shear tests on specially prepared specimens of welded metals, also were made, demonstrating the strength and uniformity of construction secured by electric welding. In all nine containers were tested, using pressures from 200 to 2,100 lb. per sq. in. The containers were 15¼ in. in internal diameter and 10 ft. long with inserted dished ends held in place by electric welding.

Some of the more important points brought out by the tests are enumerated and discussed below.

Weak points in the containers. None of the welded containers of standard design failed primarily at the welded head joint. The nature of the fracture shows that the weak points in the containers were, first, the lap weld in the pipe forming the shell, where failure occurred due to circumferential tension, and, second, the body of the shell at its junction with the head flange, where failure occurred due to the combination of longitudinal tension and bending. It appears that leakage is likely to occur first where couplings and nipples are welded in. This is due to the fact that the metal of the shell stretches and pulls away from the nipple, which does not have a corresponding strain induced in it by internal pressure.

Strength of electric welds. From the tests on four specially prepared specimens, the average tensile strength of electrically welded joints was found to be 28,500 lb. per sq. in. From tests on five specimens cut from containers, the average shearing strength of electrically welded joints was found to be 25,500 lb. per sq. in. The mean variation from the average tensile strength per linear inch of weld was found to be 2 per cent, and the maximum variation 4.5 per cent. The mean variation from the average shearing strength per linear inch of joint was found to be 5.2 per cent and the maximum variation 7.8 per cent. The results of eccentric tension tests on specimens cut from containers showed that no one of the specimens was markedly weaker than the average for the lot. It is believed that the uniformity of strength thus indicated is of especial interest and importance.

In connection with the values given above for tensile strength, two points should be noted. First, at the section through the weld, where failure took place, the load was eccentric, because of the fact that the specimen is unsymmetrically thickened at that point by the joint. This eccentricity undoubtedly made the average stress on the joint at failure less than it would otherwise have been, and so the values obtained were less than the actual tensile strength of the metal. The effective eccentricity was not as great as one-half of the excess thickness of the joint, because the ends of the specimen were restrained. No attempt has been made to allow for the effect of this eccentric loading, because it represents a condition inherent in any so-called single-V weld which has an excess thickness.

Second, each of the four specimens had, within its tested length, several transverse welded joints. The strength of each specimen, therefore, represents the strength of the weakest of these seven joints, and so the value given, 28,500 lb. per sq. in., is less than the average strength for all joints.

Relative strength of electrically welded and riveted joints. The tension tests indicated that the resistance to tension applied with a large eccentricity is greater for the riveted joint than for the welded joint. The shear test indicated that the resistance to shear per linear inch of joint is greater for the welded joint. Measurements to determine the elastic and permanent protrusion of the container heads showed that for the two specimens so tested the welded container withstood a somewhat greater pressure without permanent distortion. In the case of the riveted containers, leakage occurred at the head joints under moderate pressures. In the case of the electrically welded containers there was no leakage at the head joint under any pressure.

Efficiency of electrically welded joints. While it is customary to speak of the efficiency of a joint, whether welded or riveted, meaning the ratio of the strength of joint to strength of plates joined, the writer does not believe that this ratio is especially significant in the case of electrically welded joints nor that any generally applicable value can be given.

It is apparent that while the strength of the plates joined is dependent solely on the physical properties of the base metal, the strength of the weld is in great measure dependent on the properties of the filling metal. Furthermore, the per cent excess thickness of the weld, which influences its strength, varies with the thickness of the plates. Accordingly the efficiency of a weld depends on the properties of the base metal, the filling metal, and the thickness of the plates.

The writer believes that the correct method of computing the efficiency of an electrically welded joint is on the basis of a specified minimum strength of base metal, a specified minimum excess thickness of weld and an experimentally determined average (per sq. in.) of the metal, of which the finished weld is composed.

*From a paper presented by Assistant Professor R. J. Roark, University of Wisconsin, at the spring meeting, Atlanta, Ga., May 8-11, 1922, of the American Society of Mechanical Engineers.

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The Erie Triplex on the Susquehanna Grade

WHAT OUR READERS THINK

Suggestion for Locomotive Designs

PHILADELPHIA, Pa.

TO THE EDITOR:

One of your correspondents in the May issue suggests the use of a high speed reciprocating engine, coupled to the wheels through a reduction gear, for a steam locomotive. While not impossible, a drive of this kind would be difficult to apply and the expense would, without doubt, be in excess of the present almost universal two outside cylinders.

As I see it, one of the principal things standing in the way of the turbine drive for the steam locomotive is this same matter of a reduction gear. Having worked on reduction gears, I was surprised when I first started at the amount of room that they took up in comparison with that needed for the two cylinders of the locomotive. A small condensing unit, say for 600 kw., will be about 10 ft. long, or just about the limit of the available space under a locomotive and a unit large enough for a good sized engine would be too large to get in. This represents stationary and marine practice, but it is possible that for railroad work something smaller might be built.

The problem of designing an engine to go inside the smokebox and arranging for the smoke and cinders to pass by it without damaging the engine or cutting off the draft is a difficult one. The crossheads and guides would have to be entirely enclosed and the rods would have to be protected. It would be necessary for the rods to extend through the smokebox to the pinion shaft below, because the pinion shaft could hardly be expected to run in the heat of the smokebox. This means that there would have to be an air tight covering for the rods, otherwise the draft would be broken.

While at first sight the proposition looks favorable on account of the smoother running of the small engine and the probable more favorable action on the rail, it would seem that the same results could be obtained more cheaply by the use of a third cylinder between the frames. The use of three cylinders has been tried on but one road in this country so far as I know, and it was abandoned with a change of management on account of the increased difficulty of keeping the engines in service. GEORGE L. CLOUSER.

Co-operation, Not Criticism, Needed

LORAIN, Ohio.

TO THE EDITOR:

Comments by "Mechanic" and "Supervisor" in the April and May issues of the *Railway Mechanical Engineer* if continued along the same line, will not be productive of much good to any of us. Endless carping criticism will not get us anywhere, rather let us have a constructive criticism. The position of any railroad supervisor is not one to be envied, their responsibility does not cease with the blowing of the quitting time whistle; the majority carry their load every minute of the 24 hours. At the finish of one day any plans for the next may be entirely upset by the unexpected happenings which occur in the motive power department; to meet these exigencies taxes the ingenuity and patience of any foreman and if, as "Mechanic" states, engines are sent out with work not completed or not done, he can rest assured that the spirit of the I. C. C. laws is complied with, if not exactly to the letter.

The I. C. C. laws do not demand a 100 per cent engine, but do ask that an engine be in a reasonably safe condition. Can "Mechanic" say with his years of experience that he has looked over some engines just new from the builders and found them perfect; can he not recall some little defect which, as he and others talked it over, grew from a mole-hill to a mountain?

The writer is one in the ranks and has been for 29 years. The longer I am in the game, the more I see the need of a get-together spirit. Foremen are not perfect, neither are the mechanics. There is just as much egotism in shop men as there is among the supervising forces. "Mechanic" may have been unfortunate to have as a foreman one who is not big enough in character, nor broad enough in principle to occupy such a position. There are such, we know, but it takes all kinds of people to make a world and if we have such an opinion of a foreman, ten chances to one he has a worse opinion of us. One of the brightest spots in my railroad life came a few days ago when our local supervising head called all the men in the shop together and asked for a better understanding and more of a fifty-fifty feeling between us, the men and the company. Co-operation is what is needed; it is not an impossibility, it is one of the steps to a better understanding of each other's difficulties.

JOSEPH SMITH.
Boiler Inspector, Baltimore & Ohio.

Why College Men Do Not Stay in Railroad Service

WHEATON, Ill.

TO THE EDITOR:

It is with considerable interest that I have read many letters, editorials and communications in the *Railway Mechanical Engineer* and the Railway Age pertaining to the employment of college men in the motive power departments of our railroads. I wonder if my own case is typical of the few college men who have entered railroading as a life's vocation. If so, I believe the reason for so few men entering the doors of this, the country's greatest industry, is quite evident.

The writer graduated from one of the leading western universities six years ago and it is not without a little pride that he can point to the fact that he was awarded final honors in this institution. This statement is made simply to combat one made in the Daily Edition of the Railway Age, which statement declared that the better class of college men do not enter the employment of the railroads but that only the dregs or those who cannot find employment elsewhere are really available.

Upon graduation the writer entered the service of Uncle Sam as an officer in the Coast Artillery. Again it is not without some honest pride that the writer can state that he received honors while in the service. Also, he received some valuable training in the handling of skilled mechanics and expensive machinery.

Upon discharge from the army, the writer entered the service of a large western road as a special apprentice. In spite of very low rates of pay, lay-offs, strikes and the like, the course was finally completed to the complete satisfaction of the subordinate officials with whom he came in daily contact.

During the above apprenticeship course the writer spent over a year giving the company the benefit of his technical knowledge in the testing of locomotives and their accessories. In the performance of this work he repeatedly had men and foremen under his direction whose compensation was twice or thrice that of the writer. Also, reports were prepared out of hours in order that busy officers might have them at the time demanded, this without any extra compensation or commendation. The above was willingly done, however, due to a long entertained and real liking for railroad work.

Upon completion of the course the writer was offered two alternatives, one to accept a position as a machinist with the company, and the other to sever relations and find employment elsewhere. He was told that there were no vacancies among the positions of subordinate officers or foremen at the time but that he would be kept in mind when one did arise. Because of a liking for the work the position as a machinist was accepted. Since that time many vacancies for the better positions have occurred but the writer is still a machinist.

On July 1 the writer of necessity went on strike with the rest of the shopmen. Practically I am "outlawed" from my chosen vocation. Therefore, as many college men before me have done, it becomes necessary to leave railroading as a vocation and find some other line of work, in spite of the fact that I prefer my present work and have had considerable training in it—all this at an age when I should be fairly well settled in some vocation for life.

If my experience has been typical of that of most college men, perhaps one of the main reasons for the scarcity of technical men in the motive power departments of the various railroads is evident. A College Man.

AIR BRAKE CORNER

1923 Air Brake Association Convention

Steps are already being taken to make the convention at Denver in May, 1923, one of the most important gatherings in many years. Any member who has suggestions to offer as to subjects or otherwise, should communicate immediately with F. M. Nellis, secretary.

This year's convention at Atlantic City was well attended, as is evidenced by the registration of 310 members and 154 guests, or a total of 464. The presiding officer was L. P. Streeter, president. The officers elected for the ensuing year were: President, Mark Purcell (Northern Pacific); first vice-president, George H. Wood (Atchison, Topeka & Santa Fe); second vice-president, Charles M. Kidd (Norfolk & Western); third vice-president, R. C. Burns (Pennsylvania); secretary, F. M. Nellis (Westinghouse Air Brake Company); treasurer, Otto Best (Nathan Manufacturing Company). The election of Mr. Burns to the office of third vice-president left a vacancy on the executive committee, which was filled by the selection of Harry Flynn (Delaware & Hudson).

Defective Locomotive Brake and Train Operation

Five questions to which answers were invited were given on page 331 of the June issue. Many excellent replies have been received, some of which give correct answers to part of the questions but overlook certain points in connection with the answers to other questions. Taking all points into consideration, the best reply was from F. A. Pearce, Battle Creek, Mich. Others who sent in well-considered answers were S. P. Kennedy, Pittsburgh, Pa.; V. O. Yingst, Bethlehem, Pa.; D. A. Wade, San Antonio, Tex.; G. B. Killinger, Corbin, Ky.; R. F. Walker, Montreal, P. Q.; H. V. Reagan, Pittsburgh, Pa., and C. A. Wolfe, Bloomington, Ill. The following are the answers given by Mr. Pearce, supplemented by additional suggestions from others.

Question 1—How could a train be handled if the brake pipe was broken behind the connection leading to the automatic brake valve in either A1 or ET equipment?

Answer—Plug the end of the broken pipe, then force together the signal and brake pipe hose couplings at the head end of the engine, cut the brake pipe into the signal line by opening the cocks at the front end, force together the signal and brake pipe couplings at the rear of the tender and cut out or blank off the connection from the reducing valve or check valve to the signal line. This will leave the signal system and also the brakes on the tender inoperative but the brake on the locomotive and on the train can be handled in the usual manner.

If the equipment is schedule A1, the coupling of brake pipe and signal hose should be made between the engine and tender instead of at the rear of the tender as by so doing the automatic tender brakes will remain operative. With the ET equipment the tender brakes will still be operative regardless of whether the brake pipe and signal lines are connected in front of or at rear of the tender, the only advantage with the ET equipment of making the coupling between the engine and tender is that the brake pipe vent valve will still operate provided the tender is thus equipped.

In answering this question several assumed that the locomotive if not fitted with the ET equipment would have the A1 equipment and also the combined straight air brake. One of the best answers based on this assumption was from V. O. Yingst, who said, "Plug the pressure end or apply a blind gasket in the connection at the automatic brake valve. Then cut out the driver and engine truck brake cylinders, couple the brake cylinder hose on the back of the engine to the brake pipe hose on the tender and with the independent brake valve in slow application position adjust the reducing valve and safety valve (as used on ET or straight air brake equipment) to the desired brake pipe pressure. To charge the brake pipe place handle of the independent or straight air brake valve in application position—the brake pipe will be charged through the distributing valve or through the straight air brake valve used with the A1 equipment. To apply the brakes slowly place handle in release position until the desired brake pipe reduction has been made, brake pipe air being exhausted through the distributing valve brake cylinder exhaust or straight air release pipe as used on the A1 equipment. If on a long train and ET equipment, it is advisable to remove the choke fitting at the cut-out cock back of the engine."

Question 2—If the automatic brake would not apply but the independent brake functioned properly, where would the trouble be?

Answer—The preliminary exhaust port in the automatic brake valve seat may be obstructed, the exhaust fitting of the brake valve obstructed, the equalizing piston in the automatic brake valve stuck, or the distributing valve equalizing piston stuck or too tight, thus not moving when the brake valve is placed in service application position.

Several other possibilities were suggested. Among them were the following distributing valve defects: Body gasket blown out; feed groove plugged up; defective, loose or missing safety valve; broken stem or lug on equalizing piston; leakage from pressure chamber.

The answer from Mr. Yingst is also worth attention. "The brake pipe being fully charged and the double heading cock open, the trouble may be due to the cut-out cock in the brake pipe branch pipe to the distributing valve closed or the equalizing portion frozen. A defective gasket above the brake valve equalizing piston or a bad rotary valve causing air to leak into chamber D, destroying the preliminary exhaust feature. A worn ring in the equalizing piston of the brake valve (this is rare) allowing brake pipe air to leak by the ring into chamber D also destroying the preliminary exhaust, the brake pipe exhaust fitting being plugged by dirt, etc. I have known a case where the signal line instead of the brake pipe had been piped to the distributing valve. On another occasion a brake valve rotary valve key came out of place due to the rotary being faced beyond the limit with the result that the handle could be moved but the rotary valve remained stationary."

Question 3—If the automatic brake would not apply on a long train but operated correctly when the engine was detached from the train, where would you look for the trouble?

Answer—Make sure that the brake pipe hose between the tender and the first car was not obstructed by a loose lining or otherwise and see that all cut-out cocks are open.

Other possible defects are: Equalizing piston ring of distributing valve loose or broken; enlarged feed groove in distributing valve; restricted exhaust from automatic brake valve.

Question 4—If, when applying the brake with either brake valve—the engine being equipped with the ET brake—the main reservoir pressure began to fall, where would you look for the trouble and what should be done to avoid stalling?

Answer—On the supposition that the train is going at a fair speed and that the engineman wishing to slow down makes a service application with the automatic brake valve, and watching his gage, notices the main reservoir begin to fall, this would denote a bad leak in the brake cylinder or brake cylinder pipe because in applying with the H-6 automatic brake valve, the pressure chamber pressure flows to the application cylinder of the distributing valve, forcing the application piston and valve to the right and so allowing the main reservoir pressure to flow to the brake cylinders. With the above mentioned leak, the main reservoir pressure would fall rapidly. To avoid stalling, use the automatic brake valve, setting the brakes with a service application—at the same time holding the independent brake valve handle in full release position. This will set the train brakes, but with the independent brake in full release the air is continually released from the distributing valve application chamber, leaving no pressure to force the piston and valve over and allow the main reservoir pressure to pass to the driver brake cylinders. This would destroy the engine and tender brake but at the first stop the defective brake cylinder or pipe could be cut out.

Question 5—On an engine equipped with the ET brake, if the feed valve pipe was broken between the feed valve and the brake valve, what should be done?

Answer—Screw back the regulating nut on the feed valve so that no air comes through feed valve. Carry the automatic brake valve handle in full release thereby charging the brake pipe through the brake valve with main reservoir pressure. When applying the brakes work the brake valve handle to service application until the desired reduction has been made, then to lap. To release the brakes, place the brake valve handle in full release position, which releases the train brakes, then to running position to release the engine and tender brakes, again going back to full release position to recharge the brake pipe.

Methods of plugging which would permit the automatic brake valve to be used in the ordinary manner were suggested, also readjustment of the pump governor, but these would take time and would hardly be necessary. However, the following procedure outlined by R. F. Walker is interesting and effective: "Remove the feed valve cap nut, take out the piston spring and spring tip and apply a wooden plug between the cap and the supply valve piston to hold the supply valve in closed position when the cap is screwed home. Take off the regulating valve cap, remove the valve and spring and apply a rubber plug between the cap and the regulating valve seat to prevent the leakage of air past the supply valve piston from escaping through the broken pipe. Remove the cap from the excess pressure head of the pump governor and screw the adjusting nut down tight, allowing the maximum pressure head to govern the pump. In handling the brake use the release position and keep a close watch on gages, returning the automatic valve handle to lap position as soon as the brake pipe pressure is up to the maximum. Unless the feed pipe next to the brake valve can be plugged, it will be necessary to avoid running and holding positions, using full release position of the independent brake valve to release the engine and tender brakes. If the break in the pipe is near a union or any fitting where a gasket can be placed to plug it, the running position can be used and the brake pipe reduction caused by the leakage of equalizing reservoir pressure avoided. Otherwise a close watch will have to be kept and release used on such occasions. Watch the brake pipe gage closely and maintain proper pressure by using the release position of the automatic valve. No harm other than the possibility of bursting hose will result if the brake pipe is slightly overcharged. The main reservoir cut-out cock and double-heading cock should be closed to prevent loss of reservoir and brake pipe air while the feed valve is being plugged."

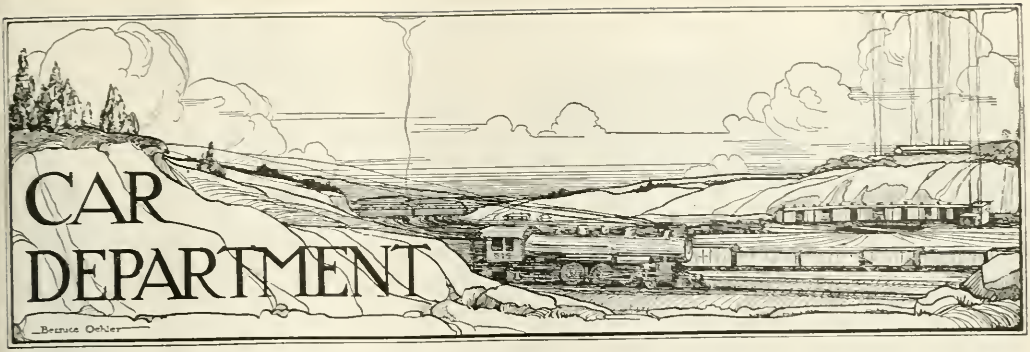
Another method was suggested by S. P. Kennedy. "Run out the adjusting screw of the feed valve to prevent loss of reservoir pressure. Lap the brake valve, then plug the broken feed valve pipe from the brake valve. Charge the 'SF' governor automatic brake valve pipe from the bottom connection of the excess governor head to the connection on the maximum pressure governor head. Plug or blank the main reservoir governor pipe and adjust the maximum pressure governor head to the pressure desired in the brake pipe, thus the governor will act as a feed valve. When the brake valve is moved from the full-release position—in which position it must be carried while running in this case—to lap, service or emergency, the governor will automatically allow the compressor to pump up an excess main reservoir pressure to release the brakes and recharge. The pump throttle may be controlled to prevent high excess pressure to accumulate and possibly overcharge the brake pipe when releasing and recharging. If the 'SG' governor is used the excess pressure head regulating pin valve must be continuously held to its seat, its port plugged or a piece of rod or wood inserted in its regulating spring case to hold the valve closed by tension of adjusting screw. The brake valve should be handled in full release position as otherwise."

THE QUESTION BOX

A or B End of Car

Question.—A.R.A. Interchange Rule 14 designates that "The end of car towards which the cylinder push rod travels shall be known as *B* end and the opposite end shall be known as *A* end." I would like to know how to designate the ends of a car on which the cylinder push rod travels downward in a vertical direction or on another car on which the cylinder is located directly in the center of the car and with the push rod traveling crosswise. Again, there are several thousands of steel hopper cars in service on which the cylinder is located directly over the center sills with the pressure head of the brake cylinder flush with the end post, the piston rod moving toward the center of the car when the air brake is applied. The hand brake is located on the same end as the cylinder on these cars.—F. J. B.

The *Railway Mechanical Engineer* publishes this question in the hope that some of those who have had to do with such cars will tell how they designate the ends.—*Editor.*



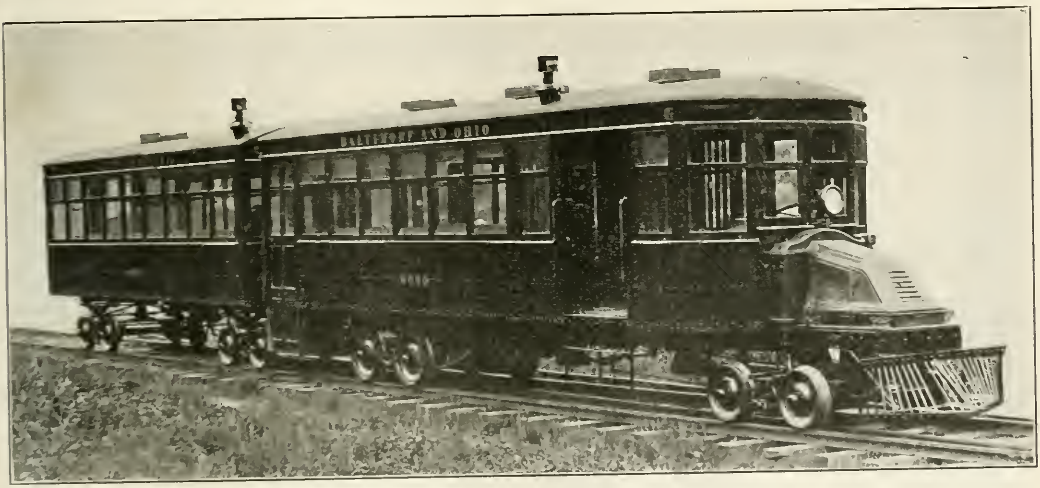
Gasoline Motor Car and Trailer for the Baltimore & Ohio

THE Baltimore & Ohio has recently received from the Edwards Motor Car Company, Sanford, N. C., a gasoline motor car and trailer for use in passenger service on branch lines out of Green Springs, W. Va.

The motor car has a baggage compartment 9 ft. 3 in. long by 7 ft. 8 in. wide just behind the operator's compartment, the rear of the car being fitted with seats for 22 persons. In addition, the trailer has capacity for seating 34 passengers. The cars are equipped with water coolers and toilets. The total weight of the motor car empty is 17,200 lb., and the weight of the trailer empty is 9,350 lb., or a total of 26,550 lb. It is stated that this equipment is lighter per seated passenger than any other of similar type due to the use of heat treated chrome nickel steel and aluminum castings in the construction. On a recent test trip from Baltimore to Philadelphia over the Baltimore & Ohio, these cars made an average speed of 30 miles an hour, the maximum speed being 40 miles an hour.

Both the motor car and the trailer are carried on two four-wheel trucks. The rear truck of the motor car has fixed axles and drives through three chains, two of the chains transmitting the power from the differential shaft, the third chain carrying the drive from the front to the rear axle. It is stated that driving on all four wheels gives unusually good traction and enables the car to run when snow or frost is on the rails. The power to propel the car is furnished by a Kelly-Springfield motor with four cylinders, 4½ in. x 6½ in., which develops 60 hp. at 1,600 r.p.m.

The equipment of the cars includes Westinghouse air brakes, an air alarm whistle, a hot air heating system and 12 volt lighting system. The hot air heaters are of special design with aluminum castings made by the Peter Smith Heater Company, Detroit, Mich. An electric fan is mounted on each heater which drives the hot air through the cars and distributes the heat uniformly.



Edwards Motor Car Unit with Seating Capacity for 56 Passengers

The air brake system is a standard Westinghouse traction brake except that the compressors are of special design made by the Edwards Railway Motor Car Company. There are two compressors, one driven from the line shaft and one from the axle of the rear truck. The compressor driven from the line shaft is used before the car is in motion. It is then cut out and the compressor driven from the axle is used thereafter. Both compressors weigh only 140 lb. and furnish 10 cubic feet of air per minute. An automatic cut-out device stops the compressors when the required pressure is obtained and a reduction starts them again.

These cars are notable for their light weight in relation to the seating capacity. The motor car weighs 782 lb. per passenger, the trailer 275 lb. and the combined unit 478 lb. per passenger.

Looking Forward from the Rear of the Trailer

Recent Decisions of the Arbitration Committee

(The Arbitration Committee of the A.R.A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, it has been suggested that information in regard to such decisions would be welcomed. The Railway Mechanical Engineer will, therefore, print abstracts of decisions as rendered.)

Settlement for Cars Destroyed in Switching

Alabama & Vicksburg box car No. 22627 was damaged while being switched by the Northern Pacific in its Pasco, Wash., yards, for the Spokane, Portland & Seattle. Northern Pacific accident report dated May 19, 1920, shows that the air brakes on the car were in good operating condition, but not working at the time of the accident, which occurred while the switch engine, in order to place 18 cars on a side track already occupied by 65 cars, was pushing the 83 cars at three miles an hour. The damaged car was the seventy-fourth car from the end. The Northern Pacific requested the Alabama & Vicksburg to prepare and furnish a statement showing the depreciated value of this car. After this had been done the Northern Pacific learned that the car was being handled on behalf of the Spokane, Portland & Seattle, and passed the correspondence to that company in July and the salvage of the broken up car was sent to the home shops of the Spokane, Portland & Seattle at Vancouver. The latter road claims that Rule 32 and the interpretation to Rule 43 should be applied in the settlement of this case. The Alabama & Vicksburg claims that the Spokane, Portland & Seattle should assume responsibility for the net value of the car under Rule 112.

In its decision, rendered November 30, 1921, the Arbitration Committee states that its investigation develops that the body of the car was destroyed and disposed of before the car owner authorized such action, and that settlement should be handled under Rule 112.—*Case No.* 1215, *Spokane, Portland & Seattle vs. Alabama & Vicksburg.*

Settlement for Draft Gear, All Parts Reported Broken

On January 27, 1920, the Indian Refining Company, Inc., received from the Louisville & Nashville a car repair bill in which was included a charge for one Westinghouse friction draft gear, account all parts broken, applied to I. R. C. X. car No. 183. The Indian Refining Company, Inc., took exception to this charge on the ground that in their experience with this type of draft gear after the removal of over 1,000 sets during the past few years, it had never been necessary to scrap an entire gear nor had one ever been found completely broken or defective, and maintained that the Louisville & Nashville charges should be confined to such parts as were defective and broken, in accordance with the decision in arbitration case No. 1062. The Louisville & Nashville's attention was directed to the fact that several such charges as the one in question had been received previously, all of which had been cancelled when brought to that company's attention. The railroad company contends that all parts of the draft gear were broken, as described by the billing repair card, and that the previous cases where similar charges had been cancelled were in no way parallel, inasmuch as neither the billing repair cards nor the original record of repairs showed all parts of the gears broken in those cases, whereas they plainly show all parts broken in the present instance.

The Arbitration Committee decided that as no evidence was presented to indicate that the condition of the draft gear removed was other than that reflected by the records of the Louisville & Nashville, the car owners should accept the charge for applying a gear, less scrap credit for the defective gear removed.—*Case No.* 1216, *Indian Refining Company, Inc. vs. Louisville & Nashville.*

Renewing Packing and Journal Bearings—Cars in Flood

On April 6, 1921, the St. Louis-San Francisco offered to the Midland Valley five cars which had been in a flood. The journal boxes had accumulated mud and sand until it was necessary to renew the packing in all of the boxes. Being unprepared to handle this work at Muskogee, Okla., the St. Louis-San Francisco issued defect cards for these cars, reading "oil boxes full of mud and sand account of flood." The Midland Valley rendered a bill for $117.60 to cover the expense of this work and the renewal of eight journal bearings. The St. Louis-San Francisco objected to the entire charge of $27.60 for renewing journal bearings, on the ground that this work was not covered by the defect cards, and also took exception to the charge for the renewing of packing on these cars, claiming that it should have been made according to item 169-B, Rule 101, 1920 code, at the rate of $3.25 a car, amounting to a total of $16.25. The Midland Valley claimed that the packing was billed at 20 cents a lb., which was the actual cost of preparing it, and that three hours labor was charged for packing the journals on each car, contending that the actual charges should govern since the work was done as an accommodation for the St. Louis-San Francisco.

The Arbitration Committee decided that the charge for renewing the packing should be confined to the amount specified in Rule 101 (1920 code), but that on account of the difficulty of determining the condition of the journal bearings at the time of interchange, the charge for them should be accepted as damage caused by the flood.—*Case No.* 1218, *St. Louis-San Francisco vs. Midland Valley.*

The Santa Fe Has Recently Received 2,500 of These Cars

New Designs of Refrigerator Cars for the Santa Fe

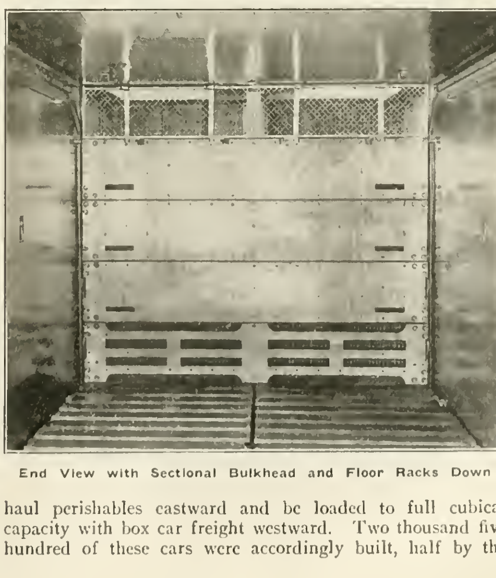
Include Two Similar Types, One with Movable, the Other with Stationary Bulkheads

FRESH fruits and vegetables form an important part of the eastbound traffic of the Atchison, Topeka & Santa Fe, and to care for this business the road had in service at the end of 1921, 11,751 refrigerator cars. This is ap-

Bulkhead Sections and Floor Racks Raised to Permit Loading Entire Length of Car Body

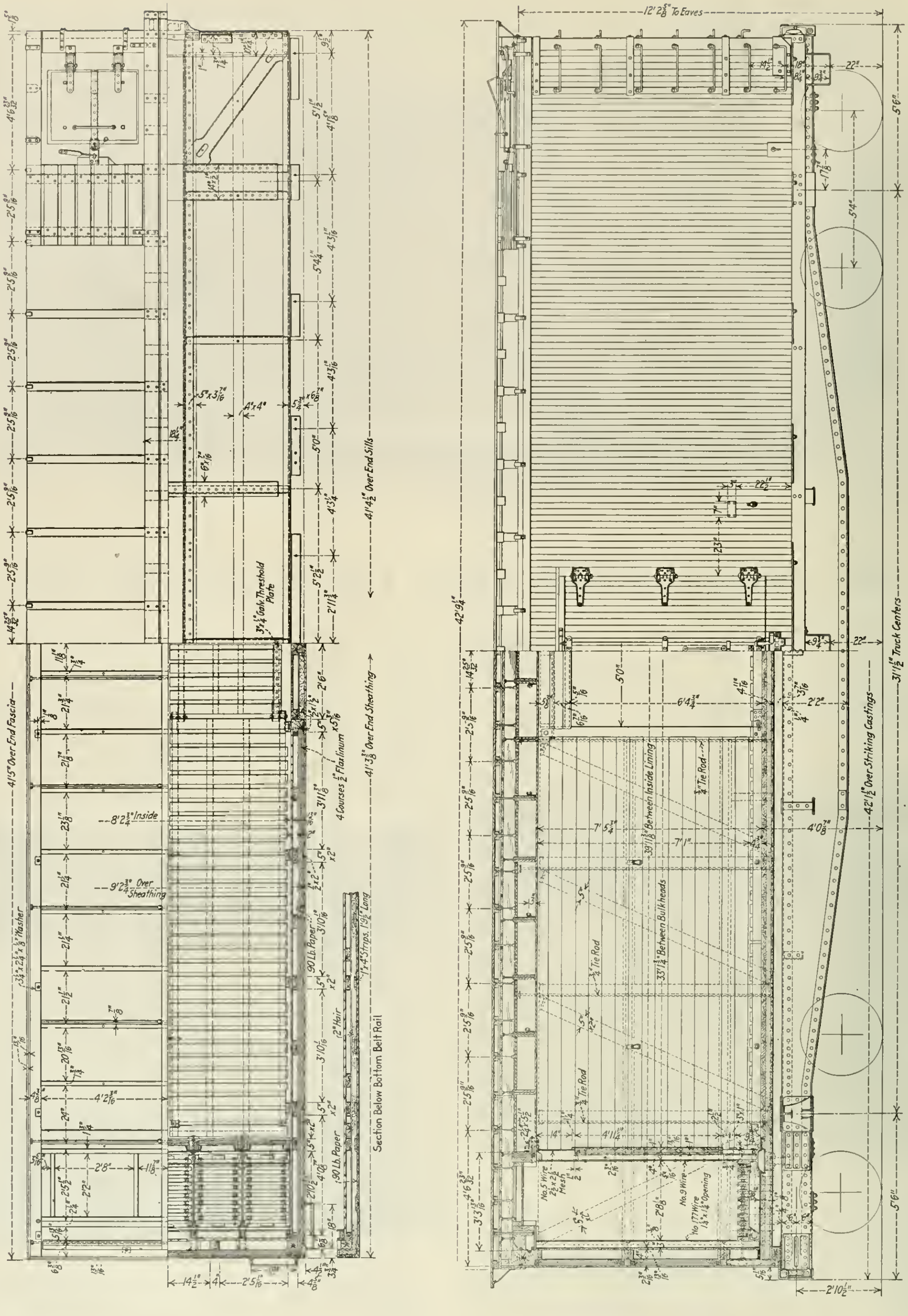
proximately 16 per cent of all the freight cars which the company owns. Compared with this is a total of 32,282 box and furniture cars. Since refrigerator cars form a comparatively large proportion of the house cars, the problem of keeping this equipment in revenue-earning service is important, and the road has followed the practice of loading suitable commodities in refrigerator cars for westbound movement. As the traffic is fairly well balanced, there has been comparatively little empty mileage, in fact it has sometimes been necessary to haul empty box cars eastward.

In 1920 the Santa Fe needed refrigerator cars and in view of the excess of westward traffic at that time, a design with collapsible bunkers was prepared so that the cars could



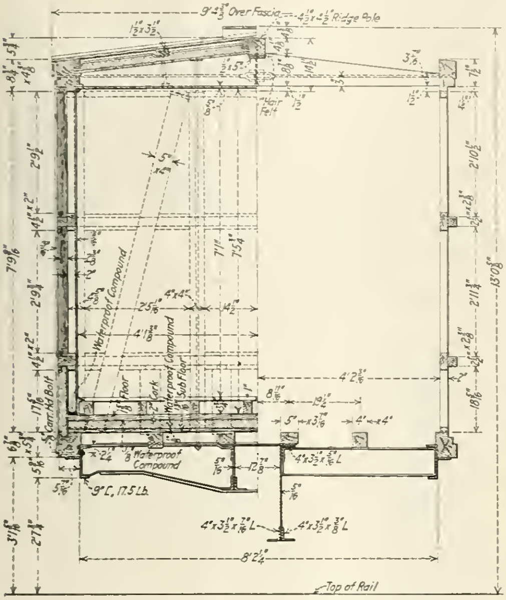
End View with Sectional Bulkhead and Floor Racks Down

haul perishables eastward and be loaded to full cubical capacity with box car freight westward. Two thousand five hundred of these cars were accordingly built, half by the



Plan and Elevation of Santa Fe Refrigerator Car with Fixed Bulkheads

American Car & Foundry Company and half by the Haskell & Barker Car Company. In the following year additional refrigerator cars were found to be required. At that time the traffic situation had changed and the box and refrigerator



Sections Through the Car Body

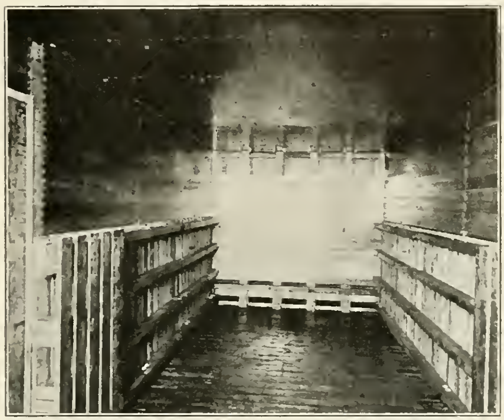
car equipment was adequate to handle the westward movement. The fixed bulkhead was somewhat cheaper and gave a capacity of 1,000 lb. more ice per car and was therefore

View of Bunker Before Bulkhead Is Applied, Showing Removable Ice Grates

adopted for the later design. An order of 2,500 of these cars, also divided equally between the American Car & Foundry Company and the Haskell & Barker Car Company, has recently been delivered.

Construction of Bunkers and Movable Bulkheads

The movable bulkhead applied to the first order of cars consists of four parts, each built up of 2½-in. boards lined on both sides with No. 20 galvanized sheets. Each section has arched screens on the inside, as shown in the illustration of the bulkhead in the raised position. A movable post is located at the center of the bulkhead to support the sections at that point. The ends of each section of the bulkhead are fitted with trunnions sliding in guides extending up the sides and horizontally just beneath the ceiling. Above the top section and hinged to the ceiling is a screen bound in a channel iron frame. When the screen is down the bulkhead sections are locked, making it impossible to enter the car through the hatches. When it is desired to raise the bulkhead the screen is swung up and secured beneath the ceiling, leaving room for the bulkhead to slide by in the guides to the overhead position. The bulkhead sections when raised are locked in place by gravity catches. The bottom of the bunker is formed by a floor rack hinged to the end so that it can be swung up out of the way when the bulkhead is raised. The back of the ice bunker consists of screens stapled to vertical wooden spacers. A recess is provided between the two center spacers to receive the movable post.



Interior of Car With Stationary Bulkheads; Floor Racks Raised

The sides of the bunker are lined with No. 24 galvanized iron sheets. A locking chain is used to hold the hatch plug down and prevent anyone entering the car through the hatch when the bulkhead is raised. The icebox pans are made of No. 12 galvanized steel with double outlet traps and drains as shown in the drawing.

Stationary Bulkheads

The stationary bulkheads used in the later cars have four intermediate posts, 4 in. by 4 in., and two side posts, 2 in. by 4 in. The tops of the intermediate posts are secured by stirrups, thus avoiding the use of a transverse member which would deflect the air current at the top of the bulkhead and retard circulation. The bottoms of these posts rest on galvanized malleable iron castings which bridge the gutters of the floor pans.

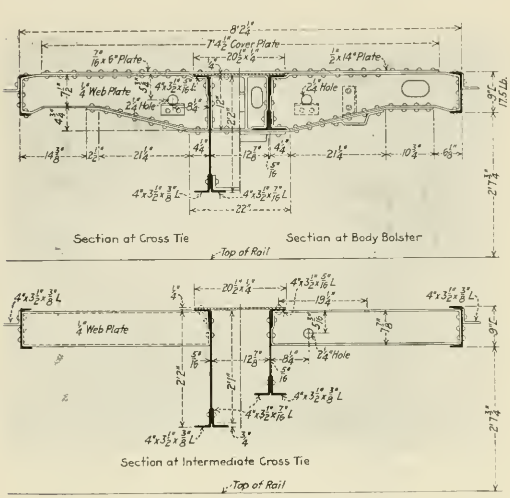
The bulkheads are insulated with two layers of ½-in. Insulite backed by 13/16-in. lining and faced on the outside of the posts by 1-in. shiplapped boards. The inner side of the bulkhead is covered with No. 24 gage galvanized sheets. The top opening of the bulkhead, which is 14 in. high, is covered with a galvanized screen of No. 15 wire, 2½ by

2½ mesh to the inch, and a netting of No. 9 wire with .977-in. openings is applied across the inside of the bulkhead posts. The sides of the iceboxes are covered with No. 20 galvanized sheets without netting. The ends of the cars are lined with No. 28 galvanized sheets. Over these sheets 2½ in. by 3 in. wood spacers are applied which in turn hold the netting of .177-in. wire with 1¼ by 1¼-in. openings.

The ice grates are supported on 4½-in. galvanized tee bars at each of the bulkhead posts and by galvanized angles at the sides of the bunkers. The grates consist of 1½ in. by 4 in. oak pieces rounded on the top, joined with rods and malleable iron spacers. The grates can be raised if it is desired to clean the floor pans and if it is necessary to remove the grates, they can be taken out through the hatches. The outlet traps and drains are of the same type used with the movable bulkhead.

General Design

Aside from the arrangement of ice bunkers, these two orders of cars have other interesting details of construction. Both types have the same general dimensions, the length over striking plates being 42 ft. 1½ in.; the width over eaves 9 ft. 4-⅜ in.; the height from rail to top of running

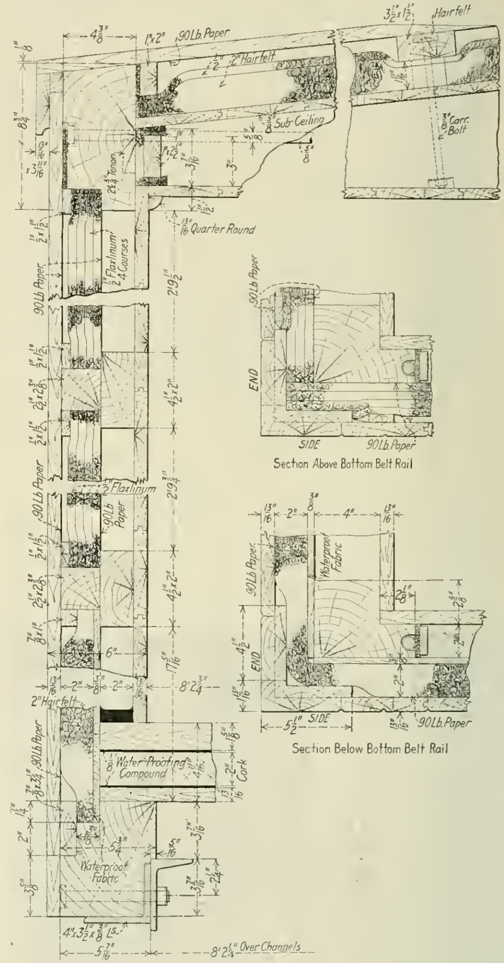


Sections Through the Underframe

board 13 ft. ⅝ in., and the height inside from floor to ceiling, 7 ft. 5¾ in. The length between inside linings is 39 ft. 11⅜ in., the distance between the stationary bulkheads being 33 ft. 1¾ in. and between the sectional bulkheads 33 ft. 2¼ in. When the movable bulkheads are raised, the inside length of these cars is increased to 39 ft. 2¾ in., thus adding about 370 cu. ft. to the capacity.

The cars have steel underframes with wooden superstructure. The underframe is of the fish-belly centersill type, the depth of these sills at the middle portion of the car being 2 ft. 2¼ in. The web plates are 5/16 in. thick and are reinforced at the top by one 4 in. by 3½ in. by 5/16 in. angle on the outside and at the bottom by one 4 in. by 3½ in. by ⅜ in. angle on the outside and by a 4 in. by 3½ in. by 7/16 in. angle on the inside. The sills are reinforced at the top by a 20½-in. by ¼ in. cover plate extending the entire length of the car. The side sills are 9-in. channels weighing 17½ lb. per ft., and the end sills are of the same section. The body bolsters are of a built-up design with cast center fillers and two side diaphragms pressed from ¼-in. steel plate. The diaphragms are spaced 7½ in. between webs and reinforced at the top and bottom by a 14 in. by ½ in. cover plate. There are two main cross ties, each with a single diaphragm of the same section as used in the body bolsters, reinforced by plates on the top and bottom. The three intermediate cross ties are pressed of ¼-in. plate and are of a channel section 7⅞ in. deep. Six longitudinal stringers of fir support the floor.

The construction of the body framing in general follows the usual practice, one novelty being found in the use of



Sections Showing Insulation in Car Body

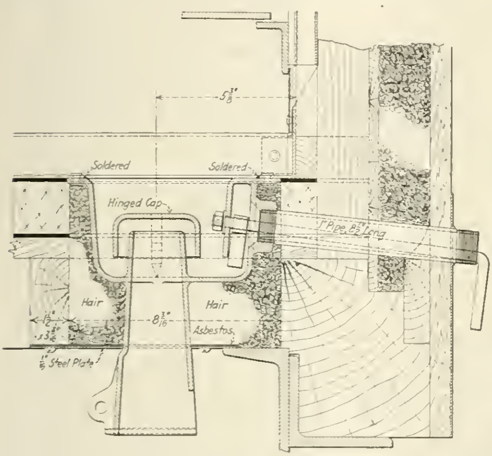
turnbuckles in the horizontal tie rods at the carlines. These provide a ready means for tightening the framing at this point should it become loose in service.

The false flooring which is laid on the floor stringers is 13/16 in. thick. A layer of paper is placed over the false floor and is covered with ⅛ in. of asphaltum. A layer of 2-in. cork board is then laid and is covered with ⅛ in. of asphaltum and one layer of paper before the 1⅝-in. top floor is applied. The floor racks used in both types of cars are the same with supports 3¾ in. high and 1 in. slats.

The sides of the car have 13/16 in. inside lining next to which is a 2-in. air space. Between the lower belt rail and the side stringers hairfelt insulation is used. A ⅜-in. blind lining is applied which overlaps the floor at the bottom and the lower belt rail at the top. Next to this a layer of waterproof fabric is placed and the hairfelt is then inserted between the fabric and the 13/16-in. outside sheathing. Waterproofing compound is poured between the blind lining and the inside lining to a depth of ¾ in. over the floor to seal the joints between these parts. Above the lower belt rail the insulation in the sides and ends is made up of four layers of ½-in. flaxlinum covered with a layer of paper.

The side of the door opening is 5 ft. 0 in. by 6 ft. 4¾ in. The doors are made double with siding on the outside and lining on the inside and with insulation to correspond with that in the sides of the car.

A ⅝-in. blind ceiling is laid over the top of the carlines and hairfelt insulation, held in place by a nailing strip, is applied to cover the joints between the blind ceiling, the lining, the ceiling and the side plate. The ⅝-in. ceiling is then applied under the carlines. The insulation in the



Double Outlet Drain and Trap

ceiling is 2½ in. of hairfelt in one 2-in. and one ½-in. layer. The hairfelt is covered with a layer of paper and a 13/16-in. sub-roof is placed over it, supported by the ridge pole and side plate and one intermediate purline. The Standard Railway Equipment Company's outside flexible metal roof, with No. 24 galvanized sheets in the center of the car and No. 20 gage around the hatches is laid over the sub-roof.

The light weight of the cars is 55,000 lb., being practically the same for both designs.

Painting

All parts coming in contact on the trucks and underframes are given one coat of carbon paint before assembling. The finished underframe is painted with three coats of carbon ready-mixed paint and the top of the underframe coated with Lucas car roof cement. The trucks are protected with two coats of carbon paint.

The sides of the car are finished with three coats of refrigerator yellow and the ends with three coats of mineral paint of the Santa Fe standard color. The roof boards, outside flexible metal roof and the hatch covers receive one coat of mineral paint. This is also applied on all tenons and in all mortises on both ends of posts and braces, on shoulders at all tenons and post and brace castings and in all places where two pieces of wood touch each other, except siding, lining, roofing and flooring. All iron fittings of the car receive two coats of paint, the same as used on the trucks and underframe.

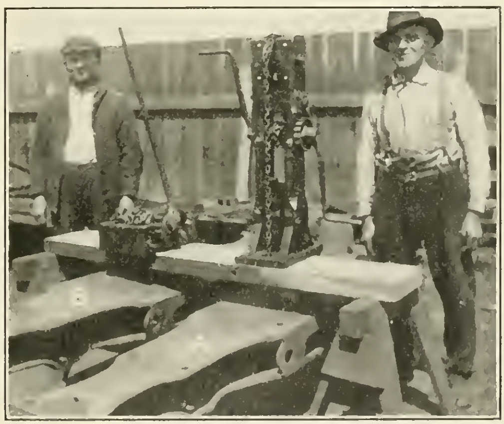
The interior of the sides, the ceiling and all exposed wood in the interior of the car body is painted with three coats of raw linseed oil mixed with an equal quantity of Sipes Japan. All nails are set and puttied after applying the first coat of oil and Japan. The floors are finished with two coats of raw linseed and Japan.

The cars are carried on trucks with 5 in. by 9 in. journals, having Andrews cast-steel truck side frames and cast-steel truck bolsters fitted with the Standard Car Truck Company's lateral rollers. A.R.A. type D couplers with 6 in. by 8 in. shanks are applied, connecting to cast-steel coupler yokes by a transverse key. The draft gear is the Miner friction type A-18-S. The brake equipment is the Westinghouse Air Brake Company's schedule KD-1012. Other specialties applied to the cars include Creco brake beams and Imperial uncoupling arrangement.

Car Bolster Lifting Device

An interesting labor-saving device used at the Chesapeake & Ohio shops, Huntington, W. Va., is shown in the illustration. It consists of a windlass (two forms of which are illustrated) used for applying or removing car body bolsters rapidly and easily and with greater safety than would be possible with ratchet jacks. The usual method of performing this work is to raise a bolster into place beneath the car by means of jacks, the workmen who apply or remove the bolts being in more or less danger unless great care is taken in placing the jacks.

The men shown in the illustration are Chesapeake &



Easy and Safe Method of Lifting Car Bolsters

Ohio employees who, among other labor-saving devices, have developed the method shown for raising car body bolsters. The operation consists of lifting the bolster by means of a windlass within the car, the windlass chain passing through a hole in the floor and being fastened to the bolster. Operation of the windlass will then raise the bolster into place beneath the car where it is held firmly while holes are being bored and bolts applied. There are no jacks to interfere with the work or by slipping endanger the workman who may be under the bolster. Any form of windlass may be used, two of the more common kinds being shown in the illustration raising the bolsters *A* and *B*.

from the total elongation the elongation due to stress alone was determined. The relation between stress and strain on samples actually taken from the wheels made it possible to convert the strain readings into stress values.

Properties and Composition of Material

The coefficient of expansion for the range from 68 deg. F. to 590 deg. F. was determined on specimens cut from one of the wheels furnished by each of the three manufacturers. The composite expansion is given in Table II.

Table II—Thermal Expansion of Wheel Specimens

Temperature Rise		Total Expansion in Inches per Inch
Deg. F.	Deg. C.	Composite
90	50	0.00055
180	100	.00113
270	150	.00175
360	200	.00241
450	250	.00311
540	300	.00384

The mechanical properties of the material were determined on specimens of 8-in. gage length taken from the plates of the wheels at right angles to the radius. For the purpose of computing the stress values in the heated wheels the modulus of elasticity is required. Since cast-iron has no such constant modulus when tested in tension, the stress-strain curve was determined up to as near the rupture as possible and then extrapolated to rupture by the data obtained for the elongation and ultimate strength. These curves for the wheels of the three manufacturers are shown in Fig. 5. Table III shows the average results for the tensile tests. The chemical composition is shown in Table IV.

Table III—Average Results of Tensile Tests

Manufacturer	Apparent elastic limit Lb. per sq. in	Ultimate strength Lb. per sq. in.	Elongation in 8 inches Per cent	Reduction of area Per cent	Modulus of elasticity at "zero stress Lb. per sq. in.
A............	9,600	26,700	0.8	0.3	17,300,000
B............	6,300	18,900	.8	.4	15,400,000
C............	11,000	27,000	.8	.4	18,400,000

Table IV—Range of Chemical Composition in Test Wheels

	Per cent
Total carbon	3.14 –3.70
Graphitic carbon	2.49 –3.06
Combined carbon	0.31 –0.77
Manganese	0.52 –0.77
Silicon	0.54 –0.87
Phosphorus	0.28 –0.41
Sulphur	0.109–0.185

Although the chemical composition of the wheels is of interest, it is thought to be undesirable to attempt to correlate so few compositions in terms of the behavior of the wheels.

The measurements of strain in the wheel are subject to a possible error of plus or minus 0.0002 in. per inch. This corresponds to an error in stress of plus or minus 4,000 lb. per sq. in. for low values of stress, but for higher values would be considerably less, or about 400 lb. per sq. in. It is a fair assumption that the possible error throughout the major range of the stress measurements is plus or minus 3,000 lb. per sq. in.

Results of Thermal Stress Tests

Stresses.—It was found in the tests that an unexpectedly large number of the wheels developed cracks in the plates. These cracks were circumferential in nature and were all approximately at the same distance from the center of the wheel, namely, 9 in. Of the 28 wheels 16, or 57 per cent, developed cracks in the plates. Some cracks were barely perceptible, others almost completely encircled the wheel.

For the 28 wheels which were used for thermal stress tests at the bureau computations were made which showed the stresses existing in the wheels at each of the strain-gage positions. The magnitude of these stresses in typical wheels is shown in Figs. 1 to 3, where they are plotted against their relative positions along the radius of the wheel. These curves indicate the stresses existing in the wheel at the time of failure of the wheel by cracking or in the event the wheel did not crack at the time the maximum temperature gradient existed between tread and hub. The temperature distribution at the same time is also shown in a similar manner.

Of the six wheels submitted by manufacturer A, wheels 3 and 4 developed slight cracks, while the remaining four wheels showed no evidence of failure. The maximum stresses in the wheels submitted by manufacturer B are considerably lower than those in the wheels submitted by either manufacturer A or C. Three of the eight wheels developed cracks in the tests. With the exception of Fig. 3, the stress distribution in wheels furnished by manufacturer C is of the same general character as in the other wheels tested. In the single-plate wheel, as shown in Fig. 3, the stress distribution is decidedly different than it is in the other types.

The single-plate type of wheel is a special experimental design and is not used by any railroad. It was thought that this type of wheel might show greater ability to withstand operating conditions.

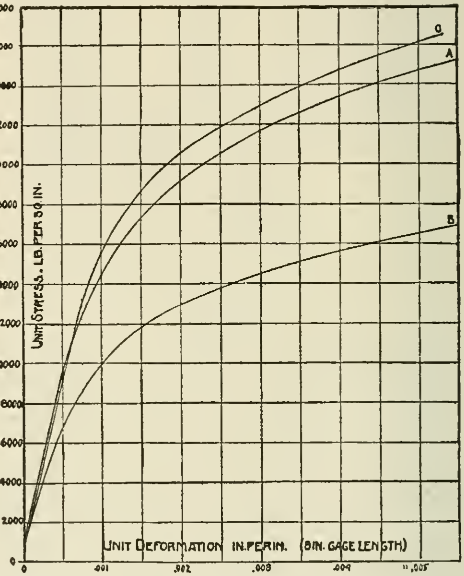


Fig. 5—Composite Stress-Strain Curves Obtained from Tensile Test on Samples of Cast-Iron from Wheels of the Three Manufacturers

Although this wheel showed higher strains and hence stresses for a given heat input than the M. C. B. and arch-plate types, yet the distribution is such that when subjected to additional stress-producing factors, such as mounting, static load, and flange pressure, it seems probable that the strain or stress under those conditions would be less than in either the M. C. B. or arch-plate designs. For instance, the compression found near the rim on the outer face through heat application may be increased slightly when the static load is added, but the addition of the flange pressure or side thrust would more than offset this addition, so that the net effect would be a reduction in the strains or stresses found. The tension unquestionably present on the inner face near the rim would similarly be reduced. Further, the magnitude of the tensile strains or stresses found in the hub region would be counteracted by compression resulting from mounting the wheel onto its axle. Both of the wheels of this type withstood the thermal and drop tests as required by the M. C. B. specifications. In view of these facts the results indicate that the single-plate design, although it does not withstand the special thermal test made by the bureau as well as the M. C. B. and arch-plate types, yet may possibly be better adapted to service conditions.

The highest maximum stress measured was 28,400 lb. per sq. in., while the lowest stress at which failure occurred was 14,000 lb. per sq. in. It is possible that the latter wheel had an internal flaw which accelerated the failure. The maximum stresses observed are in nearly all cases very close to the ultimate strength of the cast iron of which the wheel is composed. Thus, for manufacturer C the stresses are in the neighborhood of 26,000 lb. per sq. in., and this material was shown to have a tensile strength of 27,000 lb. per sq. in. The wheels from foundry B usually showed stresses around 17,000 lb. per sq. in., while the tensile strength was about 19,000 lb. per sq. in.

Relation of Weight to Strain.—To show the relative ability of different weights of the arch-plate type wheel to withstand the effects of temperature gradients, a comparison was made of the unit strains due to internal stress 40 min. after the start of the tests. The unit strains at that time were averaged for each of the types tested. Then, by using the average unit strain as found in the 625-lb. M. C. B. type of wheel as a basis for comparison, the relative average strains at the end of 40 min. of heating are given in Table V. It is evident that the 850-lb. M. C. B. (arch plate) was best able, while the 750-lb. single plate was least able to withstand the special bureau thermal test. In the case of the single-plate wheel this does not necessarily indicate that this type would be least satisfactory in service, as was indicated above. By plotting the average unit strain against the weight of wheel for the arch-plate pattern the effect of the additional weight becomes apparent.

Table V—Relative Average Strain After 40 Min. of Heating

Type of wheel	Relative average strain
625-lb. M. C. B.	100
625-lb. arch plate	100
650-lb. arch plate	113
700-lb. arch plate	80
725-lb. M. C. B.	90
750-lb. single plate	117
775-lb. arch plate	67
850-lb. arch plate	60

It is felt that the curve gives a fair approximation of the effect of additional metal in withstanding the effect of thermal gradients. Taken from the curve their relative strains are as follows:

Arch plate type	Relative strain
625-lb.	100
650-lb.	86
700-lb.	69
775-lb.	57
850-lb.	51

The curve indicates further that a certain amount of metal does more good when added to the lighter weight than it does when added to the heavier weight wheels. The total number of wheels tested is too small to draw any definite conclusions, but the results seem to point to the following generalities, which should be confirmed by a greater number of tests:

1. The method used was such that the heat input to the wheel was much greater than that which would enter a wheel doing its proportionate part in taking any car down any grade found on trunk-line railroads at a reasonable speed.

2. The rate of heating in the special thermal test as conducted by the bureau was more severe than actual service conditions, so that wheels which stand up under the foregoing tests will not fail under the extreme conditions of a long and heavy application of the brakes. These special thermal tests, however, are not as severe as the thermal test required by the M. C. B. specifications, in which for rejection a wheel must crack through the rim in two minutes. In the tests here reported no wheels cracked through the rims, although a large number developed cracks in the plates.

3. The maximum stresses developed are very close to the tensile strength of the cast iron and are some function of the strength of the iron.

4. Preliminary tests show that the stress in a tangential direction on the outer face and also the stress in both the radial and tangential direction on the bracket side of the wheel are relatively small when compared to those in a radial direction on the outer face of the wheel.

5. The maximum tensile stresses occur in a radial direction near the junction of the double plates in the M. C. B. or Washburn type of wheel. In the arch-plate type the maximum stress is somewhat nearer the hub. This seems a desirable condition in that it then lies in the region where it is counteracted by the strains due to forcing the wheel onto its axle.

6. The tests also lead one to believe that the operating conditions to which wheels are subjected may be as important a factor in the safety of the wheel as are the problems arising in their manufacture.

7. By proper distribution of metal in the single-plate type of wheel there would appear to be a possibility of securing a wheel more capable of meeting service requirements.

8. With identical rates of heat input the heavier-weight wheels withstand the effect of tread heating with less strain than the lighter wheels. It seems conceivable, however, that a wheel may be made where increased weight will not aid the wheel to withstand brake application. Such weight, however, is beyond the weights in use today.

The Education and Duties of Car Inspectors*

By H. H. Harvey, General Car Foreman, C., B. & Q.

The selection and training of car inspectors is one of the real problems of a car foreman. The car inspector has to make quick decisions, and much depends on his judgment, as no set rules can be laid down to cover each particular case he must handle.

The character of inspection is hardly the same at any two points, even on the same railroad. In general, however, it may be classified under the several heads here discussed.

Terminal Inspection of Passenger Cars

This is probably the most important of all inspections, as the safety not only of his fellow employees but of the public as well, depends on the thoroughness with which the inspector performs his duties.

At larger terminals the inspection of passenger cars is sub-divided. Inspection of trucks, draft rigging, brakes and parts underneath the car is usually made by men known as truck inspectors. It is of prime importance that this class of work be done in the most thorough manner, as any oversight may result in a serious accident, with possible loss of human life.

Truck inspectors should be well posted as to the requirements of their own road as to what classes of cars are permitted in each train, and should see that cars not complying with these requirements do not get into trains from which they are barred.

Foremen should impress on truck inspectors the need for being constantly on the lookout for loose wheels or tires, cracked wheels or tires, worn out or slid flat wheels, defective axles, hot boxes, worn or cracked truck or brake hangers and pins, missing pins, nuts or cotters, cracked equalizers, pedestals out of line, weak or broken bolster springs, equalizer springs that bottom, worn out or cracked brasses, worn out, broken or cracked brake parts, cracked couplers or parts, couplers or parts worn below the limit of safety, cracked or worn coupler pockets, rivets or pins, low couplers and any defects in trucks, brakes or draft rigging. These are the

* A paper read before the Car Foremen's Association of Chicago on May 8, 1922.

vital parts that have to do with the safety of the car, and inspectors should be trained always to take the safe side when passing judgment on them.

Inspectors who look after air brakes, heating and lighting of cars should be trained as to their particular line of work, and whenever any new device or system comes out, foremen should discuss it with their inspectors and explain in what way it differs from others they are familiar with.

The platforms, vestibules, body and interior of cars are usually looked after by men known as body or equipment inspectors. They should be trained to see that windows and fixtures are in safe and operative condition, as personal injuries may result from defective fixtures, especially window locks that permit windows to drop when in the open position. Water systems and basin and hopper fixtures should be tried out on each individual car. It is a great annoyance to passengers if these parts are defective or inoperative. Seats and fixtures should be kept in good condition, with no loose or protruding screws on which passengers might tear their clothing.

These inspectors should also be trained to see that side, end, vestibule and trap doors are kept in first class condition so that they will operate easily, and that defective or missing locks, staples, chain bolts, barrel bolts, end door bars, door hasps, door fasteners, etc., are promptly repaired, particularly on mail and express cars. They should be taught the requirements of the Post Office Department as to the loose equipment called for in mail and compartment cars, the heating, lighting and sanitary requirements of the Department, and any special state laws affecting these matters.

Foremen are held responsible for the work of their men, and it is a part of the foreman's duty to see that only men of proper calibre are assigned to the inspection of passenger cars. He can render no more efficient service to his road than in properly training the inspectors under him.

Intermediate Inspection of Passenger Cars

Foremen at intermediate passenger train inspection points should train their inspectors to be on the constant lookout for hot boxes, cracked or loose wheels or tires, sticking brakes and any defects in trucks, brakes or draft rigging that may have developed enroute. The inspectors should be drilled in methods of making emergency or quick repairs to hot boxes, broken train lines, broken bottom rods and hangers, steam heat defects, air brake defects, and electric light and gas troubles. This training is too often neglected by foremen and as a result, when an emergency arises an important train may be delayed longer than would have been the case had men been taught how best to handle such cases quickly.

Interchange Inspection of Freight Cars

Interchange inspectors should be thoroughly familiar with that part of the interchange rules which has to do with the interchange of cars, loading rules, safety appliance requirements and the rules of the Bureau of Explosives affecting their work. A foreman is expected to be familiar with all of these rules, and it is a part of his duty to know that his inspectors have a reasonably good working knowledge of them.

Local meetings at which the rules are discussed are almost a necessity; they serve not only to educate the inspectors but tend to keep the foremen better posted. Occasional examinations should be held, either written or oral, and questions asked should be really practical ones. Too often meetings that should be of great benefit to those in attendance accomplish very little because some one brings up a technical question, which may never come up in actual operation, the discussion of which takes up a great deal of time and crowds out questions that could be profitably discussed; as a result everybody goes home feeling that their time has been wasted. My personal opinion is that more practical benefit will result from an oral than from a written examination. Furthermore, we should conduct them, not with a view of finding out how much an inspector does not know, but rather to awaken his interest and help him to learn more about the rules under which he is working.

Terminal and Division Point Inspection of Freight Cars

This inspection should be made to insure that loaded cars are in a reasonably safe condition to carry the load to destination without having to be set out enroute, and that empty cars are in proper condition to load. These requirements vary on different roads, and in fact on different parts of the same road.

Inspectors at these points should be trained as to the requirements of their particular road and the work should be handled in a manner similar to that outlined under the heading "Terminal Inspection of Passenger Cars." These inspectors should be trained along the same lines as interchange men, except that possibly men who do no interchange work do not require so thorough a knowledge of the A. R. A. Interchange Rules.

Inspectors located at freight houses, on team tracks and at elevators should be specially trained on the importance of getting side door fasteners in condition so that doors can be properly closed and properly sealed to prevent pilferage.

Safety Inspection of Freight Cars at Intermediate Points

This heading is self-explanatory and Inspectors at intermediate points should be trained to look principally for only such defects as may render cars unsafe to go forward to the next division point. They should be instructed as to the quickest and best way to make emergency repairs in order to avoid undue delays to tr. ins.

In conclusion, would suggest that foremen read carefully the bulletins gotten out by the Bureau of Explosives, and discuss with their men the methods suggested as to precautions for preventing fires and explosives in case of wrecks or other accidents, as well as the best methods of handling fires caused by leakage of acids, gasoline, etc. This is a matter worthy of a great deal of study.

Discussion

Several of those who took part in the discussion commented on the value of meetings at which the application of the rules of interchange and other problems of the car inspector are discussed. Such meetings, wherever they have been conducted, have met with an immediate response, not only from the inspectors but from car repairers and apprentices, and the foremen have been as much benefitted as the men.

A number of roads are using some form of examination for car inspectors. On the Baltimore & Ohio, a list of 79 questions is submitted to these men, who have them to study for 30 days before they are required to submit their answers in writing. The opinion was voiced by several who spoke, however, that written examinations are of little value as a means of measuring the ability of an inspector because some of the inspectors with the best judgment are the least able to express themselves in writing. Here, it was pointed out, was one of the opportunities for the holding of meetings, in which the discussions stimulate the men to improve their knowledge, while the written examination may prove to be a discouraging factor.

The car men's agreements on several roads have been negotiated to include a provision requiring that men promoted to inspectors must be able to read and write the English language. In at least one case mentioned, it is further required that these men must know the first four rules of arithmetic.

The freedom from trouble from the work of inspectors at outlying points as compared with those at the large terminal yards or shops was the subject of comment. In explanation it was suggested that these men were forced to depend on their own judgment and therefore developed more independence than men working under closer supervision.

Philadelphia & Reading Locomotive Shops and Foundry at Reading, Pa.

High Points at Reading Locomotive Shops

Striking Features of Machine, Blacksmith, Boiler and Erecting Shop Work Are Described in Two-Part Article

Part I

As a background for the following description of locomotive shop work, it should be remembered that the Philadelphia & Reading owns 1,093 locomotives and slightly over 43,000 cars, practically all heavy locomotive repairs and a considerable proportion of car repairs being made in extensive repair shops located at Reading, Pa. Obviously this large concentration of work at a single point results in certain important advantages such as relatively low cost of supervision, quick communication between departments, and the use of production machinery and methods which would not be warranted in a shop of small capacity. The work at Reading shops is performed under the supervision of J. A. Seiders, superintendent of motive power and rolling equipment, and W. L. Rice, superintendent of shops, through whose courtesy the photographs, drawings and data used in this article were obtained.

In 1921 a total of 771 locomotives were given heavy general repairs at Reading and 20 new ones built, including five Pacific type, five Atlantics and ten switchers. This output was obtained in spite of the shops being closed from March 8 to April 11 and December 24 to the end of the year inclusive; also in spite of short time, the men working eight hours a day. Six new locomotives are now under construction. Heavy repairs are made to 57 steel cars per week in a car shed recently built for the purpose. In addition to this work the Philadelphia & Reading operates its own foundry, making all kinds of gray iron castings, including cylinder castings. The railroad is particularly fortunate in the operation of this foundry which is located near the mines and produces good quality castings at low cost. The ordinary manufacturer's selling cost and profit are of course eliminated and there is the other great advantage of getting prompt delivery of castings as needed.

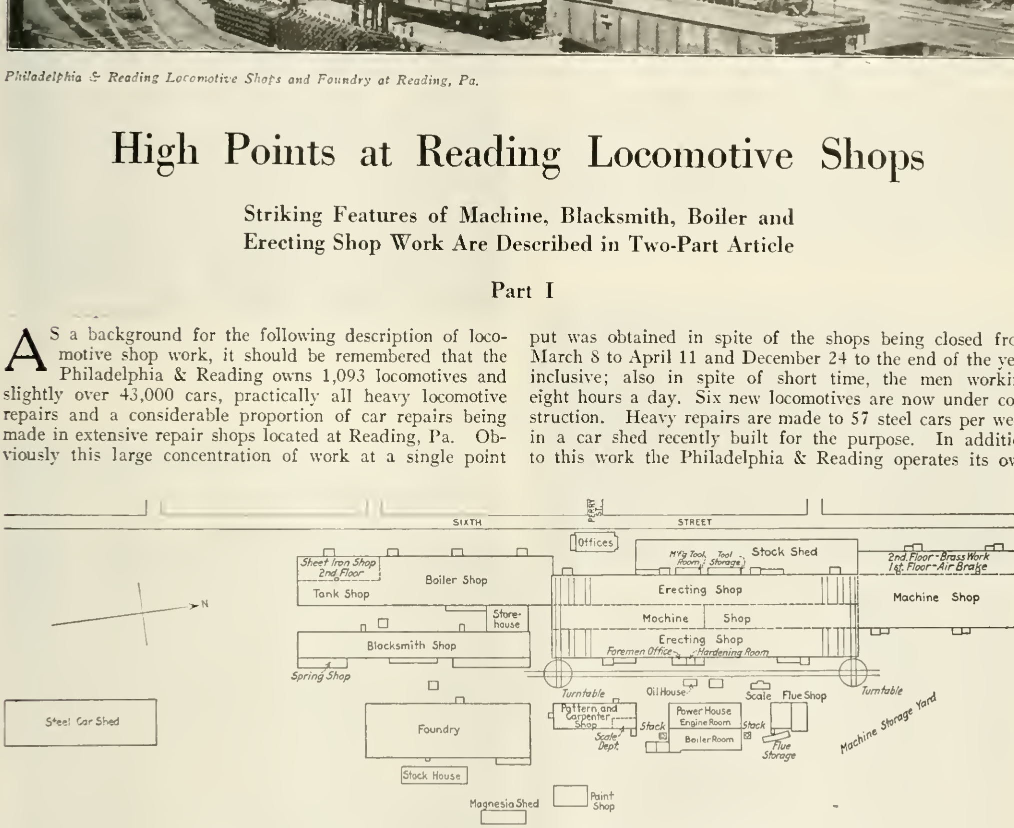


Fig. 1—Diagram Showing the Location of Various Departments of the Reading Locomotive Shops

The shop buildings, completed in 1906, are of substantial brick construction, as indicated in the leading illustration showing (from left to right) the boiler shop, blacksmith shop and foundry, with the roof of the erecting shop and two smokestacks from the powerhouse in the background.

vital parts that have to do with the safety of the car, and inspectors should be trained always to take the safe side when passing judgment on them.

Inspectors who look after air brakes, heating and lighting of cars should be trained as to their particular line of work, and whenever any new device or system comes out, foremen should discuss it with their inspectors and explain in what way it differs from others they are familiar with.

The platforms, vestibules, body and interior of cars are usually looked after by men known as body or equipment inspectors. They should be trained to see that windows and fixtures are in safe and operative condition, as personal injuries may result from defective fixtures, especially window locks that permit windows to drop when in the open position. Water systems and basin and hopper fixtures should be tried out on each individual car. It is a great annoyance to passengers if these parts are defective or inoperative. Seats and fixtures should be kept in good condition, with no loose or protruding screws on which passengers might tear their clothing.

These inspectors should also be trained to see that side, end, vestibule and trap doors are kept in first class condition so that they will operate easily, and that defective or missing locks, staples, chain bolts, barrel bolts, end door bars, door hasps, door fasteners, etc., are promptly repaired, particularly on mail and express cars. They should be taught the requirements of the Post Office Department as to the loose equipment called for in mail and compartment cars, the heating, lighting and sanitary requirements of the Department, and any special state laws affecting these matters.

Foremen are held responsible for the work of their men, and it is a part of the foreman's duty to see that only men of proper calibre are assigned to the inspection of passenger cars. He can render no more efficient service to his road than in properly training the inspectors under him.

Intermediate Inspection of Passenger Cars

Foremen at intermediate passenger train inspection points should train their inspectors to be on the constant lookout for hot boxes, cracked or loose wheels or tires, sticking brakes and any defects in trucks, brakes or draft rigging that may have developed enroute. The inspectors should be drilled in methods of making emergency or quick repairs to hot boxes, broken train lines, broken bottom rods and hangers, steam heat defects, air brake defects, and electric light and gas troubles. This training is too often neglected by foremen and as a result, when an emergency arises an important train may be delayed longer than would have been the case had men been taught how best to handle such cases quickly.

Interchange Inspection of Freight Cars

Interchange inspectors should be thoroughly familiar with that part of the interchange rules which has to do with the interchange of cars, loading rules, safety appliance requirements and the rules of the Bureau of Explosives affecting their work. A foreman is expected to be familiar with all of these rules, and it is a part of his duty to know that his inspectors have a reasonably good working knowledge of them.

Local meetings at which the rules are discussed are almost a necessity; they serve not only to educate the inspectors but tend to keep the foremen better posted. Occasional examinations should be held, either written or oral, and questions asked should be really practical ones. Too often meetings that should be of great benefit to those in attendance accomplish very little because some one brings up a technical question, which may never come up in actual operation, the discussion of which takes up a great deal of time and crowds out questions that could be profitably discussed; as a result everybody goes home feeling that their time has been wasted. My personal opinion is that more practical benefit will result from an oral than from a written examination. Furthermore, we should conduct them, not with a view of finding out how much an inspector does not know, but rather to awaken his interest and help him to learn more about the rules under which he is working.

Terminal and Division Point Inspection of Freight Cars

This inspection should be made to insure that loaded cars are in a reasonably safe condition to carry the load to destination without having to be set out enroute, and that empty cars are in proper condition to load. These requirements vary on different roads, and in fact on different parts of the same road.

Inspectors at these points should be trained as to the requirements of their particular road and the work should be handled in a manner similar to that outlined under the heading "Terminal Inspection of Passenger Cars." These inspectors should be trained along the same lines as interchange men, except that possibly men who do no interchange work do not require so thorough a knowledge of the A. R. A. Interchange Rules.

Inspectors located at freight houses, on team tracks and at elevators should be specially trained on the importance of getting side door fasteners in condition so that doors can be properly closed and properly sealed to prevent pilferage.

Safety Inspection of Freight Cars at Intermediate Points

This heading is self-explanatory and Inspectors at intermediate points should be trained to look principally for only such defects as may render cars unsafe to go forward to the next division point. They should be instructed as to the quickest and best way to make emergency repairs in order to avoid undue delays to tr. ins.

In conclusion, would suggest that foremen read carefully the bulletins gotten out by the Bureau of Explosives, and discuss with their men the methods suggested as to precautions for preventing fires and explosives in case of wrecks or other accidents, as well as the best methods of handling fires caused by leakage of acids, gasoline, etc. This is a matter worthy of a great deal of study.

Discussion

Several of those who took part in the discussion commented on the value of meetings at which the application of the rules of interchange and other problems of the car inspector are discussed. Such meetings, wherever they have been conducted, have met with an immediate response, not only from the inspectors but from car repairers and apprentices, and the foremen have been as much benefitted as the men.

A number of roads are using some form of examination for car inspectors. On the Baltimore & Ohio, a list of 79 questions is submitted to these men, who have them to study for 30 days before they are required to submit their answers in writing. The opinion was voiced by several who spoke, however, that written examinations are of little value as a means of measuring the ability of an inspector because some of the inspectors with the best judgment are the least able to express themselves in writing. Here, it was pointed out, was one of the opportunities for the holding of meetings, in which the discussions stimulate the men to improve their knowledge, while the written examination may prove to be a discouraging factor.

The car men's agreements on several roads have been negotiated to include a provision requiring that men promoted to inspectors must be able to read and write the English language. In at least one case mentioned, it is further required that these men must know the first four rules of arithmetic.

The freedom from trouble from the work of inspectors at outlying points as compared with those at the large terminal yards or shops was the subject of comment. In explanation it was suggested that these men were forced to depend on their own judgment and therefore developed more independence than men working under closer supervision.

Philadelphia & Reading Locomotive Shops and Foundry at Reading, Pa.

High Points at Reading Locomotive Shops

Striking Features of Machine, Blacksmith, Boiler and Erecting Shop Work Are Described in Two-Part Article

Part I

As a background for the following description of locomotive shop work, it should be remembered that the Philadelphia & Reading owns 1,093 locomotives and slightly over 43,000 cars, practically all heavy locomotive repairs and a considerable proportion of car repairs being made in extensive repair shops located at Reading, Pa. Obviously this large concentration of work at a single point results in certain important advantages such as relatively low cost of supervision, quick communication between departments, and the use of production machinery and methods which would not be warranted in a shop of small capacity. The work at Reading shops is performed under the supervision of I. A. Seiders, superintendent of motive power and rolling equipment, and W. L. Rice, superintendent of shops, through whose courtesy the photographs, drawings and data used in this article were obtained.

In 1921 a total of 771 locomotives were given heavy general repairs at Reading and 20 new ones built, including five Pacific type, five Atlantics and ten switchers. This output was obtained in spite of the shops being closed from March 8 to April 11 and December 24 to the end of the year inclusive; also in spite of short time, the men working eight hours a day. Six new locomotives are now under construction. Heavy repairs are made to 57 steel cars per week in a car shed recently built for the purpose. In addition to this work the Philadelphia & Reading operates its own foundry, making all kinds of gray iron castings, including cylinder castings. The railroad is particularly fortunate in the operation of this foundry which is located near the mines and produces good quality castings at low cost. The ordinary manufacturer's selling cost and profit are of course eliminated and there is the other great advantage of getting prompt delivery of castings as needed.

The shop buildings, completed in 1906, are of substantial brick construction, as indicated in the leading illustration showing (from left to right) the boiler shop, blacksmith shop and foundry, with the roof of the erecting shop and two smokestacks from the powerhouse in the background.

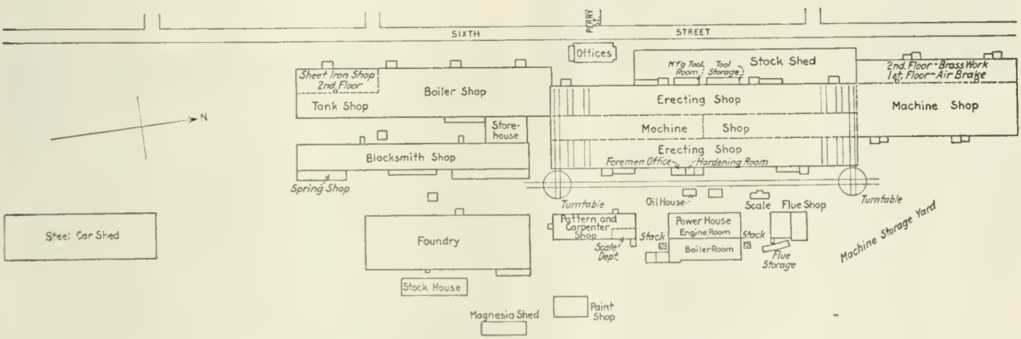


Fig. 1—Diagram Showing the Location of Various Departments of the Reading Locomotive Shops

From the ground plan, illustrated in Fig. 1, the location of the various departments and their relation to each other will be evident. The main offices are at the junction of Sixth and Perry streets, Reading, Pa.

It will be noticed that the machine, erecting and boiler shops are practically in one continuous building, the boiler shop and blacksmith shop being connected at one end by the storehouse. Only a short space separates the blacksmith and erecting shops. All departments are thus brought relatively close together and this tends to conserve both time and labor in transporting material between the various departments. The erecting shop is laid out in two sections, east and west, with a total of 64 transverse working pits with several additional pits devoted to electric welding and other work. The erecting shops are provided with ample crane capacity to handle the heaviest locomotives, with the exception of the Mallets which are unwheeled on a Whiting hoist in the north machine shop.

The work of repairing steel freight cars has been greatly facilitated by the new steel car shed, one end of which is shown in Fig. 2. This shed is not equipped with cranes and machinery, except electric rivet heaters, welding apparatus and pneumatic tools, but its location within a short distance of the locomotive boiler shop is favorable. The boiler shop is equipped with a large amount of sheet metal working machinery, including a 500-ton hydraulic press which greatly facilitates the manufacture of parts for car repair work.

A feature worthy of special attention is the stock shed (Fig. 3), the location of which is shown in Fig. 1. This shed is 548 ft. long by 67 ft. wide, being made with a substantial roof but no side walls. Two 10-ton traveling cranes are provided to handle the material which is carefully stored and protected from the weather. It is difficult to estimate the annual loss from the deterioration of material stored out of doors and other roads could profitably follow the example of the Philadelphia & Reading in providing a substantial, covered stock shed with suitable crane facilities. Owing to the length of time required to make cylinder castings, for example, one or two of each type must be made up in advance and it is an important advantage to be able to store these and other locomotive parts where they will be protected from the weather and can be obtained readily as needed. The north end of the stock shed, shown in the background of Fig. 3, is provided with two lye vats large enough to take driving wheels when necessary and it is here that locomotive parts are cleaned of grease and dirt. One of the stock shed cranes is available for lifting heavy parts in and out of the vats.

Fig. 2—Partial View of New Steel Car Repair Shed

The Reading shops are now operating with about 85 per cent of their normal force. Two hundred and nine men are employed in the steel car shed, 127 men in the foundry, 77 men in the electrical repair department and 30 men on outside construction work. The men employed in what may be called strictly locomotive departments are shown in the following list:

Locomotive shop Department	Number of Men Employed
Machine shop	596
Erecting shop	318 (four gangs)
Wheel shop	60
Boiler shop	278
Tank shop	103
Flue shop	42
Blacksmith shop	128
Forge shop	39
Sheet iron shop	110
Powerhouse	42
Laborers	159
Total	1,875

As stated, this force is about 85 per cent of normal. The men are working eight hours a day, five days a week, 200 men being employed nights, watching, wheeling and unwheeling engines, and for emergency work.

Fig. 3—A Valuable Asset—The Large and Orderly Stock Shed

Machine Shop Work

Approximately 20 per cent of the present machine shop force is devoted to manufactured material and outside repair work. There are so many interesting and instructive features about this work, as handled at Reading, that space is not available to describe them, except in the case of a few of the more prominent ones. The work on two new Sellers machines, including a cylinder boring machine installed in July, 1921, and a car wheel lathe installed in January, 1922, is worthy of special notice on account of the production secured. The cylinder boring machine, a partial view of which is shown in Fig. 4, is a powerful machine designed to bore and face cylinders and valve chambers, using heavy cut-

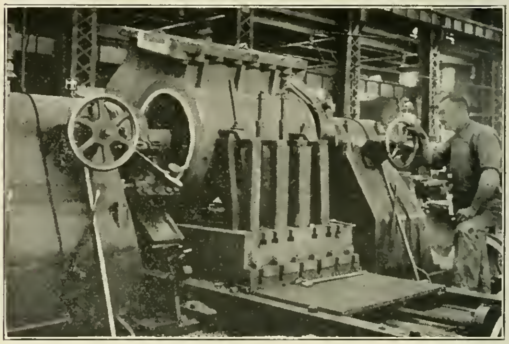


Fig. 4—Powerful Sellers Cylinder Boring and Facing Machine

ting feeds and speeds. Owing to the proportions and rigidity of the machine, the work is very accurate and the arrangement of operating levers and hand wheels is such as to render the machine easily controlled. Six feeds, varying from .0531 to .7498 in. per revolution of the boring bar, are available on this boring machine, the speed of the boring bar varying from 2.4 to 9.6 r.p.m. The cylinder, shown in

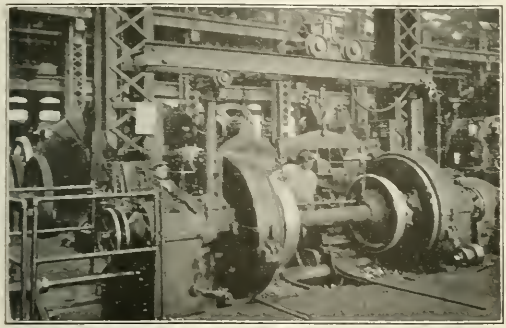


Fig. 5—High Production Car Wheel Lathe Recently Installed

the illustration, has a diameter of 23 in. and is rough bored using a feed of ⅛ in., the finish feed being practically ¼ in. The time required for the operation depends on the hardness of the casting and the amount of stock to be removed.

The method of clamping the cylinder in the machine may have suggestive value, the arrangement being quite plainly shown in the illustration. The cylinder itself rests on a suitable cast-iron bracket bolted to the massive table provided with cross travel. The cylinder is set in this bracket with the saddle resting on the table on the other side of the machine, clamping bolts and brackets being applied as in-

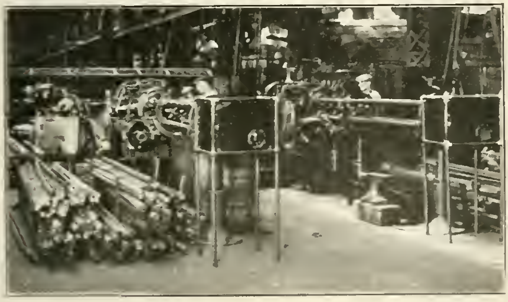


Fig. 6—Gridley Automatics Used for Making Small Parts in Quantity from Bar Stock

dicated. In view of the cutting feeds used, the cylinder must be securely held in place. Since the Philadelphia & Reading casts its own cylinders and it takes considerable time to make a mold and casting, it is necessary to have several cylinders of each class made up and machined in advance. The new cylinder boring machine is, therefore, kept busy on cylinders a large proportion of the time.

Highly satisfactory results are being obtained with the new car wheel lathe, shown in Fig. 5. This car wheel lathe can be operated with ⅛-in., ¼-in. or ⅜-in. feed, the speed of the face plate varying from 1.1 to 2.2 r.p.m. The ⅜-in. feed is usually employed with a cutting speed of 30 ft. per min., the maximum depth of cut being about ½ in. The convenient arrangement of tracks and pneumatic hoist for applying and removing wheels is evident from the illustration and the entire design of the machine has been developed with one thought in view; namely, to turn car, engine truck and tender wheels in the shortest possible time and with the least effort on the part of the operator. The machine has fully four times the productive capacity of car wheel lathes made 15 or possibly 10 years ago.

A considerable proportion of the manufacturing work at Reading shops is done on a battery of four Gridley automatics, three of which are shown together with storage racks for the bar stock in Fig. 6. These machines are made by the Windsor Machine Company, Windsor, Vt., and include two 4-spindle machines with a capacity to take work up to 2½ in. in diameter by 7 in. long and two 1-spindle machines with a capacity to take work up to 3¼ and 4¼ in. in diameter respectively. Fig. 7 shows a few typical ex-

Fig. 7—Typical Examples of Work Done on the Automatics

amples of the work done on these automatics including the work mentioned in the following list:

PARTS MADE ON AUTOMATICS

Spring rigging pins up to 7 in.	Blower valve sleeves.
Rivet set blanks	Standard studs.
Slip rings for driving box brasses.	Set screws.
Knuckle pins.	Balance plate studs.
Standard switch bolts.	Wedge bolts.
Eccentric rod pins.	Boiler plate switches.
Spring rigging bushings.	Boiler plate punch dies.
Front-end main rod key washers.	Grease cup sockets.

The way in which three of these parts are machined will be described in detail as typical of the work performed on the automatics. A close-up view of the 4¼-in., 1-spindle

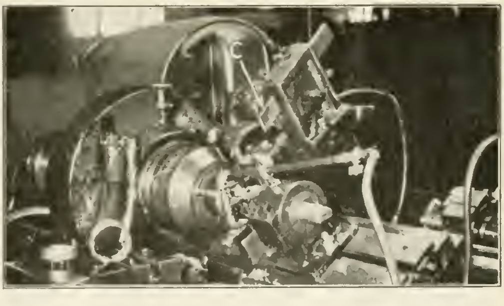


Fig. 8—Close-up View of Automatic Making Slip Rings

machine is given in Fig. 8, the particular operation involved being machining slip rings for driving box brasses. These rings are made from bar stock, the operation of turning the outside diameter and boring the large hole in the center being performed at one time by the drill and turning tool in one position of the revolving tool head. In the second tool head position the inner edge of the slip ring is beveled. In the final operation, cutting tool *C*, held in a heavy pivoted arm, swings down and cuts off the ring. An ample supply of cutting oil is provided to lubricate the cutting edges of the tools and carry away the heat generated, enabling these slip rings to be manufactured in quantity and in far less time than would be required by other methods.

This battery of automatics is well adapted, naturally, to the quantity manufacture of all sorts of pins, a representative eccentric rod pin being shown in Fig. 9. This pin is made on one of the four spindle machines, the operations performed in each position being as follows: First position—turn body size to 1½ in. and body thread size to 1¼ in.; Second position—counterbore in rear of thread, turn 1-in. end;

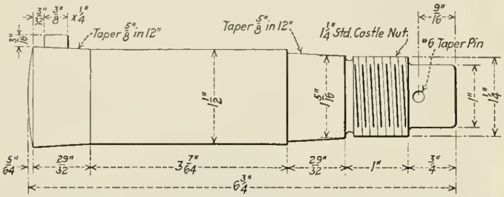


Fig. 9—Drawing of Representative Eccentric Rod Pin

Third position—form tapers, thread; Fourth position—cut off. To make a complete change of the machine and set-up requires about three hours so it obviously would not pay to set up this machine for three or four pins. There is a certain limited number for which it is economical to set up the automatic and all pins made in excess of that number represent a continually decreasing cost per piece.

Front-end main rod key washers, a typical example being shown in Fig. 10, are made on a 1-spindle machine. The revolving tool head has four positions on which tools are assembled to perform the operations of machining these washers in the following sequence: First position—drill washer and form outside diameter; Second position—counterbore; Third position—form tapers, cut off; Fourth position—not used. In this case also it takes about three hours to set up or tool the machine, consequently the runs are made as long as possible.

In addition to turning out the work on this battery of

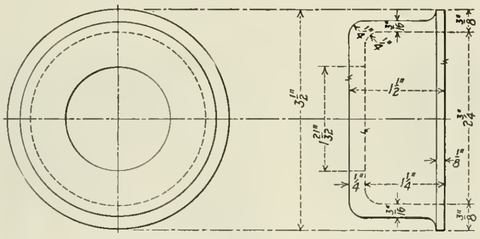


Fig. 10—Front End Main Rod Key Washer

automatics more rapidly than would be the case on engine lathes or even turret lathes, the labor cost is greatly reduced because one operator can take care of two machines. After insertion of the bar stock the machines are fully automatic in action and require no further attention except in a general way to see that they are properly lubricated and that the cutting tools are kept in good condition. In certain instances, however, the operator is able to speed up the indexing by hand operation.

Drop Forging and Spring Shop Work

Two features of especial prominence in the blacksmith shop are the work done under drop hammers and the comparatively new spring shop equipment for repairing and rebuilding springs. The drop hammer work is centralized at one point where there are two steam drop hammers of 1,500 and 1,000 lb. capacity respectively, together with two E. W. Bliss trimming presses for removing the flash. One drop hammer and trimming press making large hexagonal nuts are shown in Fig. 11, the dies and method of forming the nut being shown in Fig. 12.

These nuts are made in sizes from 2¼ to 3 in. The 3-in.

Fig. 11—Drop Hammer and Trimming Press Making Large Nuts

nuts, illustrated, are made from cylindrical blanks of 3¾ in. round soft steel stock cut up in pieces 3⅜ in. long. The blanks are heated in the furnace, shown in the rear of Fig. 11, the drop hammer at the right having been equipped with the two forming dies. When sufficiently hot, one of the blanks is placed in the bottom die and two or three strokes of the hammer give the nut its hexagonal shape, forming the

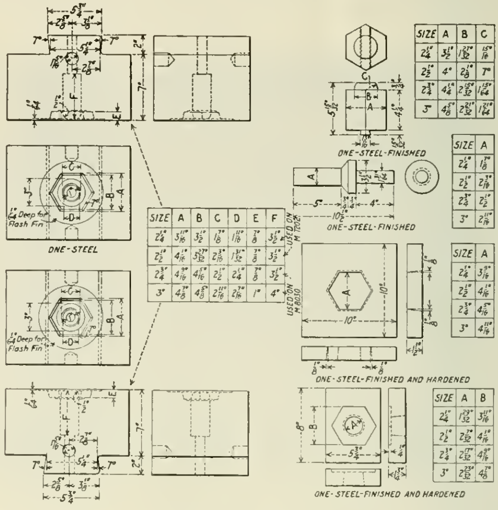


Fig. 12—Forming and Trimming Dies for Making Hexagon Nuts

hole with the exception of a flash at the center. There is also a flash around the sides of the nut. The external flash is removed by hexagonal trimming dies in the press, shown at the left of Fig. 11, the center hole in the nut being cleared out by means of cylindrical punch and die *A*, operated by eccentric *E*.

The arrangement of the dies for both forming and trimming the nut will be readily apparent from an examination of Fig. 12 which shows the dimensions of these dies for four different sizes of nuts. One man operates both the drop hammer and trimming machine. In addition to securing a high production and relatively low labor cost for nuts manufactured in this way, the action of forming them under a drop hammer improves the quality of the nuts and makes them less liable to fail.

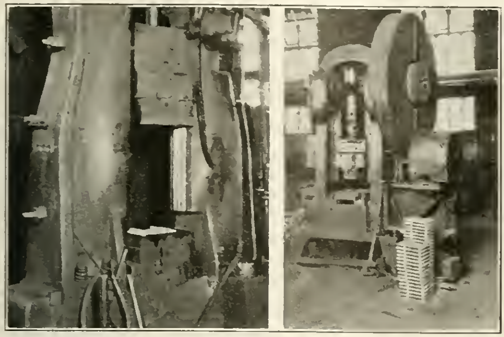


Fig. 13—Drop Hammer and Trimming Press Making Column Guides

A typical job on the other drop hammer and trimming press is illustrated in Fig. 13 which shows the process of manufacturing column guides for freight car truck bolsters. These guides are made from blank stock 1¼ in. by 4 in. by 10¾ in. The stock is heated in a second furnace adjacent to the drop hammer; when brought to a white heat it is placed under the drop hammer shown in the left of the illustration. Two, or at most three blows of the hammer are sufficient to form the column guide, but leaving a slight flash as in the case of the nut. This flash is removed under the trimming press shown at the right in Fig. 13. The column guide is then usually placed back under the drop hammer for one or more strokes to make sure that it is accurately formed in accordance with the die and smoothly finished. Two piles of finished column guides are shown on the floor at the right of the trimming press in Fig. 13. Fig. 14 is a drawing of the column guide as forged and drilled. As in the case of the nuts, one man handles this work on both the drop hammer and press. Experience has demonstrated that this is a cheaper method of obtaining high quality guides than to buy them.

In addition to the two jobs mentioned, these drop hammers are used for the manufacture of various parts of locomotive motion work, including guide blocks, eccentric rod jaws, cylinder cock jaws, steam hose clamps, both plain and castellated nuts, and many other parts. For the more common parts, dies have already been made and saved many times their cost.

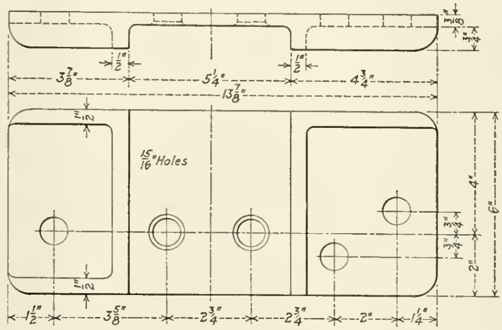


Fig. 14—Column Guide for Freight Car Truck Bolster

(*To be continued*)

Methods of Training Railway Shop Foremen

A Discussion of the Need for Foreman and Group Leader Training: Outline of a Typical Training Course

By Hugo Diemer

How can the latent capacities of the railway shop foreman be most effectively developed so as to make him realize and exert to the fullest his part in bringing about greater efficiency?

In my experience as a shop superintendent and industrial engineer, I have had occasion to observe the type of mechanic and foreman who has come into other industries from the railway shop. The outstanding characteristics of the railway shop man when he comes into a manufacturing shop are:

1. A very praiseworthy quality of resourcefulness. He has been accustomed to get results with poor equipment and poor tools. He has been schooled in the importance of getting work done the best way possible with poor facilities. The outstanding fact, however, is that he does manage to get the work done somehow. If he happens to get into the maintenance and repair department this quality is a very desirable one.

2. This willingness to be satisfied with makeshifts is, however, quite harmful in work where interchangeability and economy of production are essential. Neither railway mechanics nor railway shop foremen taken as a whole, have been given systematic training in either modern mechanical methods or modern methods of organizing production work. Is not this really the reason why many railroad shops find it cheaper to farm out a great deal of their work to shops where modern methods have become thoroughly established? I have had occasion as head of engineering and shop work in two large educational institutions to be located very near to, and to be closely associated with the shop work of a prominent western railroad for three years, and with the shop work of a prominent eastern railroad for eleven years. In the case of the western railroad shop I have seen the installation of improved stores methods, better equipment and a more satisfactory wage system which, while it constituted a great step forward, did not by any means put the railway shop on a basis of real equality with a modern commercial industrial shop. In the case of the eastern railroad which about ten years later adopted these methods, I saw the same improvement. It was, however, a slow process of conversion of even the engineering and higher executive staff that brought about these changes. This staff were, by reason of the fine reputation of the road as a whole, inclined to discount the idea that they could learn anything from other industries. Having now made the improvements in the way

of centralizing stores, better equipment and more scientific piece rates they are still inclined to be skeptical as to the applicability of the organization and training methods of the modern industrial shop to the railroad field.

In the railroad shop as in the industrial shop the foreman is the connecting link between the management and the worker—the key man, the top sergeant who reports the policies and orders from the front office and passes them on to workers under his direction. It is his job to convert plans into product. To do this he must know how to handle men; he must understand company policies; he must be able to pass them on to his workers in a manner that they will understand; in other words, he must be a leader, an executive. Nobody can attain leadership without paying the price for it, which means he must be willing to study. The present day foreman cannot employ the old "driving" tactics and hope for much success in his efforts.

Too often the foreman promoted from the ranks has become overbearing and arrogant in his treatment of those now under him. If the foreman is cheerful, loyal and efficient, the men under him naturally tend to become that way also; while the foreman who is unfair, a tyrant, or a toady, will do more damage to an organization in a day than his influence on production can undo in a year.

The foreman of today is a human engineer and must be able to gain confidence and good will. As such he must prepare himself for industry's big job, the education of the worker. Education must therefore begin with the foreman, for from him it will naturally reach the worker.

The outstanding need in industry today is for foremen who not only know what is to be done and how to do it, but who also know how to convey that knowledge quickly and surely to the workers directly responsible for doing a job. Training departments, no matter how well developed, can never take the training entirely out of the hands of the foreman on the job. Getting successful results in training employees involves not only methods of quickly acquiring manipulative skill but also standardizing intelligent leadership.

Development of Foremanship Training

Foremanship training is a term which has come to be applied to those agencies which attempt to prepare individuals for discharging effectively the responsibilities of the foreman's job. It further is used to familiarize others whose work draws them in contact with foremen and foremanship problems with the underlying principles and practices of foremanship.

As the idea of foremanship training has grown, it has come to be generally recognized that a survey of the people who can profitably make a study of foremanship includes a wider range than just practicing foremen. It is desirable to include in this training men filling minor executive positions such as gang leaders, sub-foremen, assistant foremen; also others such as storekeepers, tool department heads, cost clerks, inspectors, who come in contact with foremanship problems.

Few foremen have ever carefully analyzed their own methods of handling men and work. The foreman is not to be blamed for this failure to analyze his situation, for it is but the result of the schooling which industry has given him ever since he began as a workman. There is something about the atmosphere of the average shop with its commands and orders, its "do as I tell you" and "ask no questions" which dulls the finer sensibilities of both foreman and worker. It is only natural that a foreman should acquire a dual personality; on the one hand a personality of good fellowship, which reveals itself to his family and relatives, and on the other hand the petty tyrant of the shop. The foreman does not want to assume a mask in the shop, but he does it because he thinks that is the way the management wants him to act. Under the pressure of his position he acts hastily, tactlessly and at times blunderingly.

Much of the apparent loyalty of the foreman to the management is only assumed and is part of the occupational mask mentioned before. In foremanship classes, where some representative of the management sits in with the foremen, it has been found that in answer to the question, or in the point of view taken in the discussion, the foremen talk only as they think the management would like to hear them talk. Only too often the management gets from the foreman that which the foreman thinks the management would like to have.

In reality, loyalty is measured in the way the foreman feels at heart toward the management. If America has been able to succeed so well industrially in the last few years with discontent and disloyalty so prevalent, what could she not do if the foreman and the workers had their hearts in their jobs? After all, the biggest result to be gotten out of any plan of foremanship training is this co-operative spirit founded on a clear understanding of the real basic facts connected with the foreman's job.

Four Common Methods of Training Foremen

The methods of foremanship training and the content matter of training courses are so intimately interwoven that it is best to consider them together. There are four prevalent methods of such training:

In the first, or disconnected lecture method, it is customary to get department heads to give prepared talks to foremen on such subjects as Purchasing, Storekeeping, Cost Accounting, Maintenance, Problems, Planning, Scheduling, Employment, etc. In this method we can expect increased general intelligence with regard to the problems of the organization as a whole. If some lectures of an inspirational type are introduced they may produce an inspirational effect provided the men are able to follow the lecturer and thoroughly grasp the points set forth.

The second plan, namely of co-ordinated lectures, is usually the outgrowth of a year's experimenting with the first plan. The department heads' talks are edited and put into educational form and all the talks are arranged in some kind of rational sequence. In this method we also often have a specific objective. For example, better co-operation between foremen and their superiors, or the improvement of the foreman's attitude in dealing with his men. This method may be expected to promote general improvements in the field covered by the lectures, if the lecturers know how to create and maintain interest and have an aptitude for imparting information clearly.

In the third, or conference method, the responsibility for results is centered in the group leader. He has a sequential program as in the second plan but instead of having the foremen listen to a talk they get only a few remarks by the leader accompanied by perhaps a chart or two. He asks questions which have been carefully prepared with a view to tying up the work of the man who is asked the question with the subject under consideration. The object is to stimulate the members of the group to think and form opinions and judgments of their own.

The members of the group are active, not passive or merely listeners. The conference leader in this plan must establish personal relations with members of the group and vary his method according to the particular make-up of different group members. The conference plan can be used to give training by means of the case method under it. Pooling of experiences is made possible. The number of individuals competent to conduct conferences without special training is of course limited.

The problems and questions must be prepared in advance. In order that the foreman can solve these problems we must first of all develop in him what we may call an industrial intelligence. The development of industrial intelligence involves a discussion under the leadership of men familiar with the actual conditions under which the foreman operates. The program of discussion should be built around men, materials, equipment and systems as they exist in the particular work of each member.

In the fourth plan the conferences are supplemented by systematic home study. There is a consensus of opinion among the best authorities that a definite co-ordinated content matter in the way of reading and problems to be studied at home by each group member, greatly strengthens the conference plan. Best results are obtained when this content matter is brought home to the foreman in such a way as to develop his thinking and initiative in applying the ideas to his own work and problems.

At present there is a wealth of material available to form a basis for the content matter of a course in foremanship training. Standardized courses in detail have been prepared with the co-operation of the best educational, industrial and editorial talent in the country. The adaptation of this standardized material to the peculiar needs and conditions of any business is far more easily accomplished and much more economical than to attempt to prepare special home-made courses.

In the conference plan with home study, it is particularly important that the man who conducts the conferences have the unqualified co-operation of a chairman of the group. This chairman is preferably a man whose position outranks that of the other members. In order to get the best work from the group the chairman must conscientiously do all the required home study and work out the problems himself. It is his example and leadership that will result in 100 per cent work by the other members.

Outline of Typical Training Course

As a typical example of the content matter of a foremanship training course the following outline of a course which I have helped to create will be representative. The arrangement and sequence in this course have been given careful thought and co-operation by an advisory counsel composed of industrial managers, production managers, personnel managers, educators and foremen.

Fundamentally the instructional material is based on the application of the methods of job analysis to the foreman and his job in the plant. In making this job analysis questions were handed to over 5,000 foremen in various industrial plants so as to get the foreman's own expressions and ideas as to what a foreman has to do and what kind of a man he ought to be. With this idea of job analysis as a basic one running all through the course, the material is divided into four groups.

The first group deals with the human element in industry and the foreman's responsibility for molding all sorts and conditions of men into a unified working force. The competent foreman must grasp his opportunity to build the team spirit. Before he can do this he must learn the qualities, characteristics, intimate desires and motives of men, how men think and feel and act; the foreman must know how to use this knowledge of human qualities to attain to leadership himself. He must learn how to develop the essential personal qualities for team leadership. This first group also deals with the subject of training a working force, discussing fundamental principles and methods of teaching and training in the shop.

The second group deals with job analysis with illustrations by cases and problems. The flow of work through a plant, the principles behind all planning and production methods, the effect of shop conditions in getting out the work, and the qualities of a good production man are discussed in this group.

The third group deals with the foreman as a business man. It discusses his participation and co-operation in stock keeping activities in keeping down production costs and material wastes. It presents the purposes and typical records of central stores and efficient practice in stock handling, not only in the stockroom but everywhere in the shop. The fundamentals of cost keeping are taken up, the stress being on practice rather than systems. The topics discussed are not of an accounting nature but include such matters as productive and non-productive labor, material and expense, depreciation, predetermined costs and cost control.

The fourth group discusses foremanship in its relation to economic and social matters. The economic facts and factors on which production and industry are based, the knowledge which it is necessary for any men to possess who would think straight on industrial questions and shop problems. Certain aspects of the law are taken up, with which the foreman should be familiar. Those activities of industrial service which are usually carried on by the personnel department, when there is such a department, but in which the foreman must be a participating factor, are taken up in this group.

Group Leaders Must Be Trained

The recognition of the benefits to be obtained from the group training of foremen has resulted in the development of courses of instruction for men desiring to become group leaders. We have recent bulletins of the Federal Board for Vocational Education and of the various state departments devoted to the subject of instructor training in foremanship work. Personally conducted classes for the training of instructors and group leaders in foremanship have been organized and carried on as resident courses by state and private educational institutions and as extension work of various state institutions.

Examples of what is contained in these teacher training or group leader training courses are as follows:

Unit 1—The analysis and classification of what is to be taught.

Unit 2—Thinking it over; what instruction is; how to get the best results out of discussion; developing broader intelligence.

Unit 3—Lesson planning; tying up auxiliary information with a standard lesson.

Unit 4—Difficulties in learning; getting local production problems into an effective instruction sequence.

Unit 5—Handling a group for effective instruction. Interest and interest factors; instructional conditions as affected by surroundings and materials.

The above is the merest abstract of what is the general content of intensive teacher or group training courses. But it will serve to show how generally we are coming to recognize the important position of the group leader in foremanship training. We must recognize also that in this field as in the teaching field in general a person may have the sincerest desire to be a good group leader, and may take the best of training and still fail. The earnest hard worker who lacks personality and vitality will not fill the bill. Neither will the smart fellow with lots of assurances and affrontery but without a background of real hard work. The most successful group leader is apt to be a man who has had actual industrial experience either by necessity or by choice and who has advanced to a higher position. A man of good physique with pronounced personality and who has sufficient humility to study hard the fundamentals applicable to all foremanship training as well as the peculiar problems of his own situation comes nearest to filling the requirements.

According to the last published census of manufactures, 98 per cent of all American industrial plants employ less than 250 people; there are 3,000 plants employing 250 to 500 people; 1,400 plants employ from 500 to 1,000; and only 648 plants employ over 1,000 people. The big industries in general have come to recognize pretty well the advantages of foremanship training.

Foreman Training Important as Scientific Management

It is the realization of the tremendous field of possibilities in the smaller industries that justifies the growth of the movement for foremanship training. We are only at the threshold of this movement. Those who are active in the movement and who have had an opportunity to observe and measure its results feel confident that ultimately it will prove as important as scientific management in bringing about greater industrial efficiency and in maintaining America's industrial supremacy.

Principles of Oxyacetylene Fusion Welding
Part 4—Welding Cast Iron, Continued

By Alfred S. Kinsey*

IN the preceding article some of the early steps to be followed in making welds in cast iron were explained. The following paragraphs deal with the methods of doing the welding and the necessary procedure in finishing the work.

9. *Cast Iron Welding Rod Should Be Carefully Applied.*—In the use of welding rod to fill the vee of a weld two things are essential:

(a) The rod should be of the proper chemical and physical composition. Cast iron contains carbon, silicon, manganese, phosphorus and sulphur. The amount of silicon is about 2.50 per cent. This element is very sensitive to the heat and easily burns out when the metal is melted to make a weld. That is, if a piece of cold cast iron is heated to the melting temperature it will lose about 0.25 per cent of its silicon. The silicon in cast iron combines with the carbon and thereby causes the iron to be hard or soft depending on the amount of silicon. If an iron casting therefore should contain 2.50 per cent silicon and welding should reduce this 0.25 per cent the metal would be much harder at the weld. Then if after the weld is started the welder is interrupted so that the molten metal becomes cold he will have to remelt it to proceed, and this may happen three or four times during a weld, thus reducing the silicon to say 1.75 per cent. This amount of silicon causes the combined or hardening carbon to influence the metal more than the graphitic or softening carbon, and the weld will be so hard it cannot be filed or machined. This often accounts for the brittle cast iron welds which sometimes puzzle even a good welder. Now to prevent this desiliconizing of a cast iron weld the welding rod is made to contain about 3.00 per cent or 3.25 per cent of silicon, which allows for the usual loss of this element and leaves the filled in metal with about the 2.50 per cent of silicon required to keep it machinable. Therefore the composition of cast iron welding rod is of first importance. Just scrap iron or rod of uncertain composition will not do.

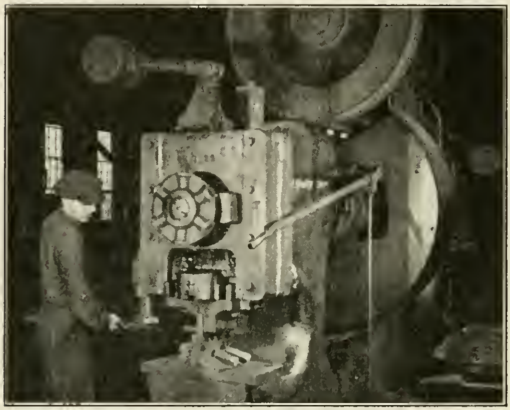


Fig. 1—Bar Shears Reclaimed by Welding. The Head Was Broken Off and Machine Scrapped. Saving by Welding $2,000

(b) The rod should be properly fused in the vee. To make a strong weld the rod must be properly fused to the sides of the vee. This can best be done by a continuous flow of metal from the end of the welding rod. Some poorly trained welders have been known to melt off a cold piece of the rod an inch or two long, drop it down in the vee and then whirl the torch flame over it to melt it quickly. The dropped end rarely ever is completely melted, and does not make good fusion, and the practice should be condemned as being unsafe. To obtain a rapid flow of metal to fill a big vee the best way is to bunch two or three rods and melt their ends all at once.

Considering that none of the chemical and physical characteristics of the metal needs to be lost in a cast iron weld made with the oxyacetylene torch, it would seem unfortunate to sacrifice these possibilities by the use of an improper welding rod or by the careless application of a good rod.

10. *Cast Iron Cannot Be Welded Without Using a Flux.*—When cast iron is being melted by the oxyacetylene torch it will be noticed that a film of molten sluggish material covers the pool of metal and prevents it from being brought to the proper melting temperature. This coating is composed of iron oxides and dirt, whch are released from the metal as it melts, and float to the surface because they are lighter than the pure iron. The iron oxides and dirt form a liquid slag having a melting temperature higher than that of the molten iron under it. It is almost impossible to melt the pure iron through this slag. Therefore a flux is thrown upon the molten oxides, with which it unites, forming a compound having a melting temperature lower than that of the cast iron. Then it is easily possible to melt the oxides out of the way and complete the weld with the clean metal. Cast iron fluxes are usually made from potassium chlorate, borax, caustic potash, salt, etc. The flux is usually applied by heating the rod, dipping it down into the can of flux and then melting the rod and the flux sticking to the rod simultaneously into the vee of the weld.

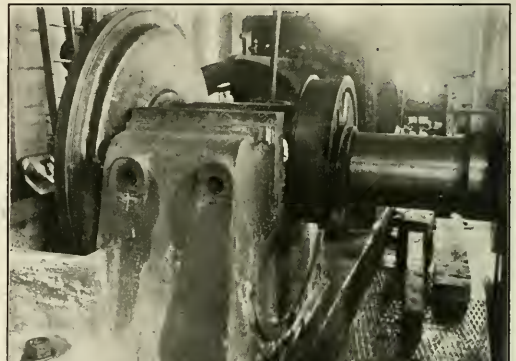


Fig. 2—Welded 7-Ton Air Compressor Casting

Flux should be used with moderation. If it is applied too freely there will be a tendency to make the weld porous, and in the finishing of a weld too much flux will probably form

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a hard scale on the surface. If this should accidentally occur the scale can be removed by rubbing an old file over it while it is still dark red hot. But of course it would be better to use the flux more sparingly.

11. *Cast Iron Welds Should Be Carefully Reinforced.*—By the reinforcement of a weld is meant the amount of weld metal added to the vee after it is full. It usually is thought that the greater the amount of metal added to a weld, thereby increasing its thickness, the stronger would be the weld. This is not always true under the following conditions:

(a) If the welder in beveling should leave sharp corners at the top of the vee, a strain on the weld is liable to break it at the corners through to the surface of the reinforced material. This is due to the cleavage planes formed by the poor arrangement of the crystals at the sharp corners. Designers of machinery always fillet the corners of metal parts receiving heavy strains for this very reason. The corners at the top of the vee should be melted down and rounded with the welding torch before the reinforcement is added.

Fig. 3—Welding Defective Condenser Casting

(b) If the reinforcement is only on one side, the center line of the pull on the base material is not the same as the center of pull of the weld. This would make an eccentric load or strain on a weld which might cause it to rupture. For example, suppose a bar one inch thick is single-vee welded and reinforced only on one side, the reinforcement being say 1/4 in. thicker than the bar. Then the center line lengthwise (longitudinally) through the weld would be 1/8 in. higher than that through the bar, which would cause an eccentric or bending strain through the weld while there would be a straight pull or tensile strain through the bar. This would be liable to break the weld open, as one might bend and break a stick over the knee. This eccentric load would be eliminated by reinforcing a weld on both sides, which suggests this rule of practice: *Whenever practicable double vee and reinforce a weld on both sides.*

12. *Cast Iron Welds Should Be Reheated.*—Unless a special furnace is used for the preheating of a casting it probably will gradually lose its heat and require to be heated up again, and this may happen a number of times during the making of a weld. Under such conditions strains are set up in the grain structure which are greater in some than in other parts of the metal. These unequal granular strains make themselves known sometimes without warning and when there is no load on the casting. Other times they cause the failure of a casting when it is under heavy strain. Sometimes a moderate hammer blow on or near the weld will cause the locked up stresses to be released, thereby developing a surface crack.

All of this trouble may be overcome and the unequal strains in a casting relieved by reheating. That is, after the welding is completed the casting should again be heated, covered thoroughly and allowed to cool slowly until quite cold before exposing it to the air.

13. *Cast Iron Will Expand on Heating and Contract When Cooled.*—If a piece of cast iron is heated from the cold to the molten condition it will be expanded to its limit. Then as it cools to the original cold state it will contract almost but not quite to its first dimensions. This movement of the granular structure of the metal will be about the same in all directions providing the metal is of uniform thickness and width. Many castings, however, are constructed of thick and thin parts, like an ordinary pulley, for example. Then there will be unequal expansion and contraction throughout the casting, and special precautions must be taken to allow for these changes of dimension. For a plain straight casting in which the expansion and contraction is uniform and unconfined, no special preparation need be made for its heating by the oxyacetylene torch. But for castings of intricate design preheating will be necessary. Let us see how this would take care of the expansion and contraction of cast iron.

Expansion.—A metal like cast iron consists of crystals, grains and the chemical elements common to all irons and steels, i.e., carbon silicon, manganese, phosphorus and sulphur. Each flat sided grain is composed of a group of crystals which are uniformly interlocked. The grains are held together by the law of attraction. Now when heat is applied to a piece of cast iron the crystals respond by gradually separating. This enlarges the grain they form and at the same time the power of attraction or cohesion is reduced from say 30,000 lb. per square inch in the cold state to nearly zero when the iron is in the liquid condition. The growth of the crystals and the corresponding enlargement of the grains increases the size of the piece of cast iron. This is expansion. Naturally the thicker the piece of metal the greater the mass of crystals and grains and the greater the amount of heat necessary to produce the expansion. Therefore if an iron casting is composed of thick and thin parts, the thin portions will be the first to receive the effects of the heat and will expand before the thicker, slower sections This unequal rate of expansion sometimes will start small

Fig. 4—Welded Cast Iron Superheater Header

cracks in the metal. The expansion may be made more uniform, however, by using an abundant supply of heat, say from a big oven or an oil torch.

Contraction.—Just as the crystals and grains of iron were allowed to separate by the heat weakening the cohesion holding them together so the withdrawal of the heat from the metal and the fall of temperature allows the law of cohesion to operate again thus pulling the crystals back in place, reducing the size of the grains and contracting the whole piece of metal as it cools and becomes solid. This is contraction. Now it readily will be seen that if an iron casting having thick and thin sections has been heated red hot and expanded to the limit throughout, when the heat is withdrawn from it and it is allowed to cool in the open air of a shop, the thin parts will be the first to lose their heat. Then the casting will be in two thermal conditions, the thick parts hot, with grains weakly held together by low cohesion, and the thin parts cold, with the grains pulled back together by almost the original power of cohesion. Of course there will then be junctions of the hot and cold metal where the power of attraction will be in opposite directions and the pull of the contracting grains of the colder metal frequently will be sufficient to fracture the joint. These usually are called shrinkage cracks and are due to unequal contraction. A simple method for preventing shrinkage cracks is to surround the iron casting with an envelope of heat of sufficient volume to retard the cooling of the thin parts so that they do not get cold before the thick ones. This causes a uniform rate of shrinkage of the grains throughout the whole casting and prevents unequal cohesive pull as the crystals and grains contract. In the oxyacetylene welding of a cast iron locomotive cylinder, for example, uniform expansion and contraction of the metal is accomplished by heating the whole cylinder inside of a fire brick casing built around the job with a space of a few inches between it and the brick covering. Taking one brick out at a time provides the necessary opening to do the welding, and then closing up all openings in the brick jacket after the weld is completed and the preheating stopped envelops the cylinder in an atmosphere of high temperature which cools so slowly that the grains of the thick parts shrink at the same rate as those of the thinner sections.

New York Central Engine Terminal at Syracuse

Interesting and Economical Design With Unusual Ash Pits Characterize Solvay Enginehouse

THE New York Central has recently completed and placed in operation an interesting 30-stall enginehouse and terminal layout at Solvay, outside the city limits of Syracuse, N. Y., for the care of passenger locomotives turned at this division point. The new terminal, which replaces one that had become congested and crowded because of its circumscribed limits within the city, contains many features of economical design, construction and operation which are a departure from ordinary practice. This is notable in the design of the ash pits, which are circular in section, of concrete and economical both in cost and operation.

A Compact Well-Arranged Layout

Location and General Features of the Terminal

The new terminal had been under consideration for a number of years preceding the war and in 1918 construction was started but on account of financial and other conditions little was done. Work was resumed in 1921 and the project was carried through rapidly to completion. The layout is primarily for the care of passenger train locomotives received from and sent out over the several divisions of the New York Central centering at Syracuse. Some freight power is handled, however, as well as switching locomotives. The terminal is located about 3.5 miles west of the Syracuse passenger station. It adjoins the four-track main line to Buffalo and the two-track line of the West Shore Railroad, also a part of the New York Central.

The terminal includes a 30-stall enginehouse of brick walls and timber roof on concrete foundations which is served by a 100-ft. turntable. All stalls are completely equipped with modern facilities, including electric welding and are exceptionally well lighted, aside from the natural light, by a comprehensive overhead direct lighting system. Portable inspection lights are also provided. Flood lights are used in considerable number in and around the turntable, the ash pits and the coaling station. A modern power plant furnishes hot air for heating, steam and compressed air. A well equipped machine shop adjoins and is a part of the enginehouse, as are the offices, etc. The coaling plant has a rated capacity of 1,000 tons with duplicate hoisting machinery.

Both the New York Central's four-track main line and the West Shore's two-track main line pass through Syracuse and there is a heavy through passenger and freight traffic over both of these lines. There is also considerable traffic which originates at or is destined for industries in Syracuse

Arrangement of the Three Ashpits on Inbound Tracks

and the immediate vicinity. In addition the Rochester division, better known as the Auburn Road, leads to the west, the Ontario division to the north and the Chenango branch to the south. The traffic handled through Syracuse is naturally large and the problem of turning power quickly and efficiently becomes important. Under the method of operation now in use in connection with the new terminal, freight and passenger engines are, with a few exceptions, turned at separate points. Freight power from and to the west, i.e., locomotives used on the Syracuse and Rochester divisions, are handled at DeWitt, a combined engine terminal and freight yard, while those on the Mohawk division (Syracuse to Albany) are handled at Minoa. Both of these terminals are east of Syracuse proper. Other freight power is ordinarily handled at Belle Isle to the west but at the present is being turned at Solvay.

In more detail, the power now turned at Solvay consists of both passenger and freight locomotives for the following approximate number of trains and divisions over which they pass: The passenger train movement over the Syracuse division is about 30 trains daily each way and the number over the Mohawk, its complementary division, is about the same. There are about six passenger trains each way over the Ontario division, about five each way on the Rochester division and about three each way on the Chenango branch. Added to this number of passenger train movements, there are five double header freight trains each way on the Ontario division while from one to three coal trains are received daily from the Pennsylvania or handled by the Pennsylvania from Elmira, N. Y., over the Central's line. Thus 85 or more locomotives are handled daily without taking into account the switching power housed and handled at Solvay.

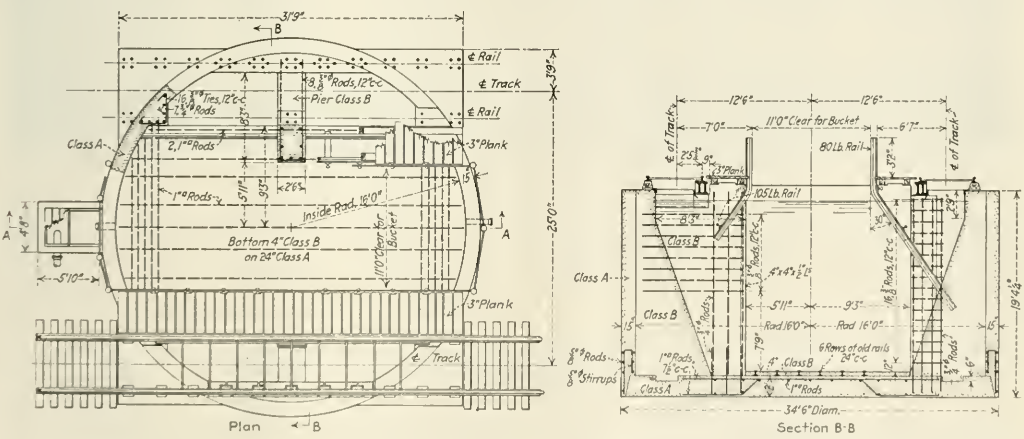
The Ash Pits Are of Unusual Design

The ashing facilities at Solvay are easily the outstanding features of the Solvay terminal because of their departure from ordinary practice, their low cost and their ease of construction. The arrangement consists of four wet ash pits of mass and reinforced concrete, built in the form of circular wells. Three of these pits are located under the inbound engine tracks and one under one of the outbound tracks, thus providing ashing facilities for outbound power, an arrangement of which the advantage is obvious.

Certain advantages are accorded to this type of pit which are of importance. They can be built for about $11,000 each, exclusive of water connections and drainage. Three pits, giving the same number of engine positions as would be permitted by a 200 ft. pit, can be built for less than half the first cost of the long pit.

As compared with the long 200-ft. pit, there is very much less structure to maintain. In the case of the long pit, 400 lin. ft. of steel girder construction must be maintained, as contrasted with 150 ft. for the three small pits. The storage is concentrated directly opposite the engine positions for the full capacity of the pit, and until any one pit is completely filled, the number of engine positions is not reduced. While the long pit will allow greater storage capacity for the same number of engine positions, nevertheless to utilize the maximum storage capacity of the long pit, the number of engine positions must be reduced for a portion of the time in order to completely fill it, thereby reducing the efficiency of the terminal from an ash pit standpoint. In the circular types, additional storage can be obtained by deepening the pit.

If an extension of plant is required, one or more pits may be added without disturbing the others. In view of the lesser lengths of track supported over or adjacent to the water, a much better opportunity is afforded for protection and a man



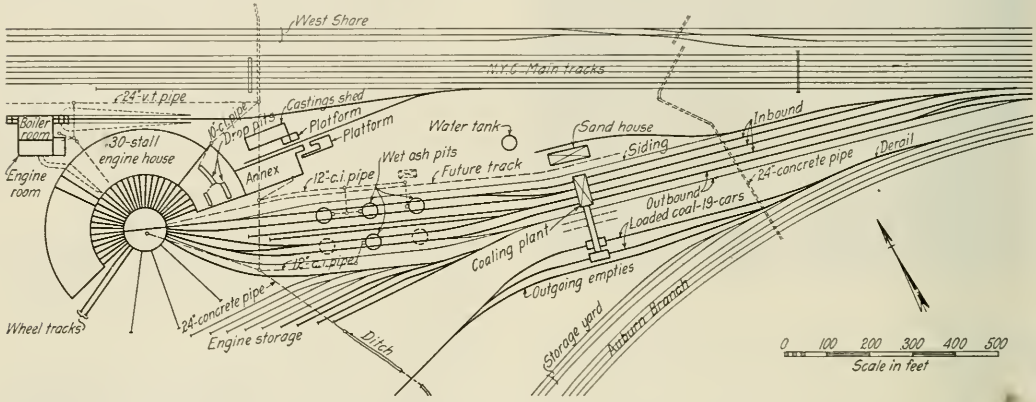
A Plan View and Cross Section of One of the Circular Pits may cross between the engines without as great an element of risk. On account of the smaller first cost, it is reasonably economical to install pits with walkways on the water side rather than to leave them open or to install gratings.

The pits are designed to be cleaned by a locomotive crane with clam shell bucket, operating on a stub track adjacent to the pit tracks. In order to protect against damage from the bucket six rows of old rails 30 ft. long and on 24-in. centers have been imbedded in the concrete at the bottom of the pit with the ball of the rails slightly above the surface of the concrete. Each side of the opening between the 4 ft. walks on the inner side of the pit tracks has been protected by a series of 80-lb. rails bent at about a 30-deg. angle. These rails are vertical above the edge of the pit but slope toward the walls, thus forming guides for the bucket when it is withdrawn. Each alternate rail is extended and imbedded in the concrete sectors mentioned. The ends of the shorter lengths of the bent 80-lb. rails and the centers of the longer ones are tied together on each half of the pit by a length of 105-lb. rail paralleling the center line of the track while a second line higher up adds to the rigidity of the arrangement. A clear opening, 11 ft. wide, is secured. The extended vertical sections of the 80-lb. rails form the posts for the protective "railing" on the inside of the walks. The railing consists of 3/4-in. steel cables run through holes drilled in the web of the rail and is carried around the ends of the pits by wooden posts, making a continuous protection. The two walkways are placed independently in the pit and are built of timber, easily removed and replaced.

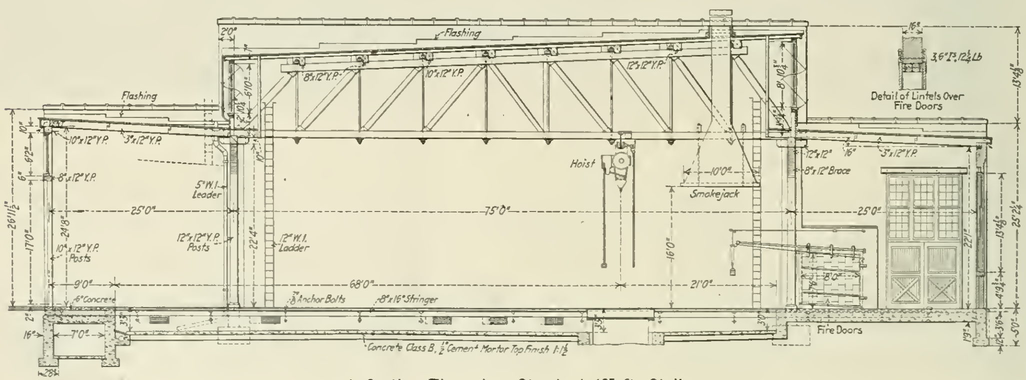
A Well Arranged 30-Stall Enginehouse

The type of enginehouse which has been built at Solvay is one which has become, in a way, a standard on the New York Central. This particular house is a 30-stall structure with mass concrete foundations, brick walls and fire walls, timber posts and a timber monitor roof structure.

The enginehouse is a semi-circular structure with an inner radius of 126 ft. 5 9/16 in. With the exception of five stalls at one end which are 125 ft. deep, all stalls are 110 ft. from center line of the door posts to the interior faces of the pilasters in the rear wall. One stall has been constructed as an outbound track through the building; this divides it into sections of 10, 14 and 5 stalls, respectively, each separated by fire walls. The angle between center lines of stalls is 6 deg. 48 min. for all except the outbound track mentioned where the angles to either side have been increased to 7 deg. 15 min. This gives an opening of 15 ft. center to center of door posts on 29 stalls and 16 ft. 11 3/4 in. for the outbound track, although this section has no doors at front or rear. Each stall is divided into three bays which, in the 110 ft. sections of the house, are 25 ft., 64 ft. and 21 ft., respectively, from the door end. In the 125-ft. 5-stall section they are 25 ft., 75 ft. and 25 ft. The roof is a timber structure carried on 12-in. by 12-in. yellow pine posts. The center bay forms the monitor and this section is supported by timber trusses between stalls. The trusses are reinforced with steel rods in the 125-ft. section, which is chiefly the repair section of the house and little affected by hot gases. The roof over each bay is of the shed type, the slope of the inner bay and



General Layout of the New Terminal

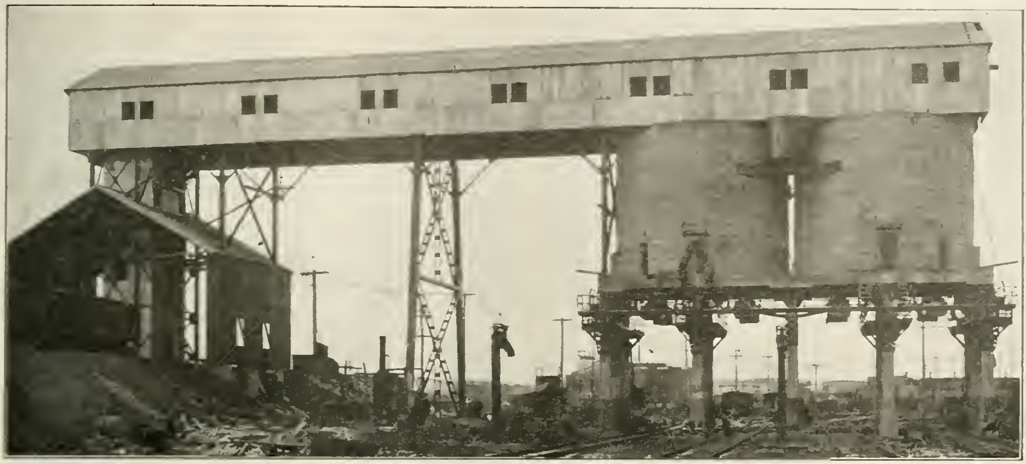


A Section Through a Standard 125-ft. Stall the monitor being toward the first line of interior posts and of the outer bay toward the rear of the house. In the 125-ft. 5-stall section the entire roof structure has been raised slightly over five feet, thus increasing the clearance under the monitor section for the use of a monorail hoist of 7½ tons capacity. The effectiveness of the lighting was also improved.

Windows of large size have been installed in the rear and end walls, in both sides of the monitor and over the doors of the 125-ft. section. Smaller sash has been installed over the doors of the 110-ft. section. Daylighting is thus well taken care of, there being about 19,000 sq. ft. of windows in the enginehouse and in the 52-ft. by 92-ft. annex which includes the machine shop, offices, oil storage and quarters for engine crews. The interior electric lighting is also well taken care of. Besides three large drop lights between stalls, six drop lights have been provided in clusters of two with large reflectors, so arranged as to throw the light on each side of the locomotives. These lights are controlled by a switch arrangement on the rear wall. There are also numerous outlets for the use of portable lights. Another installation of interest electrically is the provision at each stall for the use of a portable electric welder.

The engine pits are of concrete, crowned slightly at the bottom and drain toward the inner and outer circles. The wheel pits have all been installed in the 125-ft. section, three tracks having driver wheel pits and two tracks having pony truck and tender pits. One wall of the pits forms one side of the hot air ducts through which the pits and the house are heated. These air ducts have five screened openings into each pit and connect at the inner circle with a large hot air duct which follows the line of the inner circle just below the floor system and inside the doors. It is of concrete of variable inner dimensions to secure the most efficient flow of the heated air. The two arms of this duct tap into the main heating duct from the power house adjacent to the enginehouse between stalls Nos. 18 and 19, the sides of the pits at this point forming the sides of the duct. The clear height at this point is about 7 ft. 6 in. The junction of the two arms is constructed to divert the air in the proper quantities. This is accomplished chiefly through a "V" or baffle wall located so as to give different dimensioned passageways to either end of the house. The entire enginehouse is floored with six inches of concrete, this flooring forming the top of all air conduits except the feeder extending around the inner circle, over which the enginehouse tracks pass. At these points a reinforced concrete slab 11½ in. thick forms the top and on this is placed 7½ in. of cinders and then the regular floor construction. As a precaution against engines going through the rear walls, an opening has been left in the floor back of the bumpers. This opening is covered with plank flooring which the pony trucks can easily break through, thus effectually stopping the engine.

In addition to the equipment mentioned for the enginehouse proper, each stall is provided with a link in the rear wall by means of which, in conjunction with a special motor and drum on the turntable, dead engines can be hauled into position. Another unit of interest is a portable oil and repair truck used by the enginehouse forces. This truck contains a generous equipment of tools, oils, grease, etc., necessary for the pit work and inspection on the engines. It also contains a special high candle-power inspection light which can be placed in the pit or at any other desired location, greatly facilitating the work. By concentrating all of the various needs of the locomotive, electrical, air brake and other inspectors, and the men and their helpers, it is estimated that a substantial saving has been made in time saved. A test indicated that the amount of walking eliminated by the foreman and his 11 men in one 8-hour period was the equivalent of 43 miles by one man.

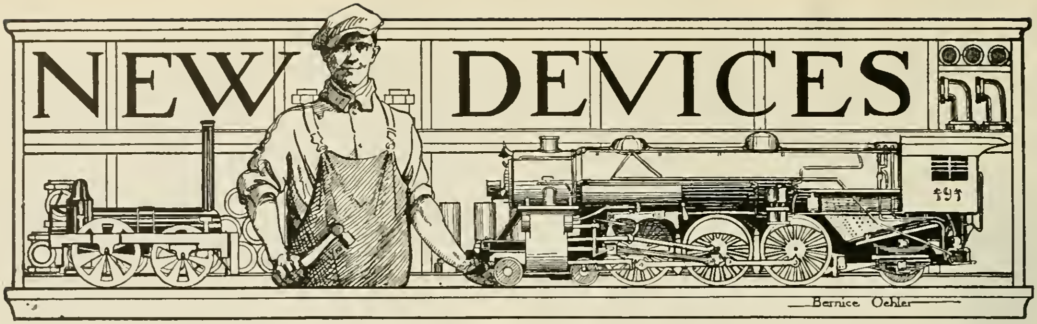


A Modern, Workmanlike Coaling Plant

The enginehouse, power house and machine shop are completely equipped with all necessary facilities where needed, arranged for easy access. The equipment includes three 400 hp. water tube boilers with space for a fourth unit, pumps, feed water heaters, boiler washing plant, hot air heating coils and large size blower, oil filters and an ash hoist and storage bin, etc. The power house has an inside trestle for coal cars.

A Large, Modern Railroad Designed Coaling Plant

The coaling plant is of reinforced concrete and steel throughout, making a fireproof structure with a rated capacity of 1,000 tons. The actual capacity appears to be somewhat greater than this. The entire design aside from the machinery was prepared by the engineering department of the road with the purpose, among other things, of facilitating the rapid construction of the plant. Coal is delivered in hopper-bottom cars operated by gravity over two tracks and is discharged into hoppers under the tracks from which it is elevated to a conveyor gallery. Duplicate hoisting and conveying machinery has been installed. The storage facilities are in the form of two circular concrete bins 33 ft. 8 in. inside diameter and 30 ft. 8 in. in height.



Changes in Design of Elvin Stoker

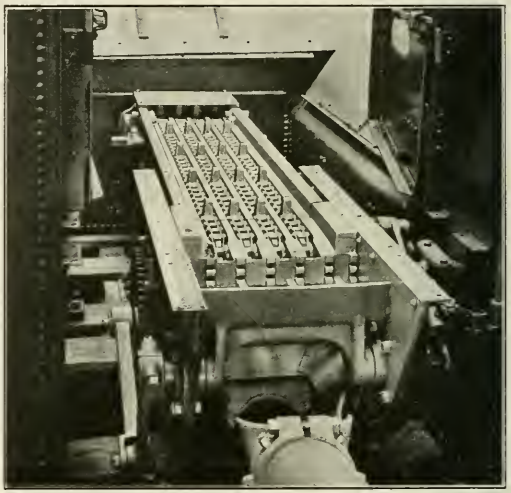
IN the original design of the Elvin Stoker a screw conveyor was used to carry the coal forward from the tender to the screw conveyor that delivers it to the elevator. In machines now being constructed, the Elvin Mechanical Stoker Company, New York, is applying an improved type of chain belt feeder combined with a reciprocating crusher.

The feeder consists of four endless drag chains in a wide, shallow trough. The rate at which coal is delivered to the stoker is governed by the speed of the chains which are fed forward intermittently at any rate required by the operator, delivering coal at any desired rate up to the maximum capacity of about seven tons per hour.

Coal which does not require crushing passes through four slots just back of the main crusher jaws, leaving the crusher to handle only the coal which requires breaking in order to reduce it to the proper size for the stoker shovels. No slide plates are used over the chains as the feeder operates under a full load of coal with a relatively small consumption of power. There is no possibility of injury to anyone walking back in the tender as the maximum speed of the chains is only about six feet per minute.

The crusher has a single crushing roll which revolves backward and forward through a partial revolution. The crusher is ahead of the coal gates and is not covered even when the tank is full of coal, being in plain view at all times during operation. Any obstruction in the crusher will stop the entire machine thus making its presence known. By reversing the stoker engine the crusher jaws can be opened allowing the foreign matter to be removed. The cover plate over the crusher is normally set at an angle to form a guard; when laid flat it forms a shovel plate for shoveling coal by hand on sidings or at terminals.

In order to compensate for the variable loads which are imposed by the crusher the stoker engine has been provided with a simple and compact governor apparatus. This operates on the hydraulic principle utilizing the varied pressure from a small gear pump to operate a balanced piston control valve. By means of the governor the stoker speed is maintained at any rate desired by the operator regardless of whether the fuel supply consists of slack coal or lumps or a mixture of both.



A View of Feeder and Crusher with Tender Deck Removed

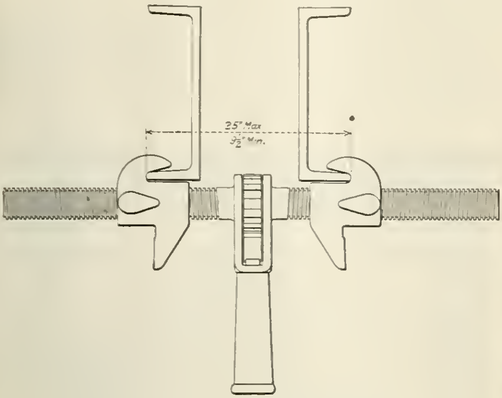
Electric Drill Provided with Mechanical Reverse

THE Independent Pneumatic Tool Company, Chicago, has placed on the market an electric drill which reverses by means of a mechanical device located in the gear case. The motor always runs in the same direction and is relieved of the severe shock which formerly resulted from reversing the current when the motor was under load and speed.

The reversing gear is equipped with a fool-proof locking device which can be shifted instantly to permit three motions: First, a locked constant forward motion for general drilling, reaming, stud driving, nut tightening and tube rolling; second, a locked constant reverse motion for backing off nuts and backing out studs and tube rollers; third, a neutral position which allows the spindle to slip into forward motion when the machine is pressed forward against the work and to slip into reverse motion as the machine is withdrawn from the work. This action is automatic, making the tool ideal for wood boring, tapping, flue rolling, and similar work. The patent, as applied for, covers the device on both electric and pneumatic tools of all sizes.

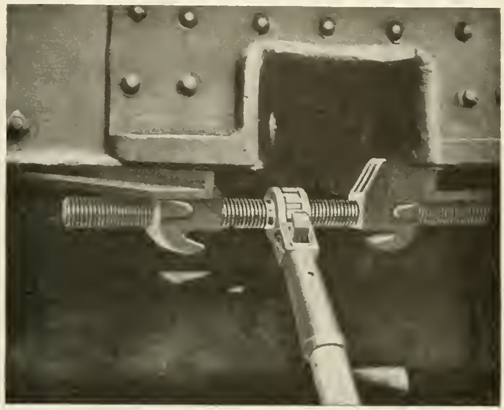
Push and Pull Jack for Car Work

A NEW jack which should prove of exceptional value in car repair work has been developed and placed on the market recently by the Duff Manufacturing Company, Pittsburgh, Pa. The special feature of this jack is its arrangement to either push or pull at the will of the operator as shown in the illustrations. The jack can be used for straightening center sills on the draft gear ends of cars either by pushing apart or pulling together where bent. With chains and hooks it can be used to advantage for pulling in freight car sides which have been bent outward.



Arrangement for Straightening Channels by Pulling

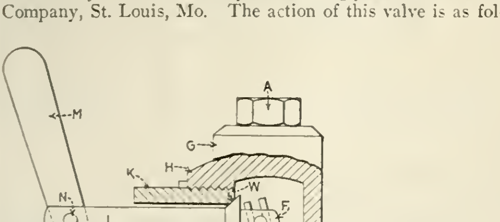
The jack is extremely simple in design, consisting of a steel screw, rachet with pawl, and two cast-steel nuts, the latter being designed with a flat projection on one side for pushing and a hook on the other side for pulling. The nut bearing has ample length for sustaining the eccentric stresses of both pushing and pulling. The jack weighs 39 lb. and has a capacity of 10 tons. For pulling, the maximum and minimum spreads are 25 in. and 9½ in. respectively. For pushing, the maximum and minimum spreads are 24 in. and 8½ in. respectively.



Duff Jack Which May Be Used for Spreading Car Center Sill

Locomotive Safety Water Gage Valve

AN automatic, safety water gage valve, which has given dependable and satisfactory service for more than five years on stationary boilers, has recently been installed successfully on locomotives by the Mattingly Automatic Valve Company, St. Louis, Mo. The action of this valve is as follows, reference being made to the illustration wherein *C* represents the main valve controlling the passage from boiler to gage glass. *R* is a link pivoted on pin *E* which extends through from one side of the casing to the other. *R* forms a connection between main valve *C* and auxiliary valve *W* and causes main valve *C* to be moved in the opposite direction to that of auxiliary valve *W*, thus preventing both valves from being seated at the same time. *L* is the auxiliary valve stem, the inner end of which is connected to link *R* by means of a fulcrum and pin which fits in the slotted end of link *R*. Valve stem *L* slides through bushing *K*, the bore in bushing *K* being somewhat larger than the valve stem. This allows a passageway around valve stem *L* which is controlled by auxiliary valve *W*, thus eliminating the necessity of any packing around this stem. To the outer end of auxiliary valve stem *L* is connected a lever *M* called the operating lever, the position of which indicates the position of the main valve *C*. When the lever is leaning outward the main valve *C* is off its seat and when the operating lever is leaning inward it indicates that the main valve *C* is closed.



Mattingly Automatic Safety Water Gage Valve in Open Position

The construction of the valve casing, as illustrated, provides a boiler connection at right angles to allow for cleaning the interior of the valve and inserting a rod or wire into boiler through plug *B* and lower plug *A*. The portion of casing marked *G* is offset from the portion marked *H* to allow for a glass or metallic water glass end being inserted from the top through the upper plug *A*.

When either the top or the bottom water gage valve is opened, as shown in the illustration, the pressure is admitted around main valve *C* through the gage glass and into the valve at the opposite end of the glass. This pressure quickly equalizes on each side of the main valve *C* and at the same time exerts itself against auxiliary valve *W* and stem *L* forcing them outward until auxiliary valve *W* rests on its seat. In other words, when one valve (either top or bottom) is opened to admit pressure from the boiler, this pressure automatically passes through the gage glass to the other valve and forces it wide open, holding it open. Should either valve be placed in closed position while the other one is open, it will not stay in that position, but will open again. This is due to the pressure acting against the auxiliary valve and stem as above mentioned.

To close the valves while pressure is in the glass, move them both to closed position at the same time. This allows both main valves *C* to close communication between the boiler and glass, at the same time unseating auxiliary valves *W*. This allows the pressure in the glass to escape around auxiliary stem *L* which has no packing around it. Should the gage glass become broken, the pressure will be quickly released off auxiliary valve *W* and the pressure rushing from the boiler will force main valves *C* to their seats instantly stopping the flow of escaping steam and water.

A valuable feature of this valve is the practical impossibility of its sticking or corroding shut. The valve is manually operated and gravity is not depended on to close it. Should dirt or grit become lodged on either valve seat causing a leak, it can usually be dislodged by pushing the operating lever in and letting it fly back.

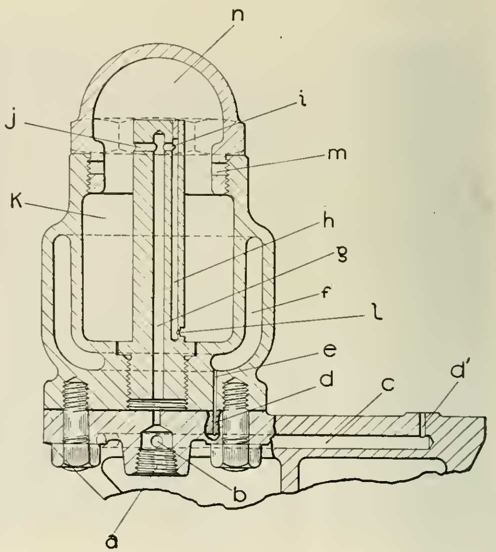
Oil Atomizing Lubricator for Air Compressors

An atomizing lubricator for all types of air compressors—cross-compound, duplex and simple—has been perfected recently by the New York Air Brake Company, New York. A unique feature of this lubricator is the provision for securing practically uniform temperature of the oil and consequently a uniform feed to the air cylinders. This is obtained by surrounding the oil chamber with an air jacket in constant communication with the high pressure air cylinder of a cross-compound or duplex compressor, or with the air cylinder of a simple compressor should it be of this type. As a result, the hot compressed air in the jacket so warms the oil that there is little difference in the rate of feed in summer or winter, while it will handle equally well either light or heavy oils.

Referring to the illustration of one of these oil cups and a portion of its supporting bracket, the pipe-tapped opening *a* is connected by a ⅜-in. O. D. copper pipe to the high pressure air cylinder, provided the compressor is of the compound or duplex type. Hot, compressed air, entering at *a*, flows through passages *b*, *c* and *d* to the jacket chamber *f*, also through *b*, *c* and *d'* to a second oil cup for the compressor cylinder not shown in the illustration.

These cups are fastened by studs to a bracket attached to the top head or to the center piece of the compressor. Oil, after passing through the restricted port *l* is drawn up through passage *h* and into *i*, where it meets incoming air drawn back by the suction stroke of the air piston. After being atomized it goes down through passage *g* to the air cylinder.

This oil cup is simple in construction, without moving parts, and requires a minimum of attention during road service. It is entirely automatic in its operation, and without valve or adjustments, the rate of feed being determined by the relative size, position and arrangement of the several ports and passages.

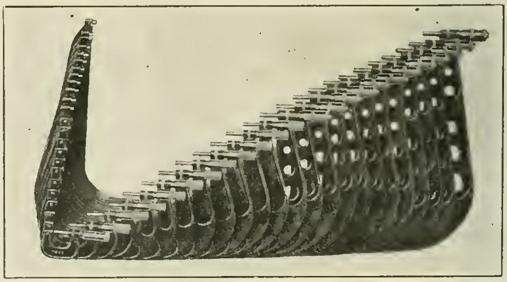


Lubricator with Bracket for Cross-Compound or Duplex Compressor

Micrometer Calipers with Rectangular Frames

Of particular interest to mechanics, tool makers and practically every user of measuring instruments is the new line of Rex micrometers made by the Brown & Sharpe Mfg. Co., Providence, R. I. This Rex line is furnished for either English or Metric measure and includes 24 different sizes of micrometers to take measurements up to 24 in. or 600 mm. The illustration shows a complete line of 24 sizes of Rex micrometers, in progression from the No. 59, measuring 0 to 1 in. to No. 88, measuring 23 in. to 24 in. These micrometers are regularly furnished with a clamp ring which clamps the spindle and preserves the setting.

A feature of the micrometers is the rectangular shape of the frames which gives greater measuring capacity than frames of the circular type. Holes are used in the larger sizes to lighten the frames. The anvil, spindle and other

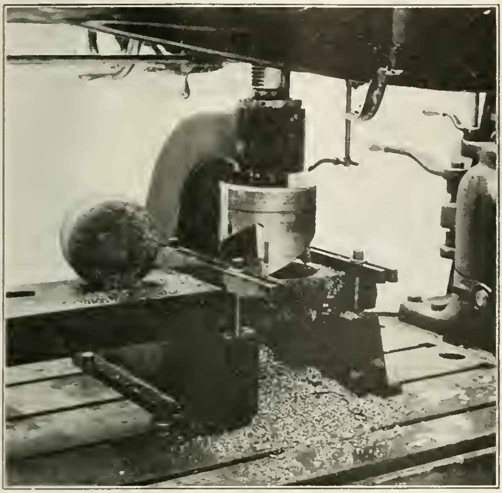

Brown & Sharpe Micrometer Calipers Featured by Light but Strong Rectangular Frame; Ranges; Range, 1 in. to 24 in.

parts of the Rex line are similar to the parts of the regular Brown & Sharpe micrometer calipers. Means are provided for adjustment for wear of measuring surfaces and screw.

In the larger sizes, Rex micrometers are supplied with finished wooden cases, substantially made and affording a safe place in which to keep the tools.

Radial Drill Equipped for Side Rod Boring

An interesting side rod boring operation is performed on a 6-ft. plain, triple purpose, radial drill built by the American Tool Works Company, Cincinnati, Ohio. The slow speeds for this and similar boring and tapping operations are obtained through an internal gear drive on the spindle, which provides the power and rigidity necessary for this class of work.



Powerful American Radial Drill Equipment for Boring Side Rods

The side rod boring equipment consists of a pair of parallel T-slotted rails, bolted across the base, upon which is mounted a heavy housing carrying a bronze guide bushing to aline the overhung spindle close to the cutter head. Mounted in the spindle is a cutter head or trepanner, which consists of a hollow steel shell carrying three cutters. A taper shank and cross drive key fit the spindle and the dead weight of the tool head is carried on a cross pin in the spindle nose. The tools are shaped so each one removes a certain portion of the material with the result that the slot is cut through the steel forging in a remarkably short time, leaving the center plug shown for some other purpose.

The cutter head is arranged to carry an auxiliary adjustable boring tool (not shown) for taking the finishing cut after removing the center plug. The extension of the parallel rails in front of the housing provides the holding means for securing the work. The rod illustrated was an annealed open-hearth steel forging of .40-.50 carbon and .50-.70 manganese content. The hole bored was 11 3/16 in. in rough diameter, being finished to 11¼ in. diameter. The rough cutting time was 23½ min. at the rate of 12 r.p.m. with .016-in. feed. The finish cut took 42 min. at 22 r.p.m. and .005-in. feed.

An outboard arm support was used in early experiments but was found to be superfluous as the arm and column were entirely free from deflection or chatter without it.

The great power delivered to the spindle of this drill enables it to perform operations never expected of radial drills before and makes it a more useful and general purpose machine, especially adapted to railroad shop use.

Die Head with Micrometer Attachment

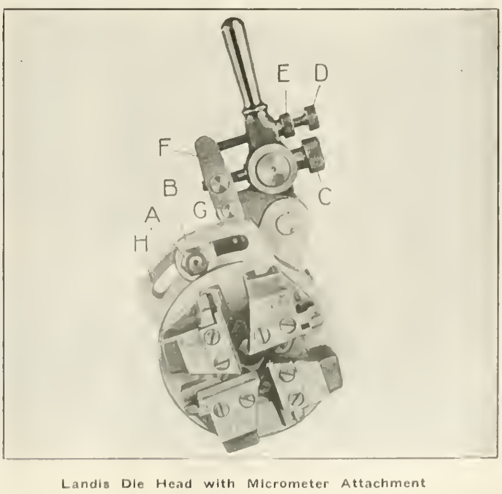
The Landis Machine Company, Waynesboro, Pa., has recently developed a stationary type die head with micrometer attachment. This head is particularly valuable when cutting threads of special form requiring one or more roughing cuts and a finishing cut. With the micrometer attachment it is possible to set the die head so that the same amount of metal is left for the finishing cut at all times. The head is graduated for both right and left hand for all sizes of bolts and pipe within its range. These graduations are stamped on the outer surface of the closing ring above the circular slot.

The operation of the die head, referring to the illustration, is as follows: To adjust the die head to size loosen the clamping nut *A* with the left hand and bring the index mark *B* opposite the required graduation on the graduated scale with the right hand. Further adjustment can be made, if desired, through the micrometer attachment and great accuracy attained.

To adjust the micrometer attachment back off stop screw *D* after first loosening the stop screw lock nut *E*. Then the micrometer screw *C* can be adjusted for increasing or decreasing the diametrical adjustment.

To increase the diametrical adjustment of the die head, turn the micrometer screw *C* in a counter clockwise direction. This causes the upper part of the link *F* to swing to the left about the center *G*. The swing of the link *F* to the left pulls the closing ring *H* to the right and increases the diametrical adjustment. Turning the micrometer screw *C* in a clockwise direction causes a counter movement of the link *F* and decreases the diametrical adjustment.

After the micrometer adjustment is made, the stop screw



Landis Die Head with Micrometer Attachment

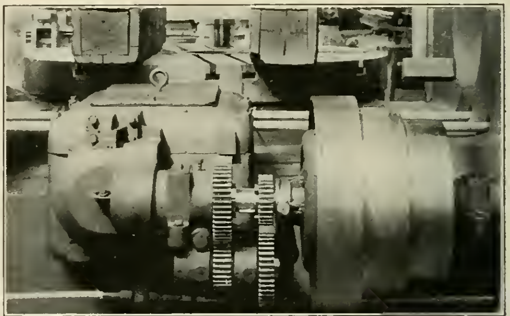
D should be set against the link *F* and locked in place with the stop screw lock nut *E*. To adjust the die head for the roughing cut, turn the micrometer screw *C* in a counter clockwise direction until the desired diametrical adjustment is obtained. The stop screw *D* should be left in the locked position. Two or more roughing cuts can be made by decreasing the diametrical adjustment of the die head in one or more increments through the micrometer screw *C*. After the roughing cut has been made, the micrometer screw C should be turned back in a clockwise direction until the link *F* comes against the stop screw *D*. The die head is now set to the final diameter and is ready for the finishing cut.

Arrangements can be made to apply this die head with micrometer attachment to turret lathes, engine lathes, and hand-operated screw machines. It may also be applied to lathe types of threading machines having stationary heads.

Slow Speed Device for Boring Mill

A SLOW speed device for a seven-foot boring mill has been developed by the Cincinnati Planer Company, Cincinnati, Ohio, as shown in the illustration. This mill is designed for boring locomotive driving boxes and other parts at a speed about 30 per cent greater than standard. In order that tires may be turned on this same mill, a slow speed of about ⅔ r.p.m. is required, this speed being obtained by means of the special gearing illustrated.

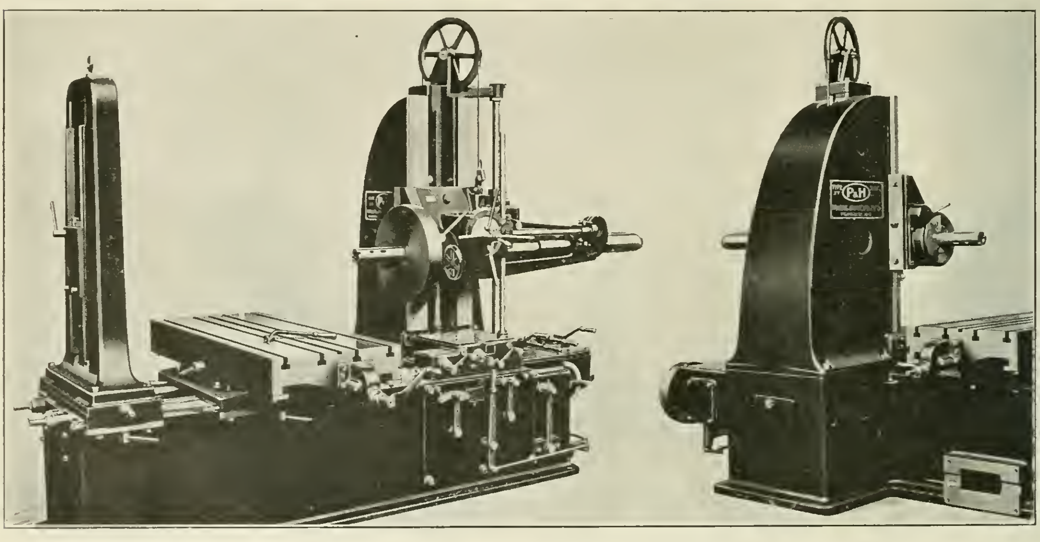
A direct drive for the standard boring mill speeds is obtained when the small upper gear is slid to the left, bringing its clutch teeth in mesh with those of the large gear on the same shaft. The standard arrangement for starting and stopping the mill consists of the friction clutch, shown at the right of the gearing. A special cover has been made to protect all the gearing, also carrying the shifter for moving the sliding gear back and forth. By means of this arrangement an unusually slow table speed can be obtained.



Slow Speed Device Applied to Seven-Foot Cincinnati Planer

Table Type Horizontal Boring Machine

SINCE bringing out the horizontal boring, drilling and milling machine, described on page 657 of the October, 1921, *Railway Mechanical Engineer*, the Pawling & Harnischfeger Company, Milwaukee, Wis., has developed a machine of similar type but with a table and outer support mounted on ways instead of the original bed plate. This machine is designed for toolroom as well as production work. The new machine is modern in construction, being designed to perform boring, drilling and milling operations with great accuracy. It is said that in milling a 22 in. square surface, the accuracy is within .001 in. This accuracy is made possible by the use of a square lock, narrow guides with taper gibs and unusually heavy construction of the spindle, saddle and column, coupled with scraped sliding fits. All sliding parts are arranged with take-up for wear. The saddle is fully counterbalanced with a counterweight located inside of



Pawling & Harnischfeger Horizontal Boring Machine, Equipped with Large Face Plate (left) and Small Face Plate (right) the column. Further features include centralized control, externally and internally driven face plates which are interchangeable, and automatic stops for the saddle and platen.

All operating levers are within easy reach of the operator, the respective movements being interlocked so that conflicting speeds or feeds cannot be set in action at the same time. The drive for this machine is delivered to the spindle through a large face plate with internal gear and tapped holes for the attachment of milling cutters and facing heads, or a small face plate with a wide face, coarse pitch gear. These two arrangements are shown in the illustration. A 14-in. driving pulley running at 350 r.p.m. is used on this machine giving 16 spindle speeds ranging from 14.5 to 225 r.p.m. with the small face plate. Speeds from 8.7 to 136 r.p.m. are available with the large face plate. Power is transmitted by a belt directly from the line shaft to the pulley on the machine itself. A 5-hp. constant speed motor, operating at 1,200 to 1,400 r.p.m., is recommended.

Eight geared feeds ranging from .005 to .288 in. per revolution of the spindle are available for boring and from .0084 to .44 in. per revolution of the spindle for milling when using the small face plate. When using the large face plate the feeds range from .008 to .48 in. per revolution of the spindle for boring and .013 to .73 in. for milling.

Combination Frame Planer and Slotter

A UNIQUE machine has just been placed on the market by the Liberty Machine Tool Company, Hamilton, Ohio, in the combination planer and slotter for locomotive frames, illustrated. Obviously, this arrangement saves floor space and considerable work in moving locomotive frames from one machine to another and setting up the frames. The standard 36-in. Liberty planer, which can be provided with four heads if desired, is the essential part of the new machine to which a slotter arrangement is added. The bed of the machine is 69 ft. long, the table being 38 ft. long and 30 in. wide. Both the bed and housings are of the box type, the method of bolting the housings to the bed and connecting them at the top by a heavy cross brace being in accordance with standard Liberty planer construction. The distance between the housings is 37 in.

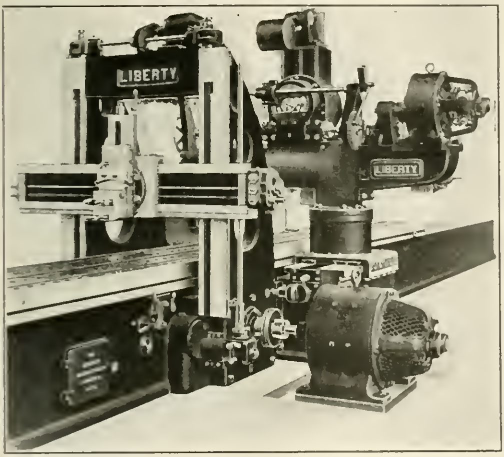


Fig. 1—Liberty Frame Planing and Slotting Machine

As shown in Fig. 1, the planer rail-elevating device is located at the center of the top brace, both elevating screws being driven from the top and supported on ball bearings. The elevating device is controlled by a handle at the side of the housing. Power for feeding the two heads is taken from the bull pinion shaft through a spur gear and mitre gears to the vertical splined feed shaft. Arrangement can be made for the feed to take place on the forward or return stroke by means of a small handle which can also be used to disengage the feed. The feed of the rail heads can be changed at any time without stopping the machine or interfering with the feed of the side heads. The amount of feed is indicated by a dial for the convenience of the operator. Owing to the length of the machine bed the operator would lose time if he had to go around it frequently. A desirable feature of the new machine is the arrangement to make all speed and feed changes from either side. The planer part of the machine is driven by a 15-hp. reversing motor but if desired, belt drive can be provided with aluminum pulleys having cast-iron centers.

The slotter arrangement, best illustrated in Fig. 2, is a self-contained unit rigidly bolted to the bed of the machine and allowing a 24-in. lengthwise travel of the ram. The design is such that the cross rail can be swiveled on a column when it is necessary to slot at an angle across the bed. The cross rail can also be swung clear of the table when using the machine exclusively for large planer work. The left end of the slotter rail is supported on a housing which moves with the right housing. Clamps are provided on the left housing for locking the rail when adjusted to the proper angle.

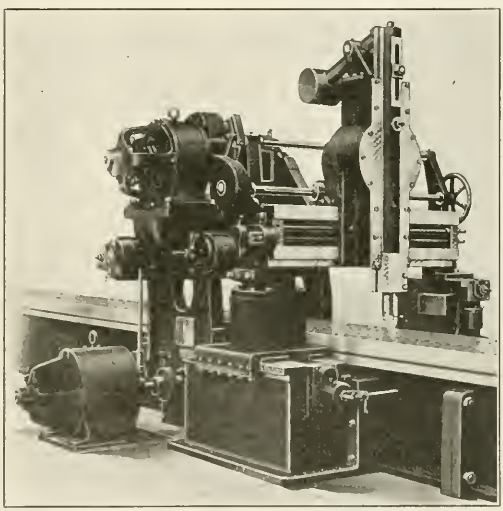


Fig. 2—View Showing Slotter Arrangement

Independent automatic feed and rapid traverse for the head on the cross rail and lengthwise of the base is provided. The ram is driven by a worm and worm wheel through a crank disk and connecting rod, the power being secured from a 10-hp. variable speed motor mounted on the end of the cross rail as illustrated. Power for operating the rail and head movements is secured from two smaller motors. The stroke of the ram is adjustable up to 14 in., the clearance between the slotter housings being 37 in. and between the slotter cross rail and planer bed, 18 in. The planer table is stationary when slotting and when the cut is completed the table can be quickly and easily moved to the next position. Attachments can be furnished for circular feeding or cutting fillers.

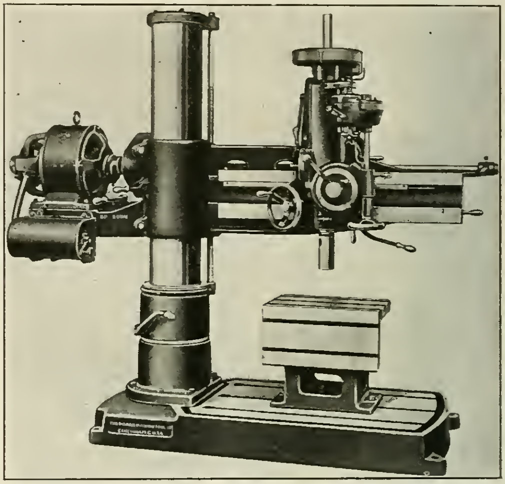
The overall height of the machine is 10 ft. 11 in., the floor space occupied being 10 ft. 2 in. by 78 ft. The weight is 69,000 lb.

New Motor Drive for Radial Drill

The illustration shows a Morris 4-ft. and 4½-ft. radial with the driving motor mounted on the back of the arm. The construction is simple and has the following advantages: There is a saving of power from 20 to 25 per cent due to the fact that the lower shaft, bevel gears in column, shaft in column, gears in column cap, outside vertical column shaft and the bevel gears in back of the arm are eliminated. Besides the saving of power to drive these parts, there is just that much less mechanism to wear or get out of order. There is also the advantage that in mounting the motor in this way, it balances the arm permitting the arm to raise and lower on the column without exceptional strain on the arm-raising and lowering mechanism.

An important feature in the Morris radial of this design is that the arm raising and lowering mechanism is mounted as a unit on the back of the arm near the motor drive gears and is only in operation when the arm is being raised and lowered. For this reason the mechanism was removed from the column cap as this meant the constant running of a pair of bevel gears, a vertical shaft in back of the column and a few gears on the column cap as long as the machine is running, or the mounting of an extra motor to raise and lower the arm. On the Morris design the screw is stationary. The revolving unit is of bronze and mounted on a ball thrust bearing large enough to carry considerably more than the weight of our arm, head, motor and other details. A safety mechanism is provided to disengage the clutch that operates the arm raising and lowering mechanism at the extreme positions of the arm.

The controller is mounted below the motor and on this size machine is within easy reach of the operator. The head has the same features as on other Morris radials, including tapping the attachment running in oil, back gears and clutches made of nickel steel, heat treated and hardened, helical spindle gears, and all bronze bearings with oil chamber, permitting ample lubrication.



Morris Radial Drill with Single Driving Motor Mounted on Arm Extension

Spindle speeds are from 26 to 450 r.p.m. A 3½-hp. motor is required. This radial drill is manufactured by the Morris Machine Tool Company, Cincinnati, Ohio.

Solid Packing Rings for King-Type Cups

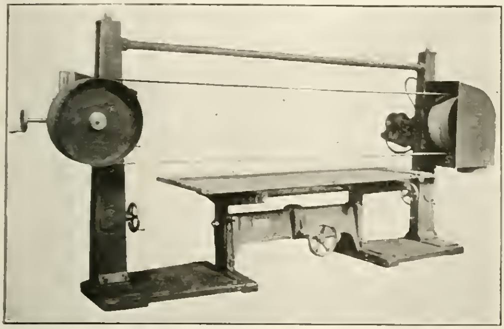
One of the great difficulties encountered in the use of metallic packing rings for King type cups arises from the fact that the packing must be divided into two or three sections. Holding these sections together while boring out the packing is a matter requiring considerable care and there is also a heavy loss of material because of the ease with which the thin edges of the sections become bent or broken in handling between the manufacturer and the point of application. In order that these difficulties may be overcome and that each set of packing may reach the locomotive in perfect condition the Jerome-Edwards Metallic Packing Company, Chicago, has developed and patented a method of packing and delivering Jerome packing for King type cups whereby the packing reaches the shop in a solid ring. In the final process of manufacture before the packing is prepared for shipment the three sections of each ring are sweated together and are intended to remain in this condition until the ring has been bored out and is ready for application.

The box in which the ring is packed contains a small quantity of waxed excelsior and three small blocks which support the ring slightly above the bottom of the box. When the ring is ready to apply it is replaced in the box and a match touched to the excelsior, which in burning produces sufficient heat to melt out the solder in the joints without injuring the

Sweated Packing Ring Packed in Carton with Waxed Excelsior sections themselves. This requires from three to five minutes, after which the sections fall apart. They are then wiped clean of the fused solder and are ready for application to the rod in perfect condition.

Self-Contained Belt Sanding Machine

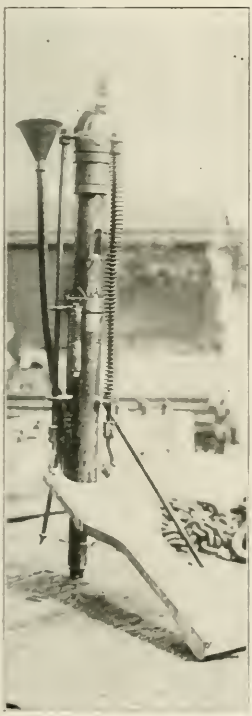
A MACHINE designed for rapidly sanding and polishing all kinds of straight, flat and irregular surfaces as well as polishing metal surfaces has been placed on the market recently by the Oliver Machinery Company, Grand Rapids, Mich. This sander will take work of any length and sand to the center of 72 in. Work up to 42 in. high can be handled on the table of the machine illustrated and by removing the table, work up to 66 in. high from the floor can be accommodated. This arrangement makes the machine extremely flexible and adapted to a wide range of work. The table travels 36 in. horizontally, the vertical adjustment being 14 in. The belt is about 31 ft. long and can be provided in any width up to 10 in.



Belt Sanding and Polishing Machine for Wood or Metal Surfaces

The pulleys of this machine run on ball bearings. The machine is said to be conveniently operated and an exhaust hood on one wheel and guard on the other are valuable safety features. The table rolls on ball bearings and there are no gravity idlers in connection with the machine. A reversible switch permits the belt to run in either direction. The table is fastened to the base plates of the stand which are connected overhead with a rigid bar or top stay. The sand belt pulleys run in ball bearings for individual vertical adjustment on graduated ways by means of a hand wheel, beveled gears and screw. The pulleys are rubber faced and recommended to run at 600 r.p.m. Owing to the relatively large diameter of the pulleys the belt life is increased.

A Pneumatic Nail or Spike Driver



The Bull Dog Safety Nail Driver

AN application of the pneumatic hammer to the driving of nails and spikes in floor and bridge work has been made by the Dayton Pneumatic Tool Company, Dayton, Ohio, in a recently developed device known as the Bull Dog Safety Nail Driver. The tool consists of a barrel or cylinder with a small nozzle at the lower end, in the top of which is fitted the body of a pneumatic hammer. The hammer is free to move up and down in the barrel and is normally held in the raised position by a long coil spring. A foot pedal is attached to the top of the hammer by two rods which pass through guides on the barrel. Pressure on this pedal lowers the hammer into the operating position against the compression of the coil spring. A chute, the top of which is located at a convenient height near the hammer handle, leads down to the lower end of the barrel and feeds the nails into the nozzle. The device has no magazine, the nails being dropped into the chute one at a time as the device is placed in successive locations.

After a nail or spike has been dropped into the chute the hammer is lowered with the pedal and the spike driven home by opening the usual type of trigger valve in the hammer handle. The pedal is then released and the momentum of the hammer, raised by the coil spring, is sufficient to permit the whole device to be lifted and moved to the next location with very little effort on the part of the operator.

The device has a capacity ranging from 2-in. nails to 8-in. spikes and will drive from 40 to 60 6-in. spikes per minute. With it, it is said that two men, working in the standing position, can spike the floors on 15 cars a day, entirely free from the danger of flying spikes. Nails may be driven either flush or with set, as required.

The illustration at the left shows the Bull Dog safety nail driver ready for operation and indicates plainly the nozzle through which nails are fed to the lower end of the barrel. The illustration at the right shows the device with the operator standing on the foot pedal. Pressure on the trigger valve will operate the hammer and drive the spike.

The Hammer in Operation

GENERAL NEWS

German Car Plant Burns

According to press dispatches from Berlin, the Orenstein & Koppel Works, builders of cars, was completely destroyed by fire on July 16.

Rumanian Railway Repair Shops Increase Output

The Rumanian railway repair shops, it is reported, are daily increasing their locomotive repair output. At present they are turning out 100 to 120 locomotives a week and it is believed that this figure will soon be exceeded.

Poland's Freight Car Requirements

Colonel A. B. Barber, American technical adviser to Poland, writing in "Poland," the journal of the American Polish Chamber of Commerce, estimates that the Polish railways will need to acquire between 110,000 and 120,000 freight cars during 1922.

"The Pennsylvania News"

On July 1 the Northwestern Region of the Pennsylvania issued the first number of its "Pennsylvania News." It is an eight-page tabloid size newspaper, four columns to the page. It will be published every two weeks and distributed to each of the 18,500 employees of that Region.

Reduction in British Railway Wages

Owing to the fall in the cost of living in Great Britain, the railway workers' war bonus has been reduced by 4 shillings (about 97 cents at the normal rate of exchange) per week. However, a number of classes have not been affected by this reduction, as they have already reached their standard of wages.

Bad-Order Cars

The number of bad-order freight cars was reduced from 15 to 14.6 per cent of the total from June 1 to June 15, according to the semi-monthly report of the Car Service Division of the American Railway Association. The number was 332,681, of which 268,305 required heavy repairs.

Freight Car Surplus

The freight car surplus for the period June 15 to 23 showed a reduction to 255,685, according to the report compiled by the Car Service Division of the American Railway Association, and for the period June 23 to 30 there was a further reduction to 239,225.

Wage Statistics, April, 1922

For April, 1922, the number of employees reported by Class I railroads was 1,578,133, an increase of 7,975, or 0.5 per cent over the number reported for the preceding month, according to the monthly bulletin of the Interstate Commerce Commission. Owing to a decrease in the number of the higher paid employees, the total compensation decreased $13,291,337, or 6.1 per cent.

Large Expenditures for Rolling Stock Disapproved in Italy

With regard to the credit of 1,750 millions of lire granted with a decree of the Italian Council of Ministers to the Italian State Railway Administration for the purchase of rolling stock and other supplies it is now learned that the parliamentary's committee for public works has not approved the above mentioned decree and that it has observed that at least one part of such material could be obtained in Germany on account of reparations.

It is known in this connection that it had been decided to grant such credit in order to aid industry, and that manufacturers are urging that the government refuse to accept from Germany machinery and manufactured products on account of reparations. Up until the present time Italy has received from Germany on the reparation's account only 50 locomotives.

Germany Building Rolling Stock

Germany is making progress in the construction of rolling stock. Already the 150,000 freight cars and the 5,000 locomotives delivered to France by Germany after the armistice have been replaced by new equipment and it is estimated that by August 1, 1922, the German railways will be in exactly the same position as they were at the outbreak of war as regards the quantity of rolling stock and even better off as regards the quality.

Interesting Colored Firemen in Fuel Economy

In connection with the fuel economy campaign on the Central of Georgia a meeting of colored firemen was recently held at Columbus, Ga., at which an address was delivered by Dr. M. L. Taylor. Dr. Taylor is a physician, one of the prominent colored citizens of Columbus and one who exerts a great deal of influence with the members of his race. It is sometimes difficult to secure the interest of colored firemen and Dr. Taylor's talk, which was widely commented on and was published in the Right Way Magazine, has served as a further encouragement to these employees in the efforts to save fuel.

A Central Purchasing Bureau for Polish Railways

A department called the "Centraine Biuro Zakupow" has been established at the Polish Ministry of Railways, which will be entrusted with the purchase for the railways in Poland of all material necessary for their operation. At the present moment orders for rolling stock and bridges, etc., will not be dealt with by this department, the activities of which will be limited to the purchase of rails, metals, lubricants, india rubber goods, asbestos, glass, etc. It is understood that the proposal is to extend this department gradually, and for it to undertake subsequently the purchase of all the requirements of the Ministry.

Freight Car Loading

The number of cars loaded with revenue freight showed another large gain during the week ended June 24 to a total of 877,856, as compared with 775,447 during the corresponding week of 1921, and 911,503 in the corresponding week of 1920. The gain over the preceding week was 17,084 cars and the fact that unusually large increases had been shown in earlier weeks indicates that instead of holding back freight to await the 10 per cent reductions in freight rates on July 1, as had been considered probable, some shippers may have hastened their shipments because of the threatened railroad strike.

The number of cars loaded with revenue freight for the week ended July 1, which was the last week before the 10 per cent reduction in freight rates took effect, as well as the last week before the shopmen's strike, was 876,896, or 960 less than the total for the preceding week. This was, however, an increase of over 100,000 as compared with the corresponding week of 1921, when the loading was 776,079 and only 14,725 less than the loading for the corresponding week of 1920, which was 891,621.

Freight car loading during the week ended July 8 showed the effect of the Fourth of July holiday by a reduction to 718,319 cars, as compared with 876,896 the week before but this still represented an increase of 77,784 as compared with the corresponding week of 1921, which also included a holiday, when the loading amounted to 640,535 cars. In the corresponding week of 1920 the total was 796,191.

Large Expenditures by Indian Railways

An expenditure of $85,000,000 annually for five years was recently recommended by the Indian railway finance committee as a minimum requirement. The estimate calls for 437 locomotives during each of the five years and 62,000 passenger and freight cars over the entire period, according to Consul North Winship, Bombay.

The shortage of cars has checked the coal mining and other industries, and it is proposed to double track many lines, strengthen bridges, remodel yards, and generally make the system equal to the needs of the country's growing traffic.

Decisions Under Federal Employers' Liability Act

The Illinois Supreme Court holds that an employee engaged in interstate commerce work, killed in a collision while going from the yard to his home on a hand-car provided by the railroad and under the direction of a foreman, was within the act.—Ramsay v. B. & O. (Ill.). 133 N. E. 703.

A blacksmith, injured while carrying a drawbar belonging to an engine used in interstate traffic, was held within the act—Glidewell v. Quincey, O. & K. C. (Mo. App.), 236 S. W. 677.

The Wisconsin Supreme Court holds that an employee sent from one town to another to make repairs on cars being used in interstate commerce, was engaged in interstate commerce when killed, on his way back, by a train engaged purely in interstate commerce.—Richter v. Chicago, M. & St. P. (Wis.), 186 N. W. 616.

The Iowa Supreme Court holds that a switchman of a terminal company moving an empty tank car having its origin out of the state, to the track of the owner, was engaged in interstate commerce precluding recovery under the Workmen's Compensation Act.—O'Neill v. Sioux City Terminal (Iowa), 186 N. W. 633.

Possibilities of Increased Suburban Service With Steam Operation

The Great Eastern Railway (England), according to F. V. Russell, its superintendent of operation, in an address before the British Ministry of Transport, had an intensive steam suburban service at London that many experts stated was incapable of improvement so far as the number of trains in rush hours was concerned, either on Saturday or ordinary week days. Nevertheless, without adopting any methods but those with which every capable railroad operator is thoroughly conversant, and diligently working on the lines of simplicity with close attention to detail, especially in the way of saving seconds wherever seconds could be saved, the rush period that was the least improved gave an increase in the number of trains of 50 per cent, and that which was most improved gave an increase of 75 per cent. The engines at their disposal were small six-coupled tanks, designed 36 years ago, the signals and points all being of the manual type. A further handicap being that, throughout a fairly large portion of their journey and in the most congested area, the trains have to run over the same tracks as main line trains. Also, near the London terminal there is a gradient of 1 in 70 for about half a mile, and tunnels on curves where signal visibility is indifferent. The density of the traffic can be gathered from the fact that 1,264 passenger trains were dealt with per day at Liverpool Street Station, in addition to many other movements, light engines, etc., the best headway of trains being two minutes.

Britain Gets Big Japanese Electrical Order

The Imperial Government Railways of Japan have just placed with the English Electric Company for their Dick-Kerr Works at Preston an order for 34 complete electric locomotives of a total value of upwards of £500,000. This represents the whole requirements of locomotives up to the end of 1923 for those sections of the main line railways which the Japanese government has decided to electrify at once. The order, it is said, was obtained in the face of keen foreign competition, particularly from America.

Eight of the locomotives now ordered are for heavy express passenger service. They are of the 2-C-C-2 (i.e. 4-6-6-4) type. Their weight is approximately 96 (long) tons and they are designed to haul a 415-ton train at a balancing speed of about 60 miles per hour. Each locomotive is equipped with 6 motors, each rated at 306 hp. at 500 volts, the motors being connected in two groups of three in permanent series on a trolley voltage of 1,500 volts. The control equipment is of the standard "English Electric" cam-shaft multiple unit type.

Of the remaining locomotives, nine are for local passenger service and 17 for heavy freight service. These 26 are all of the 4-4 type and will weigh approximately 56 tons each. They are equipped with four motors similar to those on the express passenger locomotives, but in this case the motors will be connected in two pairs in permanent series. Here too the control is the standard "English Electric" multiple unit type. The locomotives for local passenger service are designed to haul a 315-ton train and the freight locomotives a 600-ton train, the balancing speeds being about 55 and 40 miles per hour respectively.

$8,000,000 Placed in Contracts for French Electrification

A quantity of equipment for electrifying 125 miles of main line, including 80 freight locomotives and 80 passenger motor cars, is to be furnished to the Paris-Orleans Railway by a group of French manufacturers headed by the Compagnie Française Thomson-Houston. The Paris-Orleans Railway is one of the six large systems of France which operate something more than 5,000 miles of route. The Compagnie Française Thomson-Houston is the representative of the International General Electric Company. The 1,500-volt direct current system will be used and, according to dispatches received recently, this installation is the beginning of a more extensive program. The greater part of the equipment will be manufactured in France, but it is understood that considerable material of American manufacture will also be required.

The locomotives will be used on an extension of the original electrification, made about 25 years ago by the French Thomson-Houston Company. The first section of the new 1,500-volt section will cover 125 miles of main line between Paris and Vierzon. The motor cars will replace and extend the present suburban steam service out of Paris.

According to plans, high speed, through passenger service from Paris to Vierzon will be handled by 1,500-volt, direct current electric locomotives weighing 125 tons each and capable of regular running speeds of between 80 and 85 miles an hour. These locomotives are not included in the contracts thus far awarded, but the railway company is expected to announce the placing of this business at an early date and to give consideration soon to the purchase of additional locomotives for use in the Central Plateau Region.

Mechanical Division Issues Manual of Standard and Recommended Practice

The standard and recommended practice of the former American Railway Master Mechanics' and Master Car Builders' Associations has been consolidated and harmonized by appropriate committees of the Mechanical Division, American Railway Association, and together with practices adopted since amalgamation with the American Railway Association incorporated in a loose-leaf volume, designated "Manual of Standard and Recommended Practice, Mechanical Division, American Railway Association." This work has been done under the direction of the Committee on Manual.

This manual contains text and drawings for all standards and recommended practice adopted by letter ballot by the former Master Car Builders' and American Railway Master Mechanics' Associations and the Mechanical Division, American Railway Association, and is arranged in 12 sections, as follows:

A—Specifications for Materials.
B—Gages and Testing Devices.
C—Car Construction—Fundamentals and Details.
D—Car Construction—Trucks and Truck Details.
E—Brakes and Brake Equipment.
F—Locomotive Wheels, Tires and Miscellaneous Locomotive Standards.
G—Safety Appliances for Cars and Locomotives.
H—Train Lighting, Headlights and Classification Lamps.
I—Rules for Fuel Economy on Locomotives.
J—Inspection and Testing of Locomotive Boilers and Rules and Instructions for Inspection and Testing of Steam Locomotives and Tenders.
K—Specifications for Tank Cars.
L—Miscellaneous Standards and Recommended Practice.

The pages in each of these sections are numbered consecutively and each section is provided with separate index. There is also a general index of the contents of the entire manual with proper reference to section and page.

The Code of Rules Governing the Condition of and Repairs to Freight and Passenger Cars for the Interchange of Traffic, and the Rules Governing the Loading of Lumber, Logs, Stone, etc., and Loading and Carrying of Structural Materials, Plates, Rails, Girders, etc., while adopted standards are not published in this manual.

The manual contains nearly 1,000 pages of text and drawings and is bound in special hinged back binder, so that it may be kept up to date by issuing from time to time corrected pages without the necessity of printing the entire book. It will also be possible to secure separate sheets covering only such matter as is desired without the necessity of purchasing the entire book.

This manual will be supplied on requisition at the following prices:

To members of the association:

Manual complete, including binder, per copy........$6.00
Separate sections, complete, self-covered in paper, per copy .... .50
Separate sheets, each ....:.................. .05

To other than members of the association the manual is sold at double the prices quoted.

MEETINGS AND CONVENTIONS

General Foremen's Convention Cancelled

Owing to the present railroad conditions, the officers and the executive committee of the International Railway General Foremen's Association have cancelled the 1922 convention.

Master Blacksmiths' Convention Cancelled

Owing to the unsettled conditions resulting from the railway shop mens' strike, the executive committee of the International Railway Master Blacksmiths' Association has issued notices cancelling the 1922 convention. Arrangements had been made to hold the meeting at the Hotel Sherman, Chicago, August 15 to 17, inclusive.

Annual Safety Congress Next Month

The Eleventh Annual Safety Congress will be held in Detroit, Mich., from August 28 to September 1. In the past this conference, which is promoted by the National Safety Council, a co-operative non-commercial organization of men, industries and communities interested in the prevention of accidents, has annually brought together 3,000 or more persons who are actively engaged in safety work in both the United States and Canada. This year invitations will be sent to 15,000 executives and safety workers and a large attendance is expected. Complete discussions of the various phases of industrial and public safety will be conducted at the meetings of the 20 different sections into which the council's activities are divided. These meetings will cover safety problems in a wide variety of fields. The steam railroad section will hold sessions on Tuesday and Wednesday, August 28 and 29. The subjects covered will include "Safety and Publicity," "Accident Prevention from the Standpoint of the Operating Department," "Report of Progress—Careful Crossing Campaign" and "Safety as Seen from the Pulpit."

Meeting of Electric Steel Founders' Research Group

Officers and operating officials of each plant holding membership in the Electric Steel Founders' Research Group held one of their regular meetings for several days immediately following the convention of the American Foundrymen's Association at Rochester, N. Y. The group meeting was held at East Aurora, N. Y., because of its accessibility to Rochester where the group members had participated in the foundrymen's annual meeting. C. R. Messinger of Milwaukee, who is very active in this research group and is prominently connected with several foundry concerns, including the Sivyer Steel Casting Company, was selected at Rochester as the next president of the American Foundrymen's Association.

Recently there appeared in the technical press an extensive description of the co-operative technical plan followed by this research group which is made up of representatives of the Electric Steel Company, Chicago; the Fort Pitt Steel Casting Company, McKeesport, Pa.; the Lebanon Steel Foundry, Lebanon, Pa.; the Michigan Steel Casting Company, Detroit, Mich., and the Sivyer Steel Casting Company, Milwaukee, Wis. At the convention of the American Foundrymen's Association the results of comprehensive investigations in testing molding sand were presented by R. J. Doty of the Sivyer Company who had been delegated by the group to carry on such a research for its own account. The group made some of its information on the subject available to the industry at large. The result of this, as announced at the convention, has aroused great interest, particularly as it was stated there that certain testing methods developed by the research group have been approved by the sub-committee on tests of the Joint Committee on Molding Sand Research organized by the American Foundrymen's Association and the National Research Council, and participated in officially by the American Society for Testing Materials and numerous technical departments and bureaus of the United States Government.

It is stated that at East Aurora further steps for the group molding sand investigation were planned and interesting reports were presented by the members on annealing, electric furnace practice, the elimination of slag in castings, and other matters that now engage the attention of the group members.

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

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City. 1923 annual convention; Denver, first Tuesday in May.

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

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

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

Division V.—Purchase and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago. Annual convention will be held at the Hotel Sherman, Chicago, September 5-8.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, A. F. Stuebing, 2201 Woolworth Building, New York.

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

American Society for Steel Treating.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention and exposition postponed until October 2-7, 1922, Detroit, Mich.

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

Canadian Railway Club.—W. A. Booth, 53 Rushbrook St., Montreal, Que. Regular meeting second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal.

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

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo.

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Meeting second Thursday in January, March, May, September and November, Hotel Iroquois, Buffalo, N. Y.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill. Annual convention August 22-24, Chicago.

Cincinnati Railway Club.—W. C. Cooder, Union Central building, Cincinnati, Ohio. Regular meetings second Tuesday, February, May, September and November.

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

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich. The 1922 annual convention has been cancelled.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn. The 1922 annual convention has been cancelled.

Master Boilermakers' Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Regular meetings second Tuesday each month except June, July, August and September, Copley Plaza Hotel.

New York Railroad Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Regular meetings third Friday of each month, except June, July and August, at 29 West Thirty-ninth street, New York.

Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

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

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Regular meetings fourth Thursday in each month, except June, July and August, at Fort Pitt Hotel, Pittsburgh, Pa.

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

Traveling Engineers' Association.—W. O. Thompson, 1177 East Ninety-eighth street, Cleveland, Ohio.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Regular meetings third Monday of each month, except June, July and August.

SUPPLY TRADE NOTES

Isaac Joseph, who was the founder of the Edna Brass Manufacturing Company, Cincinnati, Ohio, and its president for over 20 years, died on May 23.

H. F. Barrus, sales manager of the Union Twist Drill Company, Athol, Mass., has resigned to enter business with the firm of Barrus & Cullen, Ltd., London, England.

N. E. Gage, formerly connected with the Standard Tool Company, Cleveland, Ohio, has recently been appointed sales manager of the National Tool Company of that city.

Harvey E. Miller, vice-president of the Fairbanks Company, New York City, died on July 9 of injuries he received in the Atchison, Topeka & Santa Fe collision at Burrton, Kan.

The offices of the Air Reduction Sales Company, formerly maintained at 120 Broadway and 160 Fifth avenue, New York, have been consolidated with the executive office at 342 Madison avenue.

The Younglove Construction Company, Sioux City, Ia., has been appointed representative of the Conveyors Corporation of America, Chicago, Ill., for the sale of American trolley carriers in northwestern Iowa and South Dakota.

K. C. Gardner, formerly general sales manager, central district, of the Pressed Steel Car Company, is now associated with the Greenville Steel Car Company, Greenville, Pa., as vice-president in charge of sales. Mr. Gardner's headquarters are at Greenville.

The Greenville Steel Car Company, Greenville, Pa., is erecting a new building 75 ft. by 390 ft. in which the company plans to install its present fabricating equipment. The company has heretofore only repaired and rebuilt steel equipment but will in the future also build new freight cars.

The Pilliod Company, Swanton, Ohio, manufacturers of the Baker locomotive valve gear, with New York office at 30 Church street, has secured control of the Southern Valve Gear Company. The former offices of the Southern Valve Gear Company located at Knoxville, Tenn., have been discontinued.

A. A. Murphy has been appointed resident sales manager of the industrial and railway paint and varnish division of the E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. He will be located at the new office the paint and varnish division has opened at 30 Church street, New York City.

The Wilson Welder & Metals Company, Inc., 132 King street, New York City, recently appointed the King-Knight Company, Underwood building, San Francisco, Cal., exclusive representatives in central and northern California for Wilson plastic-arc welding machines and Wilson Color-Tipt metals.

C. C. Clark has been appointed assistant general sales manager of the Pressed Steel Car Company and the Western Steel Car & Foundry Company, in charge of sales matters in the central district, with headquarters in the Farmers Bank Building, Pittsburgh, Pa., taking the place of K. C. Gardner, resigned.

C. M. Jacobsen has joined the service staff of the Franklin Railway Supply Company, New York, and is now in charge of Southern territory with headquarters at Atlanta, Ga., relieving B. C. Wilkerson, who has been appointed a special service representative of the company on locomotive booster applications.

A. R. Kipp, mechanical superintendent of the Minneapolis, St. Paul & Sault Ste. Marie with headquarters at Minneapolis, has resigned to form a partnership with F. L. Battey, consulting engineer specializing in railroad shop and industrial plant design and construction shop operating problems, with offices in the Union Fuel building 123 West Madison street, Chicago.

The U. S. Light & Heat Corporation, of California, has been incorporated as a subsidiary of the U. S. Light & Heat Corporation, Niagara Falls, N. Y. A site has been leased and construction started on a new plant at Oakland, Cal. The new plant is to handle the company's business on the Pacific Coast, and it is expected that production will start in the new factory about October 1.

Johns-Manville, Inc., New York, will build a new plant in Canada at Asbestos, Quebec, for the manufacture of asbestos. Work is to be started at once on the plant and is expected to be completed in about six months. The plant will cost over $1,000,000 and will give employment to about 300 people. The company has taken over the Bennett-Martin mine at Thetford Mines, Que.

H. D. Shute, vice-president and general sales manager of the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., has been elected a member of the board of directors of the Standard Underground Cable Company, Pittsburgh. A. B. Saurman, general sales manager of the Standard Underground Cable Company, Pittsburgh, has been elected vice-president in addition to his other duties.

Anson W. Burchard, vice-chairman of the board of directors of the General Electric Company, Schenectady, N. Y., has been elected president and chairman of the board of the International General Electric Company, succeeding Gerard Swope, its former president, who was recently chosen president of the General Electric Company. He also succeeds Charles Neave, former chairman of the International Company, who has resigned.

A. C. Haberkorn, formerly Detroit branch manager of Manning, Maxwell & Moore, Inc., and the Biggs-Watterson Company, and E. E. Wood, former sales manager of the Jones & Lamson Machine Company, have formed a partnership under the name of Haberkorn & Wood, with an office and warehouse at 620 E. Hancock avenue, Detroit, Mich., to handle a line of machine tools, cutting oils and compounds, also permanent mould aluminum alloy castings.

W. H. White will in the future be in charge of the New York City business of the Mahr Manufacturing Company, Minneapolis, Minn., makers of Mahrvel oil burning equipment. Mr. White's headquarters will be at 56 Murray street, New York City. He has devoted all his time to mechanical work both in the shops and on the road, having served in the steel and iron businss for the past 10 years. Until recently he was with B. M. Jones & Company, Inc., New York.

Joseph H. Towle, who joined the selling forces of the National Railway Appliance Company of New York, some time ago, is now in charge of the company's new Pennsylvania headquarters at Harrisburg, Pa., where an office was recently opened at 85 Union Trust building. Mr. Towle was formerly with the Railway Improvement Company, New York, as sales engineer. The National Railway Appliance Company is now selling a new product known as Tnemec paint. The principal use of this material is the protection and rust-proofing of metals and other materials.

O. R. Hildebrant will in future represent the railway sales department of the U. S. Light & Heat Corporation, Niagara Falls, N. Y., in the southeastern territory with headquarters at Norfolk, Va. Mr. Hildebrant began work in 1905 with the Pennsylvania at Jersey City, N. J. In 1909 he went to the Safety Car Heating & Lighting Company and later was with the Edison Storage Battery Company as chief inspector and sales engineer until February, 1918. He then entered the employ of the U. S. Light & Heat Corporation, as representative in the southeastern district, which position he held until November, 1920, when he again entered railroad work on the Florida East Coast. He now returns to the service of the U. S. Light & Heat Corporation as above noted.

W. B. Murray, chief engineer of the Miller Train Control Corporation, with headquarters at Danville, Ill., has been elected vice-president of that organization in addition to his present office Mr. Murray was born at Dunkirk, N. Y., on August 5, 1875. He entered railroad service in 1893 and was successively a fireman and engineer of the Portland, Mt. Tabor Railway, Portland, Ore., until 1897. From that date until 1899 he was engaged in engineering studies at New Haven, Conn. In 1900 he entered the service of the Hill & Miller Electrical Company, Washington,

D. C., as construction engineer. Two years later he became chief engineer of Palais Royal and in 1905 he was general manager of the Murray Engineering & Construction Company, while from 1907 to 1911 he was a consulting engineer. He first became connected with the Miller Train Control Corporation in 1909, and since 1911 he has devoted his entire time to this organization.

The Dressel Railway Lamp & Signal Company, Arlington, N. J., has been incorporated with A. D. Hobbie, president and treasurer, F. Hallett Lovell, Jr., vice-president, F. W. Dressel, vice-president, and L. L. Pollak, secretary. The new company succeeds the Dressel Manufacturing Corporation, formerly known as the Dressel Railway Lamp Works, New York City, originally established in 1882, with factory formerly located at 3860-80 Park avenue, New York City. All the officers of the new company have for a long time been identified with the railroad lighting and signal field. Increased facilities and equipment have been acquired at the new plant located at Arlington. The company recently developed and made improvements in electric headlights, switch and signal lamps and intends to bring out in addition a number of new devices. A. D. Hobbie is also vice-president and general manager of F. H. Lovell & Co., Arlington, and he has been active in the railroad field for over 20 years. F. Hallett Lovell, Jr., is president and treasurer of F. H. Lovell & Co., and was president of the Klaxon Company until it was taken over by the General Motors Company. F. W. Dressel has a long record as a lighting expert in signal and maintenance of way departments and was for a number of years president of the Dressel Lamp Works. L. L. Pollak has been for a number of years, production manager of F. H. Lovell & Co.

F. W. Dressel

A. D. Hobbie

G. A. Woodman has been appointed sales manager of the Northwestern Malleable Iron Company, Milwaukee, Wis., with offices at 237 Railway Exchange building, Chicago. He will have charge of the sales of the Joliet journal box which was formerly handled by the Joliet Railway Supply Company, Chicago, now the Republic Railway Equipment Company, of the same city. Mr. Woodman was born at Dunkirk, N. Y. on August 21, 1866. On August 21, 1883, he entered the service of the Brooks Locomotive Company as a machinist apprentice and was successively thereafter, in the drafting department, same company; mechanical engineer, Lima Locomotive & Machine Company; assistant master car builder Swift & Co., Chicago; assistant superintendent, American Car & Foundry Company, Chicago; mechanical engineer, Kirby Equipment Company, Chicago, when that company sold the Woodman journal box, the name of which was later changed to the Franklin journal box; and the National Car Equipment Company, Chicago. He retired two years ago and had been inactive in the railway supply business up to the time of his recent appointment.

W. H. Marshall, formerly president of the American Locomotive Company, is chairman of the board of directors of the new company and C. K. Lassiter, formerly vice-president of the American Locomotive Company in charge of operation, is president of the new company. H. J. Bailey, H. W. Breckenridge, H. W. Champion, J. J. Dale and A. H. Ingle are vice-presidents; O. D. Miller, treasurer; and R. R. Lassiter, secretary. The directors include W. H. Marshall, C. K. Lassiter, H. J. Bailey, formerly president Hilles & Jones Company; B. J. Baker, of B. J. Baker & Company, bankers; H. W. Breckenridge, formerly vice-president of the Colburn Machine Tool Company; Lawrence Chamberlain, president of Lawrence Chamberlain & Co., bankers; H. W. Champion, formerly president of the Newton Machine Tool Works, Inc.; J. J. Dale, president of the Dale Machinery Company; T. Allen Hilles, A. H. Ingle, formerly president of the Betts Machine Company and Ingle Machine Company, and F. D. Payne, formerly manager of Modern Tool Company.

W. Woodward Williams has been appointed vice-president of the Titan Iron & Steel Company, Newark, N. J. Mr. Williams' experience in the iron and steel industry began immediately upon his graduation from Harvard University in 1905. After six years in the mills of the Carnegie Steel Company at Pittsburgh, Duquesne, Pa., and Youngstown, Ohio, he entered the sales department of the Bourne-Fuller Company of Clece-land, Ohio, and was later appointed manager of its Pittsburgh office. In January, 1914, he became general manager of sales of the A. M. Byers Company, Pittsburgh, and subsequently was made general manager. In August, 1919, he became general manager of the Reading Iron Company, being later elected vice-president in charge of sales and operation. In September, 1920, he became associated with the Pittsburgh Gage & Supply Company, jobbers of wrought iron merchant pipe. He resigned the vice-presidency of this company on May 31 of this year, entering immediately upon his present office of vice-president of the Titan Iron & Steel Company.

W. W. Williams

Attorney General Approves Steel Merger

In response to a Senate resolution Attorney General Daugherty has transmitted to the Senate a report stating that in his opinion the merger of the Bethlehem and Lackawanna steel companies and the proposed merger of the Midvale, Republic and Inland companies are not in violation of the Sherman, Clayton or Webb laws and that there is no reason to believe that restraint of trade or monopolistic control will result. He did not express his opinion as to whether they are in violation of the federal trade act. The Federal Trade Commission is conducting an investigation on this point in accordance with the Senate resolution.

The Consolidated Machine Tool Corporation of America

The Consolidated Machine Tool Corporation of America, with general offices at 17 East Forty-second street, New York City, is a consolidation of the Betts Machine Company, Rochester, N. Y.; Ingle Machine Company, Rochester, N. Y.; Hilles & Jones Company, Wilmington, Del.; Modern Tool Company, Erie, Pa.; the Newton Machine & Tool Works, Inc., Philadelphia, Pa.; the Colburn Machine Tool Company, Cleveland, Ohio, and the Dale Machinery Company, Inc., New York City and Chicago, Ill. The company's capital stock includes $10,000,000 preferred stock of $100.00 par value and 200,000 shares of common stock with no par value.

TRADE PUBLICATIONS

Superheaters for Stationary Power Plants.—Bulletin T-1, issued by The Superheater Company, New York, describes the Elesco superheaters for stationary power plants.

Locomotive Lubrication.—The May issue of "Lubrication," the monthly publication of The Texas Company, New York, contains an important article on the lubrication of superheated locomotives.

Machine Tools.—The Armstrong Manufacturing Company, Bridgeport, Conn., has issued catalogue No. 17 listing and illustrating its line of stocks and dies, water, gas and steam fitters' tools and pipe threading machines.

Ball Bearings.—The Skefko Ball Bearing Company, Luton, England, has issued a catalogue describing S K F ball bearing transmission accessories, etc. The S K F Industries, New York, is the American manufacturer and representative.

Condenser Tube Packing.—The Crane Packing Company, Chicago, has issued a booklet describing the John Crane metallic rings for condenser tube sheets and giving the reasons why packing of this character is superior to corset lace, wicking and wood or fibre bushings.

Power Hoe.—Book 444 describes the power hoe or improved drag scraper made by the Link-Belt Company, Philadelphia, Pa. The power hoe is particularly valuable in many places for storing and reclaiming coal, sand, gravel, and other bulk materials. Illustrations show a number of applications.

Heating and Power Plant Specialties.—The McAlear Manufacturing Company, Chicago, is distributing catalogue No. 27, which illustrates many new devices, including an individual temperature control valve, specialties for power plants, vacuum and vapor heating systems, and plumbing systems.

Measuring Tools.—The Van Keuren Company, Boston, Mass., has issued a new catalogue illustrative and descriptive of combination precision gage blocks, gage block accessories, plug gages, measuring wires for screw threads and profile gages, lapped steel surface plates and light wave measuring outfits.

Hydraulic Pumps.—A booklet entitled "Trade Standards in the Pump Industry" has been issued by the Hydraulic Society, C. H. Rohrbach, 50 Church street, New York, secretary. The information given will be found useful by those who have occasion to specify or purchase hydraulic pumps of various kinds.

Shock Insulated Bus.—The International Motor Company, New York, has issued a bulletin describing the Mack rubber shock insulator as applied to the spring shackle block. The applications shown are to highway buses, but practically the same shock insulator, however, is now in use on rail motor cars.

Mechanical Stoker.—The Elvin Mechanical Stoker Company, New York, has issued bulletin 101, containing very complete information in regard to the Elvin mechanical stoker. A description is given of the various parts of the mechanism, together with information relative to the application of the stoker to a locomotive.

Railroad Shop Equipment.—The Whiting Corporation, Harvey, Ill., has issued a catalogue of 48 pages outlining the advantages and labor-saving features of its locomotive hoists, coach hoists, cranes, transfer tables and turntable tractors. For the use of those contemplating new shops, a model shop layout, showing the most practical and economical arrangement of equipment, has been included; also a typical layout for a wheel foundry having a capacity of 250 wheels per day. This catalogue, No. 160, supersedes No. 145.

Steel Wheels and Circular Forgings.—The Carnegie Steel Company, Pittsburgh, Pa., has printed new editions of two of their booklets. The first covers wrought steel wheels for steam and electric service and contains drawings, specifications and considerable valuable data. Wheels for steam railway service include those for engine trucks, tender trucks, passenger train cars, freight cars and motor cars for electrified service. The second booklet shows such circular forgings as locomotive piston blanks, pipe flanges, shaft couplings, gear blanks, crane track wheels, etc.

EQUIPMENT AND SHOPS

Locomotive Orders

The Delaware, Lackawanna & Western has ordered 5 Pacific type and 25 Mikado type locomotives from the American Locomotive Company.

The Baltimore & Ohio has ordered 35 Mikado type locomotives from the Baldwin Locomotive Works. This road is also having repairs made to 25 locomotives at the Baldwin shops.

The Chicago & Eastern Illinois has ordered 10 Mikado type locomotives from the American Locomotive Company and six Pacific type locomotives from the Lima Locomotive Works.

The Illinois Central has ordered 15 switching locomotives from the Baldwin Locomotive Works, 25 Santa Fe type locomotives from the Lima Locomotive Works and 25 Mikado locomotives from the American Locomotive Company.

The New York Central has announced that in anticipation of the motive power requirements of 1923 and to protect the expected traffic needs of the winter in the territory served by the New York Central lines, orders have just been placed for the construction of 150 modern freight locomotives. The locomotives are to be the Mikado type, identical in design with Michigan Central locomotive 8,000, described in this issue. It is understood that the order has been divided equally between the American Locomotive Company and the Lima Locomotive Works, Inc.

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Locomotive Repairs

The New York Central is having 50 locomotives overhauled at the shops of the Baldwin Locomotive Works.

The New York, New Haven & Hartford will have repairs made to 25 locomotives at the shops of the Baldwin Locomotive Works and to 10 locomotives at the shops of the American Locomotive Company.

The Lehigh Valley is having 5 Consolidation type and 10 switching locomotives repaired at the shops of the American Locomotive Company and 6 Consolidation type and 9 switching locomotives at the shops of the Baldwin Locomotive Works.

The Erie has entered into a contract for the repair of 20 locomotives a month for a period of six months at the American Locomotive Company's Cooke Works and will have repairs made to 15 locomotives, including Santa Fe and Mikado types, at the shops of the Baldwin Locomotive Works.

Freight Car Orders

The United Verde Copper Company has ordered 24 ore cars from the Pressed Steel Car Company.

The Great Northern has ordered 300 underframes from the Minneapolis Steel & Machinery Company.

The Western Pacific has ordered 2,000 refrigerator cars from the American Car & Foundry Company.

The Northern Refrigerator Car Company has ordered 500 refrigerator cars from the Pullman Company.

The Northern Pacific has ordered 70 express refrigerator cars from the American Car & Foundry Company.

The Manila Railroad Company has ordered 50 cane cars of 30 tons' capacity from the Koppel Industrial Car & Equipment Company.

The Argentina State Railways have placed an order with the Standard Steel Car Company for 100 ballast cars.

The Pittsburgh & Western Virginia has ordered 1,000 hopper cars of 55 tons' capacity from the Cambria Steel Company.

The Delaware, Lackawanna & Western has given an order for 370 gondola car bodies to the American Car & Foundry Company.

The Alabama & Vicksburg has ordered from the Kilbourne & Jacobs Manufacturing Company 25 all-steel automatic air dump cars of 40 tons' capacity.

The Philadelphia & Reading has ordered 500 cars of 70 tons' capacity from the Pressed Steel Car Company and 500 from the Standard Steel Car Company.

The Southern Pacific has ordered from the Kilbourne & Jacobs Manufacturing Company 40 all-steel automatic air dump cars with improved apron attachment of 40 tons' capacity.

The Nasville, Chattanooga & St. Louis has ordered 500 40-ton single sheathed box cars, 250 40-ton double sheathed box, 150 40-ton stock and 100 50-ton flat cars from the American Car & Foundry Company.

The Illinois Central has ordered 1,000 from the Pullman Company, 500 from the American Car & Foundry Company, 500 from the Mt. Vernon Car Manufacturing Company, 500 from the Bettendorf Company and 500 from the Western Steel Car & Foundry Company.

The Texas & Pacific will build 532 freight cars in its shops at Marshall, Tex., as soon as the shopmen's strike is settled. This is the first authorization of a total 1,100 cars which are to be built in these shops, the company already having the necessary material on hand for the construction of the initial lot.

The Northern Pacific reported in the July *Railway Mechanical Engineer* as having placed orders for a large number of miscellaneous freight cars, has ordered in addition 250 gondola cars from the Standard Steel Car Company and 250 general service gondola cars from the General American Car Company.

The Norfolk & Western has divided an order for 2,000 hopper cars of 70 tons' capacity as follows: American Car & Foundry Company, 500 cars; Standard Steel Car Company, 500; and Pressed Steel Car Company, 1,000. The company has also ordered 1,000 single sheathed box cars of 50 tons' capacity from the Ralston Steel Car Company.

Freight Car Repairs

The Illinois Central has contracted with the Ryan Car Company for the repair of 600 gondola cars.

The Chicago, Burlington & Quincy will have 500 box cars repaired at the shops of the Streator Car Company and 500 steel gondolas at the shops of the American Car & Foundry Company.

The New York Central will have repairs made to 500 freight cars at the shops of the Ryan Car Company and to 500 cars at the shops of the Buffalo Steel Car Company.

The Central Vermont will have repairs made to 200 steel gondola cars, 100 wooden underframe box cars and 400 steel underframe box cars at the shops of the American Car & Foundry Company.

The Chicago Great Western has placed orders for the repair of 200 cars with the Pullman Company, 154 cars with the Sheffield Car & Equipment Company, Kansas City, Mo., and 173 cars with the Siems Stembel Company, St. Paul Minn.

The New York, New Haven & Hartford has given a contract to the Keith Car & Manufacturing Company, Sagamore, Mass., for rebuilding 6,000 bad-order freight cars. The company also has a large number of additional cars awaiting repairs.

Shop Construction

Missouri Pacific.—This company has awarded a contract to the T. S. Leake Construction Company, Chicago, for the construction of a car repair shed at Sedalia, Mo., to cost approximately $25,000.

Chicago, Burlington & Quincy.—This company has awarded a contract to the Great Lakes Construction Company, Chicago, for the construction of a power plant at Aurora, Ill. This company has also awarded a contract for the construction of a new roundhouse at Rock Island, Ill., to G. A. Johnson & Sons, Chicago.

Chesapeake & Ohio.—This company has awarded a contract for the construction of terminal facilities at Peach Creek, W. Va., involving a five-stall engine house addition, a shop, storehouse and power house, and for the construction of a five-stall addition to its roundhouse and shop at Peru, Ind., to Joseph E. Nelson & Sons, Chicago, the work at Peru and Peach Creek to involve expenditures of approximately $125,000 and $350,000, respectively.

Machinery and Tools

The Long Island has ordered a 150-ton overhead traveling crane from the Whiting Corporation for its Morris Park shops.

PERSONAL MENTION

GENERAL

J. E. Osmer has been appointed superintendent of motive power of the Denver & Salt Lake, with headquarters at Denver, Colo.

PURCHASING AND STORES

W. P. Dittoe has been appointed purchasing agent of the Lake Erie & Western, with headquarters at Cleveland, Ohio, succeeding W. P. Winter, resigned.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

A. Mays, general foreman of the Canadian National, has been appointed assistant master mechanic, with headquarters at Big Valley, Alberta, succeeding W. L. Loomis, transferred.

SHOP AND ENGINEHOUSE

Charles Hitchcock has been appointed erecting shop foreman of the Santa Fe, with headquarters at Richmond, Cal.

P. Spence, locomotive foreman of the Canadian National, has been appointed general foreman at Edmonton, Alberta, succeeding A. Mays.

CAR DEPARTMENT

J. K. Nesbitt has been appointed car foreman of the Canadian National, with headquarters at Edmonton, Alberta.

W. K. Smith has been appointed car foreman of the Rock Island at Chickasha, Okla., succeeding W. J. Logsdon, deceased.

M. Meehan has been appointed master car repairer of the Western division of the Southern Pacific, Pacific system, with headquarters at West Oakland, Cal., to succeed H. Englebright, retired.

OBITUARY

William C. Arp, retired superintendent of motive power of the Vandalia (now a part of the Pennsylvania), whose death on June 16 was reported in the July issue of the *Railway Mechanical Engineer*, was born on June 30, 1848, near Williamsport, Pa., and entered railway service as a machinist apprentice on the Northern Central (now a part of the Pennsylvania) at Williamsport. Following his apprenticeship he engaged in stationary engine and mill work at Williamsport until 1875, when he was advanced to roundhouse foreman. He continued thereafter as roundhouse foreman and as foreman of engines of the Middle division until 1883, when he was promoted to general foreman of shops of the Pennsylvania lines west of Pittsburgh, at Indianapolis, Ind. In 1886 he became roundhouse foreman of the Pennsylvania, at Columbus, Ohio, and a year later was promoted to master mechanic at Logansport, Ind. He served later in the same capacity at Dennison, Ohio, until January 15, 1896, when he was promoted to superintendent of motive power of the Terre Haute & Indianapolis, a position he continued to hold following the acquisition of this property by the Vandalia until the date of his retirement in 1918.

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Don't Abandon Convention Plans

All of the associations of officers having to do with the maintenance and operation of equipment, whose conventions were scheduled for August and September, have found it necessary to cancel arrangements for their regular dates owing to conditions created by the shopmen's strike. Two of these organizations have already fixed dates for holding postponed meetings and in doing so have set an example which all of the others may well follow as soon as circumstances will permit. The permanent cancelling of plans for conventions this year will, for most of the organizations, mean a period of two years during which no meetings have been held. This is a serious matter to the health and prosperity of the organizations. But, of even greater importance, it represents the loss of an opportunity for effective work by these associations at a time when it will be greatly needed. The strike, with the shifting of men from one shop to another, has entailed a serious impairment of working morale which even an immediate settlement of the controversy on a basis entirely satisfactory to the labor organizations could not restore, and however effective the forces built up during the past two months may have been in keeping the equipment in service, this effectiveness has been obtained by a resort to temporary emergency measures too expensive to be established on a permanent basis. During the next year the supervisors in the mechanical department will be faced with the task of developing the new forces into efficient working organizations. If the associations of these officers have any real function to perform, certainly the present situation offers to them a splendid opportunity for the inspiration and encouragement of their members through an exchange of ideas as to how best to accomplish the difficult task ahead of them. It is to be hoped, therefore, that these associations will plan to hold their conventions later in the year.

Value of Accessible Data

Each step forward and each new bit of knowledge is founded on what has been done before. This is true in all domains of human activity, regardless of their nature and applies to designs of locomotives, cars, or machinery and to methods of doing work, as well as to chemistry, science and management. What a man is able to accomplish often depends less upon what he actually knows than upon his ability to place his hand promptly upon a mass of accumulated data when it is wanted. An education from study and experience is not the filling of the brain with a lot of miscellaneous information but is a broadening of the range of vision so that a person knows where and how to obtain full and accurate information on any particular subject. Practically everyone reads, sees or hears of something every day that is new to him and which he thinks may be usefully applied sometime. Unless one makes a note of and properly files the information, it is apt to be forgotten or overlooked at the time when it may be used. As a convenient method of filing away a vast amount of data which will be available when required, nothing equals a small card index. It is wonderfully flexible and can be modified to suit any individual requirement. If desired, cards may be carried in the pocket on which notes can be made of an article read; a book seen; the time taken, the method used or expense of doing a piece of work; a new machine for a certain operation, or anything else of interest. Every year sees an increasing use of this little device which is just as valuable for the foreman or the apprentice as for the professional man or the executive. Are you making full use of this aid in your work?

Erie Cuts Down Air Losses

A valuable article entitled, "Pneumatic Power and Transmission Losses," which describes the successful efforts of the Erie to locate and stop air losses at various points on the system, will be found on page 529 of this issue. Some extremely bad conditions as regards the wasteful transmission and use of compressed air were found by the Erie investigators. Doubtless these conditions were no worse than now exist on many other roads which could profitably follow the example of the Erie in ferreting out air losses and stopping them.

The direct money loss taking place every day in probably the majority of railroad shops as a result of air losses is all too little appreciated. As pointed out in the article, air losses in compression, transmission and by illegitimate uses have a direct effect upon the coal pile. Moreover, air leaks result in inadequate pressure on the shop lines which has a serious effect on the production of men using pneumatic tools and devices throughout the shops and yards.

One of the striking examples mentioned is a terminal yard where, due to leakage in the transmission line beneath the ground, there was a drop in pressure of 28.8 lb. between the air compressor and terminal tower. The renewal of practically all of this transmission line was found necessary and resulted in bringing the pressure in the terminal tower practically up to that in the compressor room. Train movements were speeded up by the more effective operation of the electro-pneumatic switches and in addition, approximately 450,000 cu ft. of air was saved each 24-hour day with an estimated saving in fuel .of almost $5,000 a year. The money saving alone was large and anyone who has tried to operate a pneumatic drill or hammer on insufficient air pressure can appreciate how much adequate pressure increases shop production. Tests should be made at the earliest opportunity in every railroad plant in the country to make sure that preventable air losses are not occurring daily in compression, by leaks in transmission, or by wasteful and unnecessary methods of use. In addition, it should be determined if the undue extension of air lines and air-consuming devices has not reduced air pressures below the point at which pneumatic tools operate efficiently. If so the result is a decreased shop production which can be ill afforded at the present time.

Meaning of the Term "Wood Butcher"

The railroads of the United States consume millions of feet of lumber annually and "wood butchers" is the apt term applied to some shop men who attempt to work up this lumber into any of its almost infinite uses, employing planers, saws, chisels, bits or other woodworking tools which are dull and, therefore, unfit for use. A sharp tool will cut wood almost like cheese, requiring little effort and leaving a smooth, accurate job. If the cutting tool is dull, on the other hand, a surprising amount of energy is required to operate it and when the work is done, it is far from satisfactory. Car shop men as a rule know the above facts but some of them become careless at times and rather than take the trouble to sharpen their tools, operate them dull. Apprentices and new men in the shops particularly should be made to appreciate the value of sharp woodworking tools both in decreased power required to operate them and increased production of car shop and mill room.

With many of the tools, particularly hand planer knives, chisels, etc., it is merely a question of care and attention in grinding and whetting. With other tools, like circular saws, however, it is practically impossible to perform the operation of sharpening with a hand file as satisfactorily as it can be done on some type of automatic or semi-automatic sharpening machine. Saws should have the right hook and pitch of teeth and the right amount of throat or gullet for the work at hand. Saw teeth should be uniformly spaced, uniformly shaped and evenly set or swaged. Obviously a machine can perform this work with far greater regularity, less effort and more all around satisfaction than would be possible by hand. The provision of modern saw-sharpening machinery is necessary in shops doing any considerable amount of woodworking. With saws and other woodworking tools kept sharp and in good working order, the application of the term "wood butchers" to car shop men will not be justified.

Car Wheel Loads and Rail Stresses

Until recent years comparatively little attention has been given to the stresses set up by impact of freight cars, either in the rail or in the car. With the increase in the capacity of freight equipment, the wheel loads have increased until they are now in some cases practically as great as on locomotive driving wheels and some engineers are inclined to think that the effect of these extremely heavy loads on car wheels is quite as serious as an equal load on a locomotive driver. Although the effect of the counterbalance in increasing the stress on the rail is absent, the wheel is smaller, the distance between wheels is greater and the coil springs may go solid, all of which tend to increase rail stresses. There is evidence which indicates that on some divisions more broken rails may be caused by heavily loaded cars than by locomotives. Probably further investigation will prove to what extent cars are responsible for rail breakage. In the meantime, designers may well keep on the safe side and build cars so that they will not be likely to cause excessive impact loads.

Most of the destructive impacts from freight cars are caused by the springs going solid and if stresses are to be kept down, this must be avoided. One way to do this is to increase the capacity of the truck springs, which would also be desirable because it would probably reduce the number of spring failures. If a high-capacity coil spring was not satisfactory, a leaf spring might be used. Experiments have shown that coil springs on freight cars go solid only because of variations in load synchronizing with the period of vibration of the car. The friction between the leaves of an elliptic spring would damp the oscillations and should prove effective in avoiding excessive impact.

The Scrap Pile Teaches a Lesson

Railroad men of long experience maintain that the scrap pile is one of the best places to go for an indication of the efficiency of shop operation. Certainly many lessons can be learned from the scrap pile by both shop men and higher mechanical department officers. Many locomotive and car parts fail in service and are scrapped due either to defective material or design. Reducing these service failures to a minimum is a job worthy of, and requiring the closest co-operation of mechanical engineers, engineers of tests and practical shop men. When a driver brake fulcrum, or adjusting rod, for example, fails in service from an evident defect in design, why should not the mechanical engineer's office profit by the experience of the blacksmith foreman in developing a new design which will have the requisite strength? Not only is the up-to-date blacksmith foreman a good judge of the strength of metal, but he is also familiar with the details of forging the redesigned part and, in the case of two designs having possibly equal strength, he will be able to decide which is the quicker and more economical to make. In far too many cases weaknesses in design are corrected at the expense of unnecessary manufacturing cost. Shop foremen, like all other railroad men, have pet hobbies and not all of their suggestions for improvement in design could probably be accepted, but it stands to reason that with their long experience in making, repairing, dismantling and assembling locomotive and car parts they see many points where small changes in design would eliminate breakage or reduce the cost of making and applying. Advantage should be taken of their experience to the fullest possible extent.

Are Railroad Shops Inefficient?

Ever since the flood of would-be reformers, misnamed efficiency engineers, descended on the railroads about ten years ago, it has been the fashion to criticize railroad shops as being poorly managed. The promises made by the efficiency engineers have never been fulfilled but their comparisons of methods in industrial plants and railroad shops, always unfavorable to the latter, are still being repeated. Probably no railroad shop foreman would deny that in some particulars the railroads can learn valuable lessons from manufacturers but it is only right that they should resent and combat the oft-repeated statements reflecting on the management of their plants.

It is probable that when all the circumstances are considered, the average railroad shop is as efficiently operated as the average industrial establishment. The workers in both cases are drawn from the same classes and have approximately equal opportunities. There are just as good brains among railroad men as will be found anywhere else. Any number of instances could be cited where railroad men who have gone into industrial plants have developed improved methods and have made good most decisively, but the industrial experts who have promised to revolutionize railroad shop methods have yet to prove their case.

The statement is often made that railroad shops are not as efficient as industrial plants because they are not spurred on by competition. Those who make this statement should realize also that the absence of competition is a very good reason why railroad practice should differ from that in manufacturing plants. The best method for the manufacturer is the one that will enable him to sell his goods to the best advantage; finish and appearance are usually important factors. The railroad on the other hand need only consider the method that will give the lowest cost per ton and passenger-mile, and oftentimes would not find it economical to use the same refinements as the manufacturer.

Railroad men are no doubt right in their contention that locomotive and car shops present a special problem and cannot fairly be compared with manufacturing plants. Probably the most satisfactory comparison would be between railroad shops in our own and foreign countries. Engineers who have studied the methods used abroad generally agree that while other countries may put a finer finish on locomotives, for high output and low costs American railroad shops are in a class by themselves. One foreign visitor recently said that all the shop methods in his country could be improved by copying American practice. This would surely apply to the locomotive shops in Germany also, judging by a recent article in a German railroad magazine which pointed out methods of avoiding superfluous labor. These included rolling boiler tubes with an air motor instead of by hand and setting valves with rollers (turned by hand) under the main wheels instead of moving the locomotive along the track with pinch bars. The latter improvement is especially interesting as it has been obsolete in this country for 20 years. On the whole, it seems that the men who operate American railroad shops are doing as well as anyone could under similar conditions. It is easy to find fault but the critics of the railroads do not deserve a hearing until they prove that they can effect some real improvement, which up to this time they have not been able to do.

Progress in Locomotive Design

About ten years ago the American Locomotive Company built its experimental Pacific type locomotive, No. 50000. It established records that have seldom been equalled since and represented the highest development of railroad steam motive power at that time. Another experimental locomotive, Michigan Central No. 8000, described in this issue, is now receiving considerable attention from railway mechanical men. This, like its predecessor, has been designed with extreme care and embodies all the latest appliances. While the locomotives are of different types, one being intended for passenger and the other for freight service, it is interesting to compare the two designs and note the changes in the most advanced practice of ten years ago and of today.

One of the objects sought in No. 50000 and in No. 8000 was the elimination of superfluous weight. In both cases a considerable reduction in weight was secured as compared with prevailing practice, but apparently there is very little difference between the two locomotives in this respect. A comparison on the basis of rated boiler capacity, though not conclusive, indicates that the ratio of weight to power is about the same. The appliances used on No. 8000 may have a noticeable effect on the power output and it will be interesting to compare the results of road tests when they are available.

To save fuel No. 50000 was fitted with a carefully designed boiler having a superheater and a brick arch. No. 8000 likewise has a high capacity boiler. The tubes are larger than in No. 50000, the superheater is designed to give a higher temperature, the brick arch is arranged to secure increased circulation of the water in the boiler and mixing of the gases of combustion in the firebox, and the feedwater heater by reclaiming heat from the exhaust steam reduces the fuel consumption. With these improvements it is reasonable to expect the new locomotive to give a considerably better performance than the design of ten years ago.

Another important characteristic of any locomotive is its hauling capacity. At high speeds this is dependent on the boiler output which has already been discussed. At low speeds No. 8000 has a decided advantage because the booster utilizes the weight on the trailing truck to obtain additional tractive power, thus bringing a very large proportion of the total weight of the locomotive into play as adhesive weight when starting. On the whole, the notable Michigan Central Mikado may be expected to show enough improvement over No. 50000 to demonstrate that the last decade has added its full share to the progress of the steam locomotive.

Cranes and Trucks for Railroad Shops

No locomotive erecting shop, heavy machine shop, boiler shop, blacksmith shop, foundry or other building for heavy work is properly equipped unless it is provided with a sufficient number of overhead traveling cranes of a suitable capacity and speed. While such cranes are of vital importance, it is desirable to investigate the way in which they are utilized and the cost, for example, of moving a load from one end of a shop to the other. A careful analysis of a day's expenses for crane service in any shop will often show some rather unexpected facts. In such expenses should be included not only the operator's time, power, maintenance and overhead, but also any time that may be lost in waiting for crane service. This last item is at times quite a serious one in some shops, one very difficult to hold to the minimum. In addition to delays while waiting for service, it is not unusual to see a crane of large capacity called on to lift a small load or even used to transport it the full length of a long shop. It should be remembered that a crane is fundamentally a hoisting machine and afterward a transporting device. For transporting purposes it is not an efficient type of mechanism and where possible other forms of material handling machinery can be used to better advantage. The shop output frequently can be increased and general cost of operation decreased by the addition of small stationary jib cranes, a wall jib traveling underneath the overhead crane runway, monorail cranes or some form of overhead carrier. Of these, the two last are more frequently valuable where the loads are not very heavy. During recent years there has been a marked development in the design of storage battery and gasoline trucks and tractors and these are now available in many types and sizes. A very useful form of such a machine for roundhouse or shop is one equipped with a power crane having a long jib arm. Industrial trucks are free to travel from one bay to another, or from one building to another. If the proper type is selected attention is given to routing, trucks and tractors are highly economical and serve to relieve cranes of work for which they are least adapted.

NEW BOOKS

Proceedings of the Master Boiler Makers' Association, 1922. *Edited by the secretary, Harry D. Vough, 26 Cortlandt street, New York.* 208 *pages,* 6 *in. by* 9 *in. Bound in cloth.*

This book contains the proceedings of the tenth annual convention of the Master Boiler Makers' Association which was held in Chicago, May 23 to 26, 1922. The reports submitted included oxyacetylene welding, electric welding, advantages of various types of crown stays, methods of welding safe-ends on boiler tubes, prevention of deterioration of fireboxes behind grate bars, cause of cracking through girth seam rivet holes or on circumferential seam and best type of side sheets for narrow and wide fireboxes. The discussion of many of the papers was quite complete. This applies particularly to welding processes.

International Railway Congress.—The Permanent Commission of the International Railway Association has announced that the next congress will be held in London during the latter half of 1925. This time is selected in order to participate in the centenary of the first English railway. The questions to be discussed will be limited to three for each of the five sections; way and works, locomotives and rolling stock operation, general, and light railways.

WHAT OUR READERS THINK

Why College Men Do Not Stay in Railroad Service

Louisville, Ky.

To the Editor:

In the August issue of the *Railway Mechanical Engineer*, there is a question which puts in an appearance periodically, as to why college men do not continue in the railroad business. Various answers have been set forth from time to time under a variety of captions. If the writers have not all said the same thing substantially in dealing with this query, they have endeavored to do so and the amount of difference between their opinions is small.

I have met college men who thought they wanted to acquire the knowledge necessary to equip themselves for railroad service, but they were puffed up to such an extent that the details of the business were a bore to them. They could not or would not get down to the practical things which are so essential in supervisory work. They never learned to adjust spring rigging, quarter a pair of driving wheels or fit a crank pin, but they could hang guides, fit shoes and wedges and set valves. They obtain just enough general information and linger long enough to enable them to say, "We took a special course in so and so shop and are now ready to set the world afire."

Coming right down to brass tacks, the railroad shops are in need of intelligent men; not of this brand or the other, but men who know how to think and do it quickly and accurately. Not drivers so much as leaders, not doers entirely, but *knowers*, i. e., to be able to tell in a few words what is wanted and to be sure of the results. Such knowledge can only come with experience and this is like the time difference between growing a squash and an oak. It requires a great amount of patience and perseverance to reach the top rung in the railroad business. We can not kill the old guard even if we desired to do so, and we are helpless when it comes to pushing a faithful one out to make room for an ambitious, untried person. And so the lane is a long one and the turn seems out of all earthly sight, but such is not the case. It is right where it should be, awaiting the persevering one.

The reason why a college man does not stay is not because he is unappreciated, but because of his lack of patience. A real railroad man requires quite an equipment besides the one he gets from his Alma Mater; he needs to take on a good stock of cheer, a fair supply of diplomacy and full tank of genuine Job-like patience—and then work like the deuce until the reward comes. It may perchance not come in the form he would most desire it, but it is sure to follow if he persistently hangs on. I have never yet seen the above rule to fail.

This then, is my answer to the oft propounded question—it is because the average shop boy outwaits the average college man and wins over him on account of bull-dogish-hang-on-itiveness.

I can not leave this subject without venturing a practical solution, which is a *bang up compulsory apprenticeship system* in every railroad shop throughout the country with first class instructors—men possessed of character as well as mechanical skill and knowledge.

Since we can not hold the college men, let us see to it we get the next best thing.

Millard F. Cox,
Mechanical Engineer, Louisville & Nashville.

Waste of Steam with Extremely Long Cut-Off

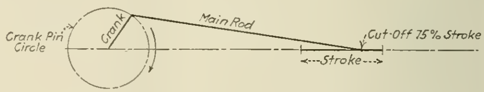
Kansas City, Mo.

To the Editor:

In helper and freight service on long grades where it is the custom to work the engine with valves cutting off, at or near full stroke, a waste of steam results from the use of a cut-off later than 75 per cent of the piston stroke without any appreciable gain in power. The angle formed by the main rod and crank-pin is such that little turning effect is imparted to the driving wheels during the last quarter of the stroke.

That this fact has been recognized in Europe is proved by the latest design of una-flow locomotives which exhaust at 75 per cent of the stroke. While this early exhaust is primarily intended to shorten the cylinders, it would not have been adopted had it proved in any way detrimental to the engine's performance.

To further support the above statement I will quote an extract from a series of tests that were conducted by a large eastern road in which a Mikado type locomotive developed



Power Obtained from Last Quarter of Stroke Is Slight

1,320 hp. at 90 per cent cut-off on a steam consumption of 31.6 lb. of steam per horsepower hour at 40 r.p.m., while with a 75 per cent cut-off at the same speed it developed 1,300 hp. on a steam consumption of about 25 lb. per horsepower hour, which shows that it is possible for an engineman to waste 25 per cent of the steam used with practically no gain in power.

As a further example, take the average Mikado locomotive with 27 in. by 32 in. cylinders and 200 lb. steam pressure with maximum cut-off of 90 per cent (which is generally adopted) and observe the increased steam consumption per revolution by cutting off at 90 per cent stroke instead of 75 per cent.

With 90 per cent cut-off the piston has traveled 28.8 in. of stroke. With 75 per cent cut-off the piston has traveled 24 in. of stroke, a difference of 4.8 in.

The area of a 27-in. piston is 572.5 sq. in.

$572.5 \times 4.8 = 2{,}748$ cu. in. $= 1.59$ cu. ft.

1 lb. of steam at 200 lb. pressure occupies 2.12 cu. ft.

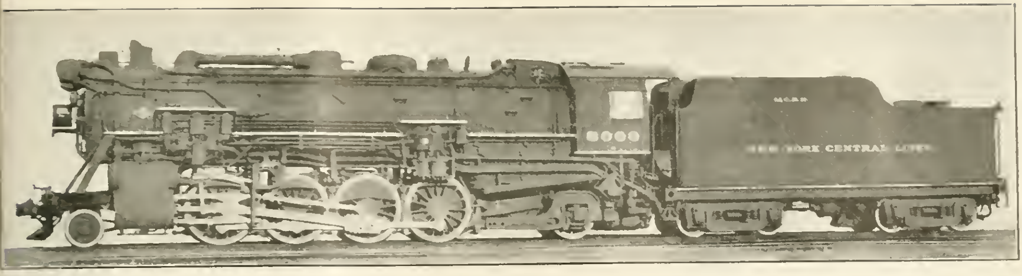
$1.59 \div 2.12 = 0.75$ lb. extra steam consumed per stroke.

As there are four strokes in two cylinders per revolution $0.75 \times 4 = 3$ lb. extra steam consumed.

From the above it will be seen that enormous quantities of steam may be wasted on long grades.

In conclusion I may say that most English locomotives have a maximum cut-off of 75 per cent of stroke and that no difficulty is experienced in starting with a full load.

P. D. Anderson.



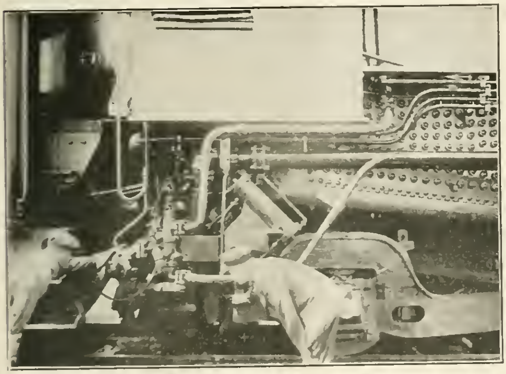
Left Side View of Michigan Central No. 8000

New Michigan Central Mikado Has Many Special Features

Modern Appliances Co-ordinated To Give Maximum Efficiency: Refinements in Design To Reduce Weight

FEW locomotives built in recent years have created as much interest as the special Mikado type, No. 8000, built for the Michigan Central by the Lima Locomotive Works, which was described briefly in the *Railway Mechanical Engineer* for August, 1922, page 437. Further details including drawings, have now been made available.

As outlined in the earlier article, the object of the design was to provide the maximum hauling capacity with the



Rear of Locomotive, Showing Stoker, Booster and Grate Shaker

minimum fuel consumption and without exceeding the allowable limit of weight. The Michigan Central was already using a very well designed Mikado, designated as type H7E, and the problem of effecting a marked improvement over the performance of this locomotive was a difficult one. That a satisfactory solution was found is indicated in Table I.

It will be noted that with an increase of 1.8 per cent in total weight, the maximum tractive force without the booster has been increased 7.6 per cent and with the booster, 26.3 per cent. The weight per cylinder horsepower, based on Cole's method, has been decreased 5.1 per cent. This does not take into account the improvement in performance due to the feedwater heater, high degree superheat and the operation of auxiliaries with superheated steam. The estimated performance curve shows a maximum of 3,070 cylinder horsepower, an increase of 17.0 per cent and a decrease of 12.8 per cent in weight per cylinder horsepower.

The figure for the boiler horsepower of No. 8000 by Cole's method is an approximation because only incomplete data are available regarding the evaporation from 3¼-in. boiler tubes. The figures are given to afford a comparison of the two boilers on the basis of a steam consumption of 20.8 lb. per horsepower hour. While any prediction of the water rate for this locomotive is subject to error, 18 lb. per horsepower hour does not seem too low. At this rate the estimated boiler output would be 3,160 hp. and since the

TABLE I—COMPARATIVE DATA FOR CLASS H7E AND NO. 8000

	Class H7E	No. 8,000	Increase Per Cent
Weight on drivers, lb.	246,000	245,500	0.2*
Total weight, lb.	328,000	334,000	1.8
Cylinders, diameter and stroke	27 in. by 30 in.	28 in. by 30 in.	...
Tractive effort without booster, lb.	59,000	63,500	7.6
Tractive effort with booster, lb.	......	74,500	26.3
Cylinder horsepower, maximum (Cole)	2,624	2,824	7.6
Weight per cylinder horsepower (Cole), lb.	125	118	5.1*
Cylinder horsepower, maximum, estimated from performance curve	......	3,070	17.0
Weight per cylinder horsepower, estimated lb.	......	109	12.8*
Boiler horsepower, maximum (Cole)	2,420	2,735	13.0
Weight per boiler horsepower (Cole)	135	122	9.6*

*Decrease.

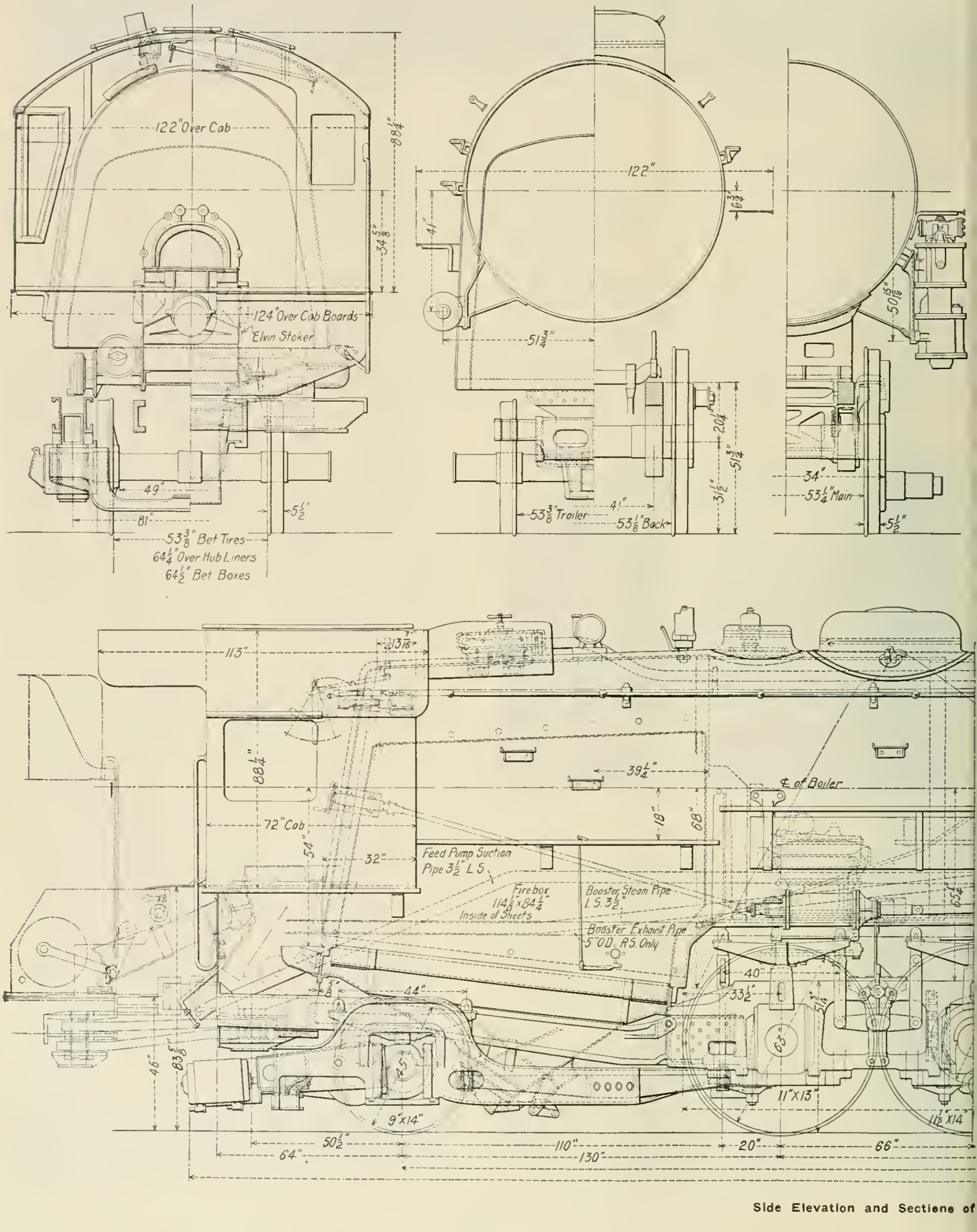
feedwater heater increases the steaming capacity, the evaporation should be fully up to the cylinder requirements.

Another primary consideration in the design of No. 8000 was fuel economy, not necessarily the burning of less fuel than previous locomotives, but the ability to obtain greater drawbar output for the fuel consumed. This object was attained by incorporating into the design well-known fuel-saving devices properly proportioned with respect to the locomotive and its appliances to give the best results.

The Superheater Company's type *E* superheater is used and provides steam for all auxiliaries as well as the cylinders. This design of superheater permits of using but one size of tube and the entire boiler is equipped with 3¼-in. tubes. A large proportion of these tubes contain superheater units and the steam is raised to a higher temperature than is obtained from the usual type *A* superheater. The design also provides a greater total steam area through the units than the type *A* and at the same time permits of greater gas area through the tubes. In view of this greater gas area, more heat is absorbed from the gases before they pass into the smokebox and consequently there is a better boiler and superheater performance and less heat is lost through the stack. The damper usually found in the type *A* superheater has been omitted because the throttle is ahead of the superheater and protection to the units is afforded by the flow of steam through them for the blower and the other auxiliary apparatus when the main engine is shut off. A removable plate is applied to the smokebox over the superheater header to facilitate the tightening of joints when assembling the superheater. The Superheater Company's feedwater heater is applied which utilizes a portion of the exhaust steam to heat the feedwater from tank temperature to about 225 deg. F., the condensate being returned to the tender.

The firebox is supplied with coal by an Elvin stoker and is equipped with the American Arch Company's type *P* double firebrick arch, consisting of two sets of refractory brick supported on two horizontal rows of arch tubes, each comprising four 3½-in. tubes. This design of firebrick arch is new. Its purpose is not only to ensure complete combustion, but to improve water circulation in the boiler, the chief object of the double rows of arch tubes.

Additional economy of steam is secured by the use of superheated steam in the auxiliaries, including the air com-

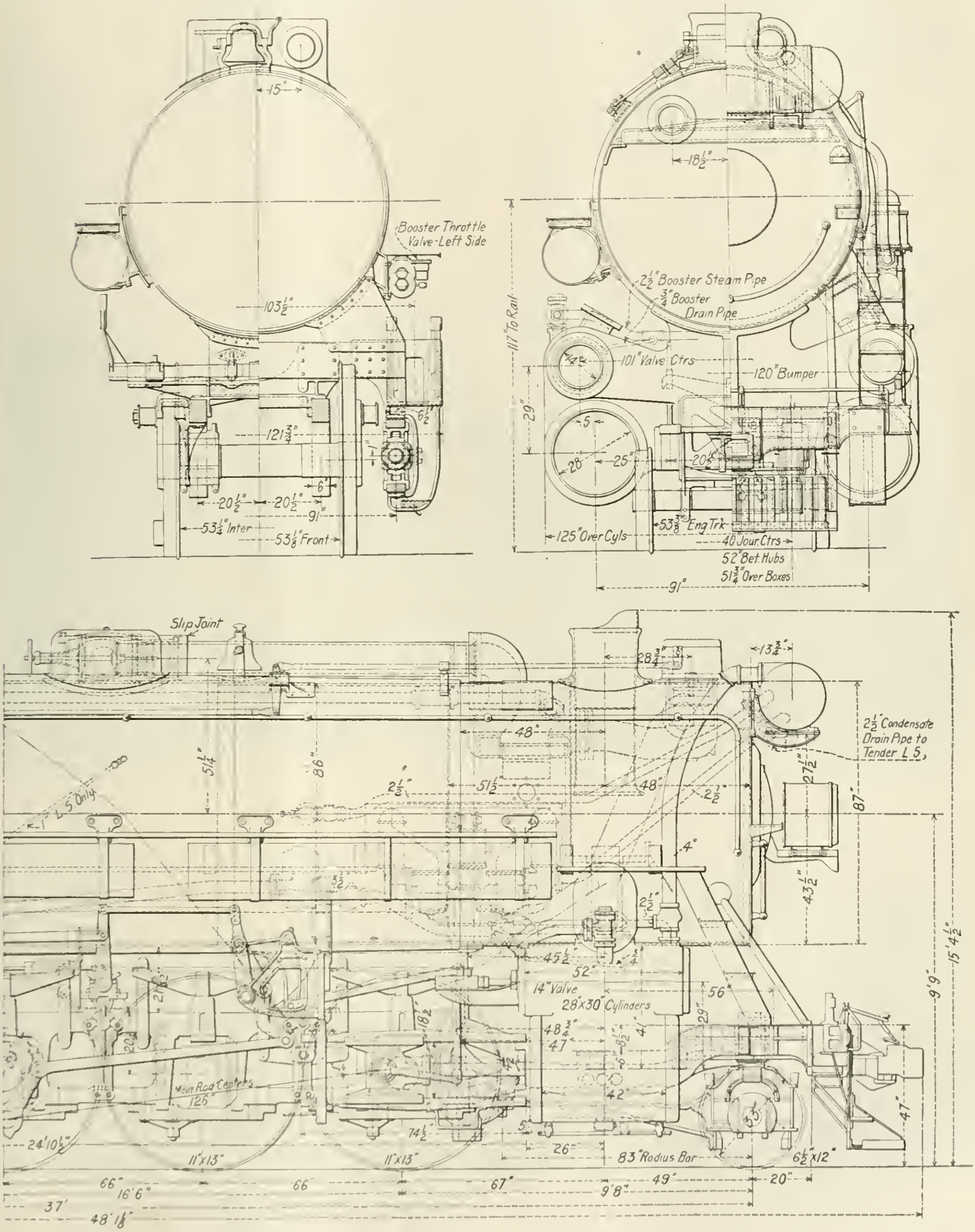


Side Elevation and Sections of

pressor, feedwater pump, blower, turbo-generator, stoker and locomotive booster. These accessories at times use more than 25 per cent of the steam from the boiler. The consumption per unit of work done is quite high and the saving by superheating the steam should be relatively large.

Reduction of Weight and Dynamic Augment

Careful attention was given to all the details of design to eliminate every pound of unnecessary weight. Little opportunity for reduction was found in the boiler or frames, but surprising savings were made in some of the minor details. For example, by refinement in design, the foundation brake rigging was cut down 1,800 lbs. without sacrificing strength. The use of magnesia lagging saved several hundred pounds. One of the reasons for the selection of the Elvin stoker was its relatively light weight.



Michigan Central Mikado Locomotive

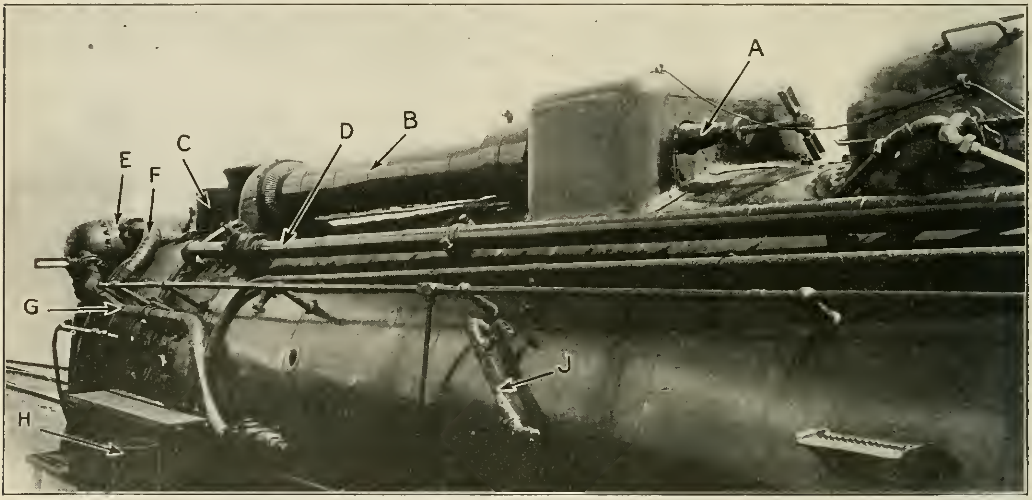
To keep down the weight of the locomotive, the axles and main crank-pins were made hollow and Lima special quality steel, which is a chrome-vanadium steel heat treated by annealing, was used in main and side rods. Great care was also exercised in the design of the reciprocating parts so that not only was a saving made in the static weights, but it was also possible to reduce the dynamic augment, or pressure at the rail due to excess counterbalance. Table II indicates the relative dynamic augment of Class H7E, and No. 8000 at operating speeds of 30, 40 and 50 miles per hour. The reduction of 52 per cent in the maximum dynamic augment shows the advantage of the high-quality steel used in the running gear.

Table II—Dynamic Augment of Class H7E and No. 8000

	30 m.p.h.		40 m.p.h.		50 m.p.h.		
Wheels	H7E	8000	H7E	8000	H7E	8000	Decrease, per cent
Front	3,430	1,920	6,100	3,420	9,520	5,340	44
Intermediate	4,040	1,920	7,180	3,420	11,200	5,340	52
Main	2,040	1,470	3,630	2,610	5,680	4,080	28
Back	3,510	1,860	6,240	3,300	9,750	5,160	47

Special Features of Construction

In order to attain the objects sought in the design of No. 8000 many innovations were made in the construction. The special features are the subject of patents now pending.



Forward End of Boiler from Left Side

A, Shut-off Valve; *B*, Outside Steam Pipe; *C*, Throttle; *D*, Superheated Steam Pipe to Turret; *E*, Feedwater Heater; *F*, Exhaust Steam Pipe to Heater; *G*, Feedwater Discharge Pipe from Heater; *H*, Feedwater Pump; *J*, Drain Pipe from Steam Separator.

The boiler is of the straight-top type and carries 200 lb. per sq. in. pressure. The barrel has an outside diameter of 86 in. at the first ring and contains 253, 3¼-in. flues, 20 ft. long. The firebox has a grate area of 66.4 sq. ft. There is no combustion chamber but, as mentioned above, a double arch is applied on eight arch tubes. One of the interesting details is the large mud-ring corners which have a radius of 12 in. This easy curve makes it possible to apply rivets instead of patch bolts, improves the circulation around the firebox and facilitates inspection and cleaning. The heating surface of the firebox and arch tubes is 291 sq. ft. and of the flues, 4,287 sq. ft.

To insure that dry steam is delivered to the superheater, a steam separator is placed at the highest point in the dome. Any entrained moisture is removed from the steam before it enters the dry pipe and is returned to the boiler.

New Throttle Arrangement

The throttle valve, instead of being located in the dome, is placed in the top of the smokebox just ahead of the stack, shutting off the steam from the cylinders but not from the superheater. On account of this arrangement an outside dry pipe with a shut-off valve as clearly shown below, is used so that the steam can be shut off and the throttle ground without blowing down the steam pressure on the boiler. To reduce the number of joints, the dome and the back end of the dry pipe are made integral of a steel casting.

The steam after flowing through the dry pipe and superheater tubes, passes to the right side of the superheater header, which has a main outlet leading to the throttle which supplies the main cylinders and the booster and a smaller connection to the superheated steam pipe to the turret which supplies the other auxiliaries. The throttle valve is located at the top of the smokebox where it is readily accessible. It is of the usual double-seated poppet type with top lift operated by outside rigging. The expansion of the boiler tends to change the setting of the throttle valve and to overcome this the Jones compensating arrangement has been applied.

The cylinders and valves are in accordance with the usual practice with the exception of the valve travel which has been increased to 8¾ in. by a special design of Baker valve gear controlled by the Franklin type D Precision power reverse gear. The booster, which adds 17.3 per cent to the starting tractive effort of the locomotive, is the latest design type C-1 using superheated steam. The exhaust steam from the booster is discharged out of the stack, thus creating additional draft and increasing the steaming capacity of the boiler at low speeds.

The feedwater heater is carried on brackets secured to a permanent top section of the smokebox front. This elevated location of the heater enables the water condensed from the exhaust steam to flow to the tender by gravity. The arrangement of the smokebox front avoids any difficulty in removing it to reach the front end netting or superheater.

Superheated Steam for Auxiliaries

Reference has already been made to the use of superheated steam in the auxiliaries. Special arrangements have been made so that if necessary, saturated steam can also be used. Two turrets are mounted over the firebox just ahead of the cab. The left-hand turret is connected to the superheated steam pipe leading back from the header and carries transverse pipes leading to the right turret. The right turret has a connection to the saturated steam space in the boiler which is normally shut off. A stop valve is located in the superheated steam pipe to the turret just back of the point where it issues from the smokebox, so that by opening the valve between the right turret and the boiler and closing the valve in the steam pipe, saturated steam can be used. It is of interest to note that no changes in the design of the auxiliaries were necessary to adapt them for superheated steam, the only modifications being in the use of materials that would withstand the higher temperatures.

The tender has a capacity of 10,000 gal. of water and 16 tons of coal. It is carried on Commonwealth four-wheel trucks and has a Commonwealth cast-steel tender frame.

The accessories used on this locomotive include the Commonwealth-Franklin engine truck, type B Delta trailing truck with constant resistance centering device, Franklin radial buffer and unit safety drawbar, Pyle-National type K-2 headlight generator, Franklin grate shaker, Franklin adjustable wedge and driving box spreader and cellar, Franklin sprinkler and McLaughlin flexible joints.

The dimensions, weights and factors are as shown in the tabulated data sheet:

Locomotive Data Sheet

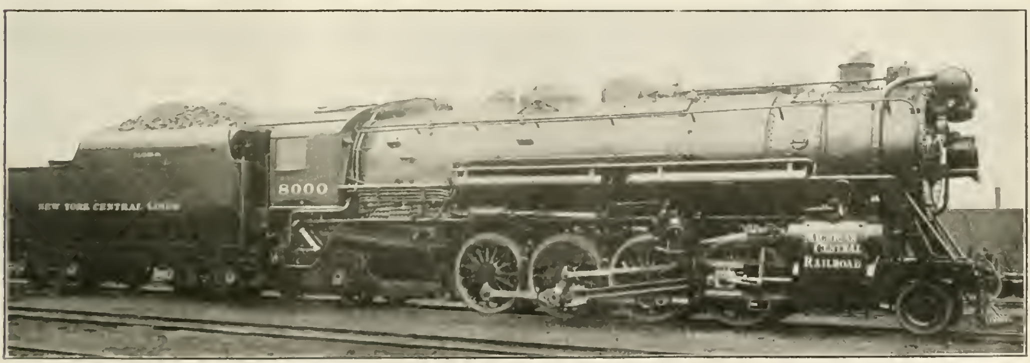
Railroad	Michigan Central
Type of locomotive	2-8-2
Service	Freight
Track gage	4 ft. 8½ in.
Cylinders, diameter and stroke	28 in. by 30 in.
Valve gear	Baker
Valves, kind and size	Piston, 14 in. dia.
Maximum travel	8¾ in.
Outside lap	1¼ in.
Exhaust clearance	1/16 in.
Lead in full gear	3/16 in.
Weights in working order:	
On drivers	245,500 lb.
On front truck	30,000 lb.
On trailing truck	58,500 lb.
Total engine	334,000 lb.
Tender	199,700 lb.
Wheel bases:	
Driving	16 ft. 6 in.
Rigid	16 ft. 6 in.
Total engine	37 ft. 0 in.
Total engine and tender	71 ft. 6½ in.
Wheels, diameter outside tires:	
Driving	63 in.
Front truck	33 in.
Trailing truck	45 in.
Journals, diameter and length:	
Driving, main	11½ in. by 14 in.
Driving, others	11 in. by 13 in.
Front truck	6½ in. by 12 in.
Trailing truck	9 in. by 14 in.
Boiler:	
Type	Straight top
Steam pressure	200 lb. per sq. in.
Fuel, kind and B.t.u.	Bituminous coal, 14,000 (app.)
Diameter, first ring, outside	86 in.
Firebox, length and width	114⅛ in. by 84¼ in.
Height, grate to crown sheet, back	68½ in.
Height, grate to crown sheet, front	87 in.
Arch tubes, number and diameter	8—3½ in.
Combustion chamber	None
Tubes, number and diameter	253—3¼ in.
Tubes, length	20 ft. 0 in.
Tubes, spacing	⅝ in.
Tubes, inside diameter	2,982 in
Gas area through tubes	[illegible].26 sq. ft.
Net gas area through tubes	9.47 sq. ft.
Grate type	Table
Grate area	66.4 sq. ft.
Heating surfaces:	
Firebox, incl. arch tubes	291 sq. ft.
Tubes	4,287 sq. ft.
Total evaporative	4,578 sq. ft.
Superheating	1,780 sq. ft.
Comb. evaporative and superheating	6,358 sq. ft.
Tender:	
Style	Rectangular
Water capacity	10,000 gal.
Fuel capacity	16 tons
Special equipment:	
Brick arch	American Arch Co., double arch
Superheaters	Superheater Co., Type B
Feedwater heaters	Superheater Co.
Stokers	Elvin Mech. Stoker Co.
Booster	Franklin Ry. Supply Co.
General data, estimated:	
Rated tractive force, 85 per cent	63,500 lb.; with booster 74,500 lb.
Cylinder horsepower (Cole)	2,824
Boiler horsepower (Cole) (est.)	2,735
Speed at 1,000 ft. piston speed	37.5 m.p.h.
Steam required per hour	58,700 lb.
Boiler, evaporative capacity per hour	56,900 lb.
Coal required per hour, total	9,180 lb.
Coal, rate per sq. ft. grate per hour	138 lb.
Weight proportions:	
Weight on drivers ÷ tractive force	3.86
Weight on drivers ÷ total weight engine	.735
Total weight engine ÷ cylinder horsepower	118
Total weight engine ÷ boiler horsepower	122
Weight per sq. ft. of combined heating surface, lb.	52.5
Boiler proportions:	
Boiler horsepower ÷ cylinder horsepower	96.9 per cent
Comb. heating surface ÷ cylinder horsepower	2.25
Tractive force ÷ comb. heating surface	9.99
Tractive force × dia. drivers ÷ comb. heating surface	630
Cylinder horsepower ÷ grate area	42.5
Cylinder horsepower ÷ net gas area of tubes in sq. ft.	298
Firebox heating surface ÷ grate area	4.38
Firebox heating surface ÷ evap. heating surface	6.36 per cent
Superheating surface ÷ evap. heating surface	38.9 per cent
Tube length ÷ inside diameter	80.5

Engine No. 8000 has been in operation since about the first of June between Detroit and Toledo, and between Toledo and Jackson, Mich. The Michigan Central Railway is preparing to make exhaustive tests of the engine, data from which will be available at a later date. So far the engine has exceeded the expectation of the builders, both in developing high drawbar pull and in economy of operation.

On June 24, 9,254 tons in 138 cars were hauled from Detroit to Toledo, without help, a distance of 47.6 miles in 3 hr. 31 min., no trouble being experienced in starting this train with booster in operation; in fact, for the first 10 miles the tonnage was 9,394 tons in 140 cars, 2 cars being set off on account of hot boxes. On June 30, 10,039 tons were hauled over this division in 147 cars, no assistance being required to start or haul this train.

No trouble has been experienced in maintaining full boiler pressure when operating at maximum capacity.

The evaporation per pound of fuel is phenomenal, as for three of the full tonnage runs made between Detroit and Toledo, the total water divided by total fuel averaged 9.7 lb. which indicates a combined efficiency for the boiler and superheater of about 77 per cent.



Right Side of the Locomotive, Showing Removable Plate Over Superheater Header and Outside Throttle Rigging

Nick-Bend Test for Wrought Iron*

THE material examined represents the finished product of four different manufacturers and an intermediate stage in wrought-iron manufacture from a fifth source, nine grades in all being tested.

The methods used for fracturing the nicked bars varied from a slowly applied transverse bending stress to a severe single-blow impact stress. This range is permitted by most current American specifications. Although the investigation has not been comprehensive enough to furnish answers to all the questions which may arise concerning the nick-bend test for wrought iron, the results obtained are definite enough to permit certain conclusions being drawn and to warrant certain recommendations concerning the test.

1. The rate of application of the stress used in rupturing the bars appears to be one of the most important factors which affect the results of the test, that is, the appearance of the fracture. All of the grades tested successfully passed inspection when slowly or moderately stressed. Under shock, however, all showed crystallinity in the fracture, several to an extent which would cause rejection. The results obtained suggest the desirability for defining more strictly the conditions for carrying out this test than is the case in many current specifications. The ordinary methods used in mechanical testing fail almost entirely to give an indication of the features shown by the nick-bend test.

2. The appearance of the fractures of nicked bars broken by impact is dependent upon the character, particularly the extent, of the notch to a very marked degree. The depth and length of the notch relative to the specimen tested should be carefully regulated. This can be more readily done by notching in the press with a special chisel than by hand. Specimens having complete circumferential notches, when broken by severe impact, showed very little crystallinity, whereas the same material notched on one side only often showed very large crystallin patches.

3. There are two distinct types of crystallin areas produced in the nick-bend test of wrought iron. The one near the tension side of the stressed bar is the direct result of the stress applied and indicates certain characteristics of the material. The crystallin area on the compression side, which is often the larger and more conspicuous of the two, depends for its formation upon the preliminary permanent distortion in compression of the crystals in this part of the specimen, and does not necessarily indicate any characteristic features of the unstressed material.

4. Prominent steel-bearing streaks in wrought iron appear to favor to some extent the formation of crystallin areas when fractured under impact, although crystallin areas are not necessarily indicative of steel in the iron. Prominent slag streaks often permit longitudinal separations to occur during testing, thus giving rise to a fibrous appearance. The absence of such streaks or the presence of small and uniformly disturbed streaks appears to favor the production of larger crystallin areas upon impact.

5. In the testing of plates or flat bars by the nick-bend test the relation of the location of the notch with respect to the slag plates ought to be specified, that is, whether upon the edge or the flat side of the plate.

6. Bars which had been permanently stretched before being subjected to the nick-bend test gave no indications so far as the characteristic features of the fracture were concerned of the preliminary treatment to which they had been subjected. The cold work very materially strengthened such bars, however, so that a much severer blow was necessary in the fracturing of such specimens than before stretching.

7. The present investigation was carried out upon bars of uniform size, 1 in. in diameter. An additional study of other sizes, preferably larger ones, would undoubtedly throw further light upon the results of the nick bend test and their interpretation. Likewise the testing of bars of abnormal composition, particularly irons high in phosphorus, would give results of value regarding this test. Variations in the method of gripping the specimen, relative to the notch, may also merit some attention. The present study gives no information on these points.

* Summary and conclusions of a paper entitled "Some Observations on the Nick-Bend Test for Wrought Iron," presented by Henry S. Rawdon and Samuel Epstein of the U. S. Bureau of Standards at the 1922 annual meeting of the American Society for Testing Materials.

Report on Fuel Accounting*

The committee concurred in the recommendation of the Purchases and Stores Division of the American Railway Association that locomotive fuel be accounted for by individual locomotives, both as to quantity and value chargeable to each account by divisions, main and branch line districts, freight and passenger service and by states, for yard switching service; also, a charge for quantity and value by accounts for all fuel used for miscellaneous purposes, and submitted the following conclusions on the three points carried over from the 1921 meeting:

1. Other than locomotive fuel; 2, coal picked up in yards and on right of way, and 3, coal removed from overloaded commercial cars.

1. Fuel used for all purposes other than locomotive operation, such as stations, elevators, power plants, etc., should be charged out to the facility and in the month in which it is used. Fuel ticket and department invoice, properly receipted, should be required to cover the issue.

2. Coal picked up in yards and on right of way and fuel oil reclaimed in sump should be charged to the service in which it is used and locomotive fuel account credited, as it is the clearing house for all such over and under charges.

The labor cost of recovering such fuel should be charged as follows:

(a) "Roadway Maintenance" ("General Cleaning") if outside of shop yards and used for other than locomotive operation, or recovered in hump or classification yards.

(b) "Shop Expenses" if within shop yards and used for other than locomotive purposes.

(c) "Fuel Station Operation" if such fuel, after being recovered, is used on locomotives.

3. The overload removed from commercial cars may be used by the company for its own operations, and payment made to the shipper for the actual amount of coal removed at a price agreed upon, with deduction covering cost of labor, switching and reweighing. Where car is returned to mine from scale for lightening by the shipper a switching charge should be assessed.

The report was signed by J. N. Clark, chairman (Sou. Pac.); C. N. Beyerly (B. & O.), E. E. Chapman (A. T. & S. F.), R. R. Hibben (M. K. & T.), R. E. Jones (D. & I. R.), Joseph McCabe (N. Y., N. H. & H.), Hugh McVeagh (Big Four), C. F. Needham (Grand Trunk), and W. J. Tapp (D. & R. G. W.).

*Abstract of report to International Railway Fuel Association convention, Chicago, May, 1922.

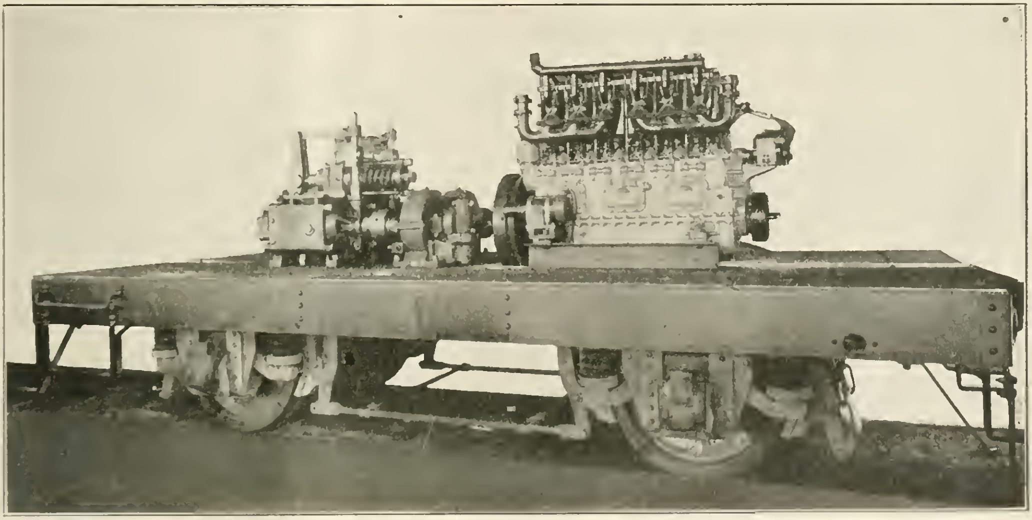
Economic Aspect of Poor Vision.—In the examination of more than 10,000 employees in factories and commercial houses, 53 per cent were found with uncorrected faulty vision and 13 per cent had defects which were corrected, making a total of 66 per cent with defective eyes. This is the summary of a report of studies made by the Eye Sight Conservation Council of America, headquarters Times building, New York city. In one manufacturing establishment over 70 per cent were found with eye defects. As an example of inefficiency and resulting waste, 20 per cent of the inspectors in a large factory were found to be unable to see sufficiently well to detect defects in the product they were inspecting. More attention has been given to the perfecting of machinery than to the correcting of physical defects in the workman. Every manager should see to it that the eyes of all associated with him are corrected to compensate for defects. It will pay from a purely business standpoint.

Hauling 14 Cars Weighing 645 Tons with a 150-Horse Power Gasoline Locomotive

Gasoline Switching Locomotive with Hydraulic Drive

Universal Oil Transmission Governs Speed and Direction and Gives Remarkable Flexibility of Control

ONE of the most promising developments in the application of the internal combustion engine for railroad motive power is a gasoline switching locomotive designed by John Robson, chief engineer of The Universal Engineering Corporation, Montreal, Can., and recently built under his supervision at the plant of the Canadian Car & Foundry Company, Montreal. The most notable feature of the equipment is the arrangement of power transmission and speed control. This is effected by a Waterbury hydraulic variable speed gear, built in this country by the Waterbury Tool Company, Waterbury, Conn., which gives any speed from zero to the maximum in either direction without steps or gradations and without varying the speed or direction of rotation of the engine. The power to drive the locomotive is supplied by a 150-hp., six-cylinder Ricardo gasoline engine, the engine and transmission being arranged to give a maximum tractive effort of 12,000 lb. and a maximum speed of 12 miles an hour. The locomotive is intended for switching service and has two independently driven axles. It is 19 ft. long and weighs 53,000 lb.

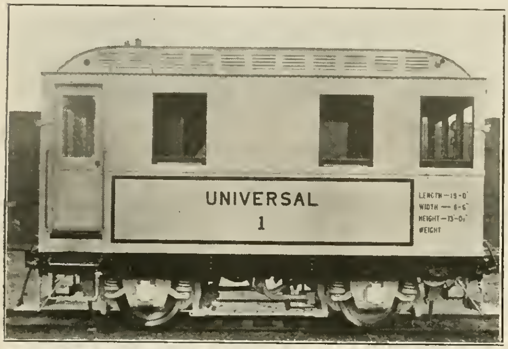


Locomotive with Power Plant and Transmission in Place, Before Cab Has Been Applied

Advantages of Hydraulic Transmission

In practically every design of railroad equipment using internal combustion engines built heretofore, the transmission of power has been effected by shifting gears and clutches, or by electric generators and motors. Neither of these methods is entirely satisfactory. While gasoline-electric equipment affords the necessary flexibility, the control is complicated and the motors and generators increase the weight very greatly. Mechanical devices for changing speed by shifting gears cannot be satisfactorily designed for any large number of speed ratios and this form of transmission can be used only for small size engines due to the limited amount of power that can be transmitted through a friction clutch.

The hydraulic variable speed gear used in this locomotive is comparatively light in weight, easily and simply controlled and gives any desired speed of the locomotive while the engine is governed at a constant speed. Control of speed and

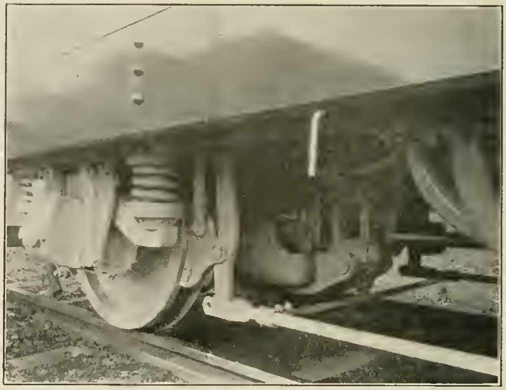


In Appearance the Locomotive Resembles a Small Electric Car

direction can be effected with a minimum of effort on the part of the operator regardless of the load on the locomotive, the flexibility and ease of control being such that complete reversal can be effected as quickly as desired without any

Description of the Gear

The Waterbury variable speed gear consists of an oil pump, designated as the A-end, and a hydraulic motor, designated as the B-end. The A-end, which is driven by the gasoline engine, delivers oil to and receives it from the B-



A View Under the Body Showing Hydraulic Drive and Suspension

end, the direction of flow and the amount of oil being controlled by a regulating device. The B-end rotates at any speed up to that of the A-end and in either direction, de-

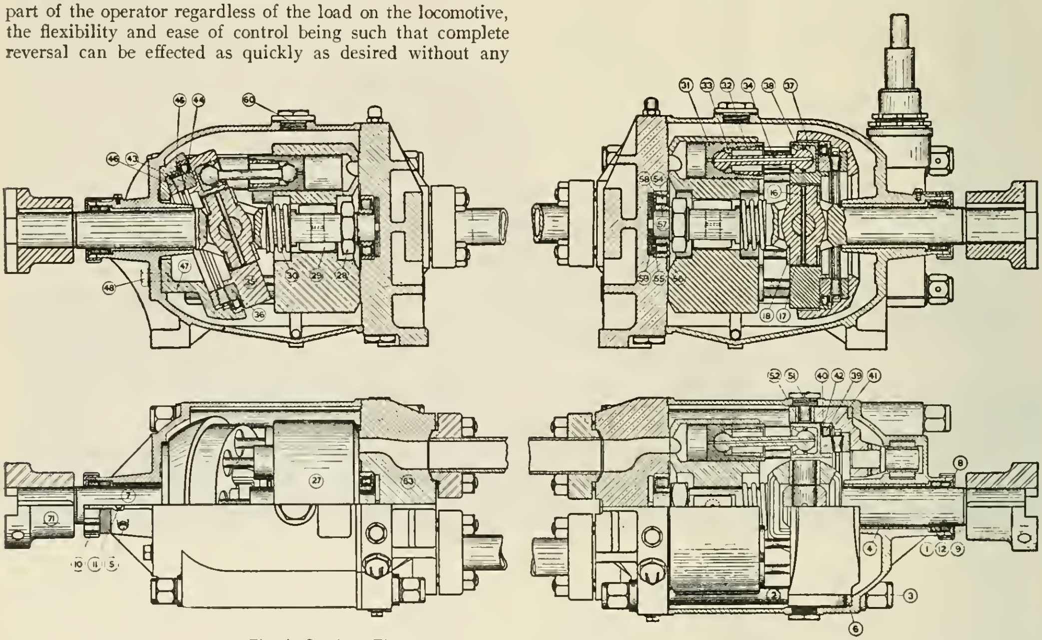


Fig. 1—Sections Through the Pump Unit (Right) and Motor Unit (Left)

undue peak load on the engine, thereby avoiding excessive stresses in the working parts. By the use of an automatic pressure control device the speed of the locomotive is regulated by the drawbar pull entirely independently of the operator in such a manner as to prevent overloading and possible stoppage of the engine owing to stalling.

pending upon the quantity and direction of delivery of the oil it receives from the A-end.

The construction and operation of the gear can readily be understood by referring to Fig. 1. In this drawing the driven shaft of the A-end, which receives the power from the gasoline engine, is shown at the extreme right hand side while the driving shaft of the B-end is at the extreme left. A cylinder barrel (27) is keyed to the inner end of each shaft. Each barrel has nine cylinders parallel to the shaft and fitted with pistons. When the barrels revolve, their inner faces slide on the valve plates (53), each of which has two ports, the ports in the A-end being connected to those in the B-end by

the shaft their planes of revolution may be at any angle with the shaft provided by the setting of the roller bearings on which the socket rings revolve.

In the B-end of the gear the socket ring runs in an angle box secured in the end of the case and making a fixed angle of 20 deg. with the shaft. Thus as the shaft, the barrel and

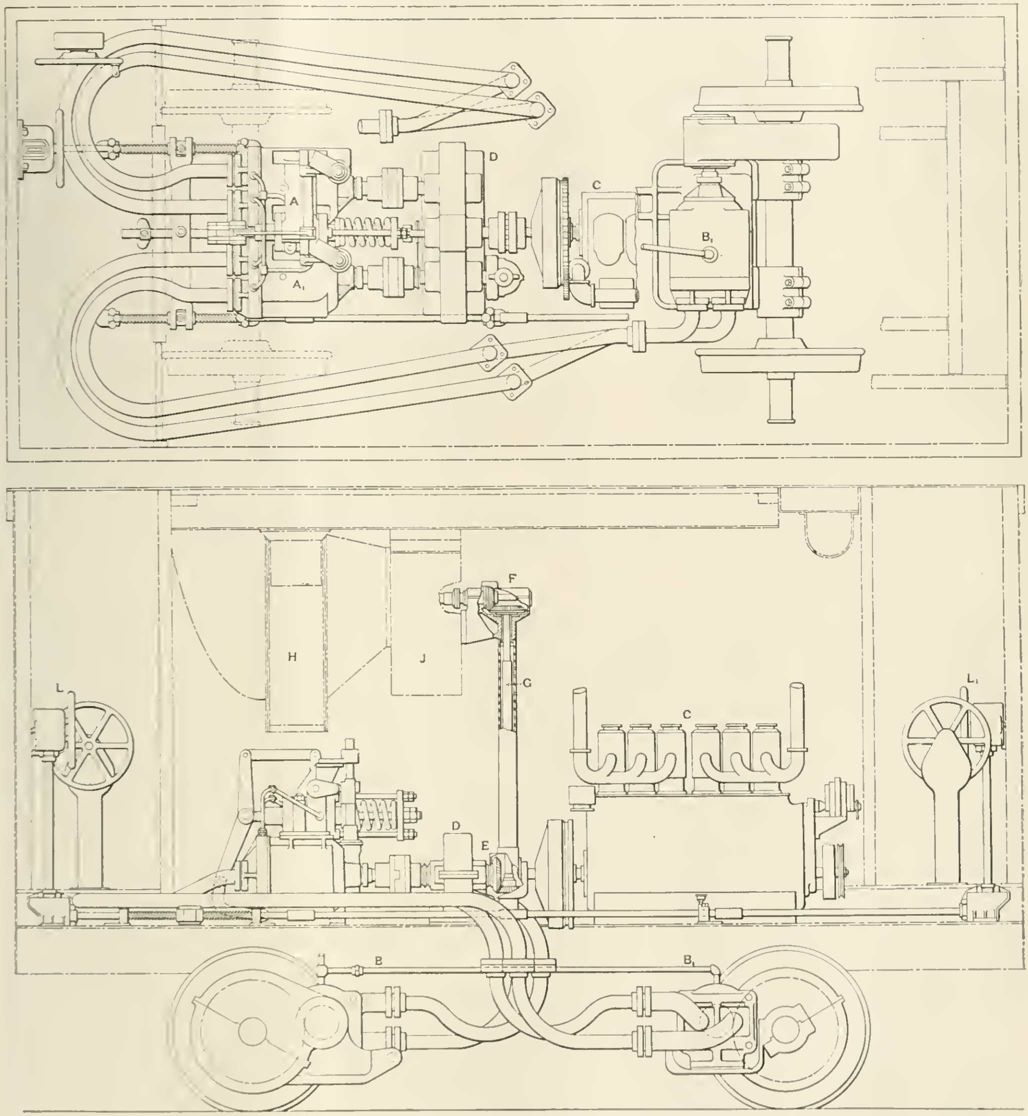


Fig. 2—Plan and Elevation of Gasoline-Hydraulic Locomotive

piping. The cylinder ports in the barrel faces register with semi-annular passages or ports in the valve plates, except at the bridges at the top and bottom of the plates. The connecting rods have one end secured in the piston and the other in the socket ring (35). The socket rings are connected by universal joints with the shaft so that while they revolve with

socket ring revolve in the B-end, the pistons will have a reciprocating motion with a constant stroke. In the A-end the angle box is hung on trunnions and may be adjusted to any desired angle while the gear is running by means of the control shaft. If the angle box in the A-end stands in the neutral position at right angles to the shaft, the pistons are carried around with the cylinder barrels but have no reciprocating motion. No oil is therefore taken from or delivered to the passages in the valve plates. If the tilting box is inclined by moving the control shaft, the pistons begin to reciprocate, the stroke depending on the angle between the socket ring and the axis of the shaft. Every cylinder during one half of the shaft's rotation is drawing in oil from one of the passages in the valve plate which it carries over and delivers into the other passage during the next half of the shaft's rotation.

The oil from the A-end is forced into one of the passages of the valve plate of the B-end. The cylinders of the B-barrel in communication with this passage make room for the oil by sliding back from the valve plate, but they cannot do this without forcing their respective sockets in the socket rings farther from the valve plates. This can only be done by turning the socket ring as a whole in its inclined plane in the angle box. While the pistons facing the pressure passage

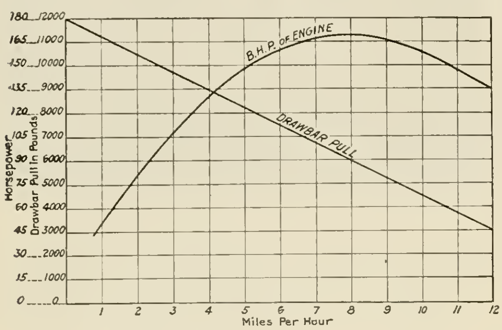


Fig. 3—Drawbar Pull and Brake Horsepower Curves

of the B-valve-plate are receding to make room for the incoming oil and so imparting rotation to the B-shaft, the pistons facing the no-pressure passage are moving toward the valve plate and delivering oil into the respective cylinders of the A-barrel. Since the receiving capacity of the B-cylinders is constant and the delivery capacity of the A-cylinders is varied at will by turning the control shaft, the speed of the B-shaft is correspondingly varied. With the engine running at constant speed the speed of the B-end depends upon the angle which the socket ring in the A-end makes with the shaft, while the direction in which the B-end revolves is governed by the direction in which the socket ring in the A-end is moved from the neutral position.

The efficiency of this type of transmission is high, ranging from 68 per cent at 25 per cent of normal speed to 82 per cent at full speed. The combined A- and B-ends weigh less than 25 lb. per horsepower transmitted. The pressures on the sliding surfaces are largely balanced so that little wear takes place and the pistons have long bearings in the barrel. In spite of the high pressures carried, leakage is negligible.

The appearance of the completed locomotive and the arrangement of the engine and hydraulic speed gear are clearly shown in the photographs. The operation will be readily understood by reference to the plan and elevation drawings.

The power for the locomotive is obtained from a six-cylinder Ricardo gasoline engine *C* with pistons of 5⅝ in. diameter and 7½ in. stroke, capable of delivering 150 brake horsepower when running at a normal speed of 1200 r.p.m. This engine drives through a double-helical reduction gear *D*, two size 50 pump units, *A* and *A*1, at 345 r.p.m. From the valve plates of these pump units, piping conveys the oil which is used as a transmission medium to two size 50 speed gear motor units, *B* and *B*1, each of which is connected by spur gearing to one of the driving axles of the locomotive. The casings of the speed gears are connected by piping to a common oil reservoir placed in a convenient position on one of the bulkheads of the engine room, the oil in this reservoir being subject to atmospheric pressure only. Flexible couplings are used between the gasoline engine and the reduction gears as well as between these gears and the pump units of the speed gear in order to allow for any vibration or springing on the framing of the locomotive.

The engine is cooled in the ordinary manner by means of a tubular radiator and fan, the latter being driven from an extension of one of the reduction gear shafts through bevel gears, *E*, *F*, and the vertical shaft *G*, the radiator *H*, and fan *J*, being suspended from the roof of the locomotive, where both the inlet and outlet passages for the fan are provided. The motor units, *B* and *B*1, of the Waterbury speed gear, together with the housing for the spur reduction gear between these units and the axles, are carried on cradles with link and swivel suspension to the under side of the frame-work, as clearly shown in one of the photographs. In this way vertical movement of the axles is provided for without interference with the gearing.

The control of speed and direction is effected by means of either of two hand wheels, *L* and *L*1, placed in the driving compartment at each end, one man only being required to operate and control the locomotive, the speed of which is governed automatically by a hydraulically operated control gear, which acts independently on the control shafts of the pump units as soon as the drawbar pull exceeds a predetermined amount. By the action of a plunger and spring, the stroke on the pistons is regulated in inverse ratio to the oil pressure and in consequence it is not possible for the operator to overload the engine. The pressure range through which the control is designed to act, is from 300 lb. up to 1,200 lb. per square inch, so that on very short piston strokes a torque of approximately four times the normal can be obtained on the axles of the locomotive.

Hand operated brakes of standard pattern are provided and work by a hand wheel placed in each compartment, these brakes being used only for emergency purposes as the stopping and starting, as well as acceleration and deceleration are controlled entirely through the speed gears. For use in coupling the locomotive with freight cars, standard air connections and cylinders are provided for operation in the usual manner from the driving locomotive.

The curve illustrated in Fig. 3 shows the relation between drawbar pull and speed up to 12 miles an hour with the control hand-wheel set for full stroke on the pump units of the hydraulic speed gear, the actual stroke, speed and horsepower of the engine being regulated by the automatic adjustment of the pressure control piston.

In actual service the locomotive has shown remarkable flexibility, which is particularly advantageous in switching service where high starting tractive effort and rapid acceleration are required. The locomotive may be started under a dead load of any amount without overloading the engine. Three turns of the hand-wheel from the neutral position will bring the locomotive up to its full speed. In stopping, the locomotive is gradually brought to a standstill by turning the control shaft to neutral, and in this position the B-end is positively locked against motion in either direction.

Several trials have been made at the plant of the Canadian Car & Foundry Company which have been entirely satisfactory. The locomotive exerts a tractive effort of 12,000 lb. at starting and 3,000 lb. at 12½ miles an hour. On level track a load of 645 tons has been handled readily. In one trial the locomotive took three cars weighing 150 tons up a four per cent grade, stopping at the steepest point and starting again under full load without difficulty. The Universal Engineering Corporation intends to apply the variable speed hydraulic gear to a locomotive of similar type designed for passenger service and also to high-capacity passenger cars.

Paint Reports to the A. S. T. M.

TWO reports on the subject of paints and protective coatings which were submitted at the annual convention of the American Society of Testing Materials held at Atlantic City, N. J., June 26-30, were of considerable general interest. Neither of these reports can be considered as final but they indicate the direction in which future progress will probably be made, as will be noticed from the following short abstracts.

Some Physical Properties of Paints

This report was submitted by P. H. Walker, chemist, and J. G. Thompson, assistant chemist of the U. S. Bureau of Standards. In introducing the subject attention was called to the fact that the life of any paint may be divided into three periods: (1) the period of storage between manufacture and application, (2) the period of application when the paint is spread out in a thin, wet film, and (3) the period of exposure covering the life of the dry paint film. Each period is characterized by certain physical properties which indicate the value of the paint. During the first period little information of value is obtainable, but certain defects in manufacture or material may be indicated by such phenomena as flocculation, caking, or excessive settling. It is during the second period that the really valuable physical properties, such as the wetting power or adherence to the surface, ease of application, hiding power, color, uniformity, gloss, spreading rate, and rate of drying appear. In the final stage of the life of the paint the only factors considered are those which affect the permanence or stability of the film established as a result of the properties which appear and function during the second period. All of these properties are important, but few if any can be measured with any degree of accuracy, and most of the properties are tested by methods in which the personal equation is so large that reproducible results can not be obtained. Any study of the physical properties of paints necessarily must begin with a standardization of tests.

The Preparation of Paint Films. In view of the number and importance of the properties which first become evident at the time of application, it is obvious that this forms the logical starting point for any investigation. The physical properties which combine to determine the consistency or behavior of a paint at the time of application are of fundamental importance, but before any comparative study could be undertaken it was necessary to devise some reproducible method of preparing paint films. Flowing produces satisfactory results but unfortunately is limited to a few of the thinnest paints. The ordinary methods of brushing and spraying are unsatisfactory since the resulting films are never uniform and can be duplicated only by accident. Some mechanical means therefore must be employed and as a result of some promising preliminary experiments centrifugal force was adopted.

A number of circular glass plates furnished the standard surfaces to be covered with paint. These plates were each 25 cm. in diameter and approximately 1 cm. thick. The surfaces were ground flat and finished by fine grinding but were left unpolished, to furnish a surface to which the paints would adhere readily. In the earlier work steel plates were used but were later discarded, as the glass proved to be much easier to handle and to keep clean.

The apparatus employed consists of a vertical spindle rotated by a belt connected with a variable speed motor. To the upper end of the spindle is fastened a circular wooden block to support the glass plate. The plate is brought up to constant speed and an excess of paint, previously screened through a 200-mesh sieve to insure uniformity and freedom from skins, is poured on at the center of the plate. The paint flows out, covers the surface, and the excess is thrown off. The motor is then stopped and the plate removed and allowed to dry. After the paint is dry the film thickness is determined by means of an Ames dial gage, reading direct to 0.01 mm. and estimating to 0.001 mm.

At any given speed, the centrifugal force increases directly with the distance from the center of rotation. One would expect, therefore, that the resulting film would be thinnest at the circumference of the plate and would reach a maximum at the center. This is what usually occurs and the resulting film is generally pyramidal, although the pyramid does not extend uniformly over the entire surface. The film usually presents the appearance of a large, flat plane with a small, sharply defined pyramid at the center. The pyramidal film which is characteristic of most paint is not produced by varnishes nor by liquids such as linseed oil. These give flat films of uniform thickness across the entire surface, in spite of the fact that the centrifugal force varies widely at different points on the plate. A table accompanying the paper gave the film thickness measured at varying distances from the center. Raw linseed oil gave a film about 0.016 mm. thick, varnishes 0.024 mm. to 0.040 mm., enamels and oil paints 0.030 mm. to 0.085 mm.

Numerous experiments with varying amounts of paint led to the conclusion that the film thickness is independent of the amount of paint applied. An insufficient amount will cover only a portion of the surface while an excess will cover the entire surface and the excess be thrown off. The resulting films in both cases are of equal thickness at corresponding points, but for the sake of convenience it is advisable to use a slight excess to insure covering the entire surface.

At speeds of 200 r.p.m. or less many paints produce films too thick to dry properly. Too high speeds cause segregation of the pigment particles and in some extreme cases a tendency to disrupt the film has appeared. A speed of 300 r.p.m. seems to be the most generally satisfactory.

The film thickness is practically independent of the time of whirling after the first short interval of time has elapsed. Working with ordinary paints at a speed of 300 r.p.m., it was found that three minutes' whirling invariably provided a comfortable margin of safety beyond the time necessary to reach equilibrium.

The most satisfactory features of this method are the uniformity of the films produced and the ease and certainty with which they can be duplicated.

The Effect of Varying Composition on Paint Films. The next investigation was a study of the effect produced upon the life and behavior of a paint film by varying the proportions of pigment and oil in the film. For comparative purposes the films should be of equal thickness and the use of centrifugal force as previously described furnishes a convenient means for determining the film thickness which will result when any paint is spread under certain selected conditions. If several paints produce films of equal thickness when whirled at the same speed it may be assumed that those paints will produce comparable films when brushed out on test panels. The object sought was to produce a series of paints of varying oil-pigment ratios thinned with turpentine until they would spread or brush out to produce dry films of equal thickness.

Four pigments were selected for study:

(a) Basic carbonate white lead;
(b) Zinc oxide;
(c) 60 per cent basic carbonate white lead, 40 per cent zinc oxide;
(d) 60 per cent basic carbonate white lead, 30 per cent zinc oxide, 10 per cent asbestine.

Each pigment was ground to a paste with a normal amount of raw linseed oil. Each paste was divided into several weighed portions and varying amounts of oil were added to the different portions until the resulting series of semi-pastes or semi-paints represented a range of pigment content varying from 15 to 50 per cent by volume, the corresponding limits for the oil being 85 and 50 per cent by volume. Liquid drier was added to each semi-paint in the proportion of 5 cc. of drier to 95 cc. of oil.

Some one mixture had to be chosen as an arbitrary standard and that consisting of 25 per cent basic white lead and 75 per cent oil was adopted, since this mixture behaved well under the brush and produced a film of satisfactory appearance and properties. The other mixtures were thinned with turpentine until they produced the same film thickness when whirled at the same speed. The turpentine being volatile serves merely to increase temporarily the mobility of the paints and later evaporates.

The preparation of the paints resulted in some interesting observations. As expected, it was found that the thinning power of turpentine varies with the different pigments, but it was rather surprising to find a variable thinning power for any one pigment depending upon the composition of the vehicle already present, as appeared in the cases of the zinc oxide and mixed pigments. It is difficult to draw conclusions regarding the consistency of the paints from the data, since the thickness of the wet films will vary widely although the dry films are all of equal thickness. Nevertheless there is unmistakable evidence that the thinning power of turpentine not only varies with different pigments but also varies for any one pigment with the composition of the mixture being thinned.

Causes of Spotting with White Lead Paints. It is generally believed that a paint resulting from the thinning or breaking up of a basic carbonate white lead paste should be allowed to stand for a day or two before being used. The probable reason for the origin of this belief was found when a white lead-oil-turpentine paint was used immediately after mixing, flowing the paint on a clean glass plate to form a smooth wet film, in the course of a few minutes small pits appeared on the surface of the film and gradually increased in depth and diameter. The phenomenon appeared over and over and could not be ascribed to any fault in the preparation of the surfaces painted. The same result was obtained no matter whether the paint was applied to glass, steel, or to a previously dried coat of paint.

Summarizing the results of many experiments it appears that the spotting tendency:

(a) Is common to all mixtures of basic carbonate white lead and raw linseed oil;

(b) Does not appear when other pigments are substituted for the basic carbonate white lead;

(c) Does not appear when other oils are substituted for raw linseed oil;

(d) Is not due to too much stirring or to lack of stirring; presence or absence of liquid driers and volatile thinners; order of mixing; presence of free fatty acids, mineral acids, or water, although any or all of the foregoing factors may at times exert a modifying influence;

(e) May be explained upon the assumption of a reaction between the basic carbonate white lead and some unidentified portion of the oil;

(f) May be eliminated by boiling the oil in the presence of driers which may convert the troublesome component to an inactive form; by treating the raw oil with basic carbonate white lead during storage prior to its use; or by aging the paint to allow the reaction to reach completion before the paint is applied.

Accelerated Weathering of Paints

This report was submitted by Harley A. Nelson as a contribution from the research laboratory of the New Jersey Zinc Company.

The most universal weathering cycle responsible for the deterioration of exposed surfaces is light, moisture, and temperature variations. Other weathering agents, such as wind and abrasive dust, are more localized. This paper describes an effort to reproduce directly on typical surfaces, not only changes in some one physical property, but all of the more common paint failures that are observed on painted wood and metal structures. With this objective, it has been necessary to study and develop the most available artificial sources for light, moisture and temperature variations.

The apparatus used consisted of a wooden exposure tank, 6 ft. diameter and 4 ft. 9 in. high with an insulating air space and a galvanized iron lining. The cover is provided with an opening, which received a removable collar supporting a vertical quartz mercury arc of 30-in. effective lighting length. The test panels are supported by zinc nails on removable racks provided with sheet-zinc water drains. Water simulating a beating rain is provided by a revolving spray, and fine fog or mist by an atomizer. An ordinary variable-speed electric fan serves to cool the mercury arc and maintain a uniform temperature.

Any accelerated test on paints depends on radiation in the ultra-violet region of the spectrum. The most active rays have a wave length of about 3,000 Angstrom units. The mercury arc adopted as a source of light is used on 220-240 volts D. C. and normally draws 6 to 7 amperes when the atmosphere within the tank is kept at about 60 deg. C. (140 deg. F.) which is taken as representing summer heat.

Exposures are made at 28 in. from the light source. The panels are of selected white pine, or standard grade steel, 6 by 12 in., painted according to approved practice. An exposure tank of the size used will hold 75 panels. For warm seasons, the cycle most used has been: Light 24 hours (temperature 50 deg. to 60 deg. C.), cooling, followed by moisture 24 hours (temperature 5 deg. to 10 deg. C.). During cold weather 24-hour outdoor exposures have been added. Exposures have usually extended for periods of 60 to 90 days, with daily inspections.

Tests were made of paints containing various pigments, including zinc oxide, basic carbonated white lead, Lithopone, Titanox together with various mixtures.

Loss of gloss and formation of removable "chalk" follow in the order that these develop under normal outdoor exposure. Saturation of the film accelerates chalking under the ultra-violet light. "Checking," developing gradually into deep cracking and fine scaling, has not been reproduced. Cracking has been reproduced to a limited extent by periodic exposures to low temperatures. Lack of adherence is evidenced by blistering and peeling when the saturated panels are exposed to the heat of the quartz mercury arc (50 to 60 deg. C.).

The relative susceptibilities of paints containing Lithopone to light darkening and the relative tendencies of tinted or colored paints to fade and discolor under light and moisture, are revealed by exposure.

The test has been applied to paints applied on metal surfaces with as encouraging results as were obtained from painted boards.

While there are at present limitations which must be recognized there is apparently a general need for accelerated tests which will give the effects in a day which take a month under actual outdoor weathering.

The French Railways are, under a Ministerial decree, being equipped with cab signals whereby a whistle is blown when an engine passes over a ramp—called a crocodile—in the "four-foot" should the distant signal be at "danger." This is not automatic train control, as the brake is not interferred with. From a statement made recently by M. le Trocque, the Minister of Public Works, this work will very shortly be completed. He also said that all passenger carriages will soon be lighted by electricity.

Report on Firing Practice*

Mechanical firing on locomotives, like hand-firing, is subject to careless and extravagant practices. Correct supervision is as necessary here as in hand-firing. The successful and economical performance of a stoker depends, first, upon the proper condition of its parts, and, second, on proper operation (granting, of course, that the locomotive may be in proper condition). The things that constitute proper firebox conditions on hand-fired locomotives similarly apply to stoker-fired locomotives.

It should be understood that a mechanical stoker is in no sense automatic.

For economy in firing locomotives which are equipped with mechanical stokers, the committee recommends the following practices:

Before a fire is built in a locomotive, the distributing features of the stoker should be inspected and known to be in proper condition. The fire should be free from clinkers and banks when the locomotive is delivered to the engine crew.

The stoker should not be used in building up the fire, either by roundhouse force or engine crew. Build up the fire by using the hand shovel. Commence the operation of the stoker as soon after starting the train as conditions require.

The fire should be maintained with the hand shovel when standing, drifting or doing short switching.

Use shovel to build up spots in the firebed which may be thin or undersupplied by the stoker. In that way maintain a uniform distribution of coal over entire grate surface. Every square foot of burning surface requires coal.

Because of the thinness of the fire on stoker-fired locomotives greater care should be exercised when shaking the grates than is required on hand-fired locomotives. If practical, grates should be shaken only when the locomotive is not using steam.

Attention should be given coal as it feeds into conveyor; removing any foreign material which would tend to clog or interfere with the operation of the stoker.

Frequently observe the condition of the fire to know that it is properly maintained. Best results are obtained by continuous stoker operation, care being taken not to crowd the fire.

See that the locomotive, the fire and the firing apparatus are properly adjusted to produce the minimum amount of smoke.

When approaching grades the fire should be properly prepared, to meet the heavier demands. Do not wait until the train is on the grade before speeding up the stoker.

*Abstract of report to International Railway Fuel Association, Chicago Convention, May, 1922.

Before beginning a descending grade or before taking on coal the conveyor slides should be closed.

In case the stoker stops, due to clogging by foreign matter, the stoker throttle should be closed before any attempt is made to remove the obstruction. The fire should be maintained by hand until opportunity presents itself to remove the obstruction.

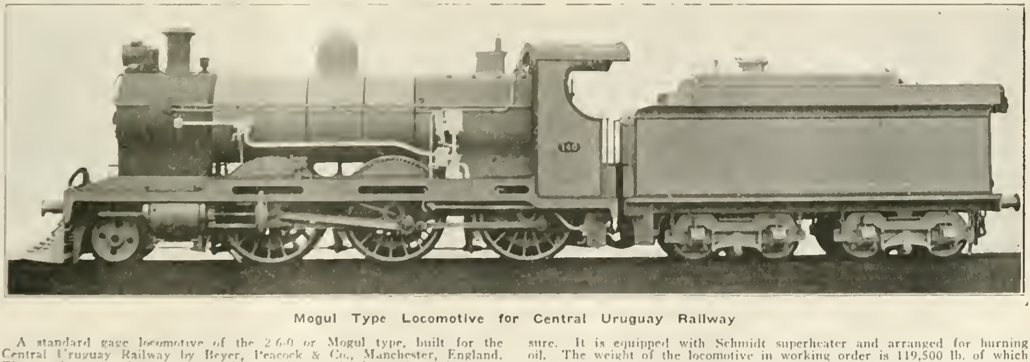
When approaching terminal, have all slide plates closed. This should be done at a sufficient distance so that without waste all coal may be worked out of conveyors. The engine crew should close all valves of stoker apparatus before leaving the locomotive.

To supervising officers who give attention to fuel, firing practice will always consist of two distinct things: first, the methods themselves for securing practical economy, and, second, the maintenance of those methods in practice. Proper methods are at hand. To develop in every-day routine the habitual use of those proper methods is the unending work of supervising officers.

Habitual clinkers and "banks" in a locomotive fire at terminals usually indicate improper firing, or improper engine handling if no mechanical defects exist. A supervising officer may select one of these extreme cases and proceed to improve the performance. A fair improvement, if permanently effected, could easily save five per cent in coal consumption. Now, since a freight crew burns approximately $15,000 to $20,000 worth of coal a year, the five per cent improvement would amount to $750 or more per case improved. If a supervisor did nothing else but improve five habitual "bankers," this alone would save $3,750, a sum which would go some distance toward paying his salary. But, who would work on only five cases a year? This illustration shows that lack of supervision means waste while well directed supervision means saving.

But it is not only the fireman who sometimes relaxes. Let us consider the engineer. Since the stoker is inanimate, an engineer may become indifferent, and perhaps his fireman too, though he may smile at his escape from a firing abuse that is now borne by a machine instead of by his back. With a locomotive equipped with a mechanical stoker the engineer may not now be able to overburden his fireman, but he is still able to "punish" the engine and the coal pile. Supervision can correct these faults.

The report is signed by M. A. Daly, chairman (Nor. Pac.); D. C. Buell (Railway Educational Bureau); M. Cavanaugh (C. St. P. M. & O.); B. F. Crolley (B. & O.); Chas. P. Dampman (P. & R.); J. W. Dodge (I. C.); J. C. Harris (Sou. Pac. Lines); L. R. Pyle (Locomotive Firebox Co.); F. P. Roesch (Standard Stoker Co.); A. N. Willsie (Locomotive Stoker Co.), and James Wilson.



Mogul Type Locomotive for Central Uruguay Railway

A standard gage locomotive of the 2-6-0 or Mogul type, built for the Central Uruguay Railway by Beyer, Peacock & Co., Manchester, England. The rated tractive force is 19,640 lb., cylinders 20 in. by 26 in. and driving wheels 72 in. diameter. The boiler is of the Belpaire type, 4 ft. 8 in. diameter of first ring outside, with steel firebox, and carries 160 lb. pressure. It is equipped with Schmidt superheater and arranged for burning oil. The weight of the locomotive in working order is 119,500 lb. of which 97,380 lb. are on the drivers. The tender has a capacity of 3,500 gal. of water and 1,560 gal. of fuel oil. The weight, loaded, is 101,300 lb. The trucks have 36½ in. wheels and a wheel base of 10 ft.

AIR BRAKE CORNER

Repairing Leaky Hose Fittings

Question.—I would appreciate it if you could furnish suggestions for repairing air hose fittings which have small sand holes in them.—J. C. G.

Answer.—Small leaks may sometimes be stopped by peening. In other cases it may be necessary to drill, tap and screw in a small brass plug. If the leakage occurs over a considerable area, as would probably be the case should it be due to shrinkage causing a porous spot, it would be best to scrap the piece as such a defect cannot be corrected with any assurance that it will remain tight.

Blow-Down Timing Port in ET Brake Valve

Question.—What is the function of the blow-down timing port in the automatic brake valve used with the ET equipment? Does it aid in overcoming leakage?—R. J. K.

Answer.—The blow-down timing port in the automatic brake valve is operative only in emergency applications. Its function is to bring about a higher emergency cylinder pressure and consequently a shorter stop than would result from the equalization between the pressure chamber and the application cylinder. The blow-down gives an action somewhat similar to that obtained from the high speed reducing valve used with older equipments. It was not incorporated in the valve to take care of leakage.

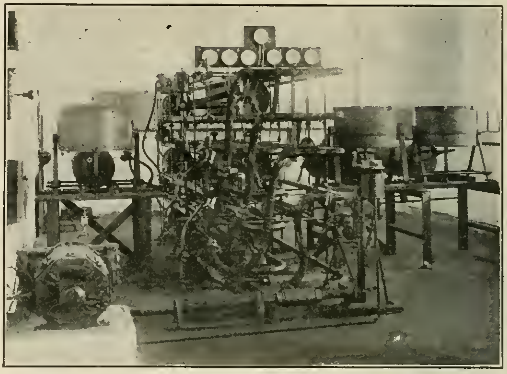
ET Brakes Leak Off

Question.—What is the cause of the following action noticed on a detached locomotive having the ET brake equipment? After the system had been fully charged the automatic brake valve was placed in service position and left there. The driver and tender brakes applied and the gage showed 50 lb. brake cylinder pressure—the initial brake pipe pressure having been 70 lb.—but the brake cylinder pressure soon began to drop.—R. J. K.

Answer.—The driver brakes will not leak off quickly unless the equipment is in poor condition and such action will not take place under average or ordinary conditions. The action noted is due to leakage from the piping or connections to the application chamber or to leakage back through the graduation or equalizing slide valve of the distributing valve. Use a soap suds test to determine the point of leakage.

Test and Demonstration Rack for Vacuum Brakes

The Consolidated Brake & Engineering Company has in use at its works at Slough, England, a six-car test and demonstration rack of the vacuum brake equipment as applied to electrically operated trains, such as those on the London District Railway. This is a two-line system with a brake pipe and a reservoir or release pipe. The vacuum is created by a motor-driven exhauster, a vacuum of 20 in. of mercury being maintained in the brake pipe, brake cylinder and reservoir and 26 in. in the releasing reservoir and communicating release pipe. The apparatus for a car in addition to brake cylinders, reservoirs, ball valves, driver's brake valves and guard's emergency valve includes a vacuum governor, rapid action application valves and release valve.

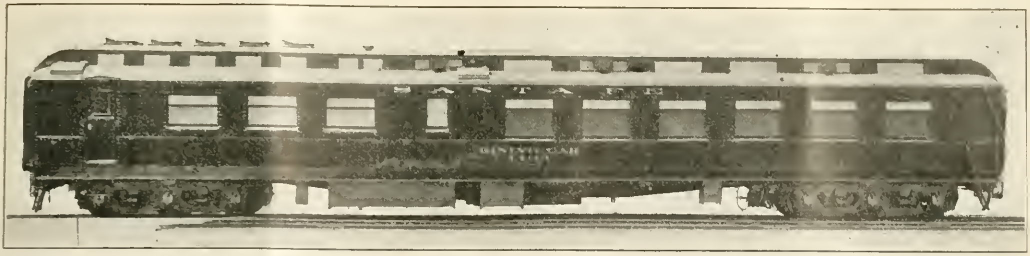


Test Rack for Vacuum Brakes on Electrically Operated Equipment

On brake equipment for such service it is necessary not only to provide for quick application, but also for a quick release and recharge. With the apparatus used a release after a service application can be made in 3½ sec. to 5 sec. and after an emergency application, in 7 sec. to 9 sec. On the London District Railway the average stopping time during slack hours is 12 sec. to 15 sec., and from 25 sec. to 45 sec. during the rush hours when a large number of passengers are handled. There is thus no delay due to the time required to release and recharge the brakes, the time required being less than the stopping time.

Eight-Wheel Switchers on the Kentucky & Indiana Terminal

Five new locomotives enabled the Kentucky & Indiana Terminal to handle the largest number of cars in their history without an embargo for the past three years. These locomotives are of 49,700 lb. tractive effort, weigh 208,700 lb. on drivers, have 24 in. by 28 in. cylinders, 51 in. driving wheels, 2,443 sq. ft. heating surface, 41.7 sq. ft. grate area and carry 185 lb. boiler pressure.



Santa Fe Dining Car from the Kitchen Side

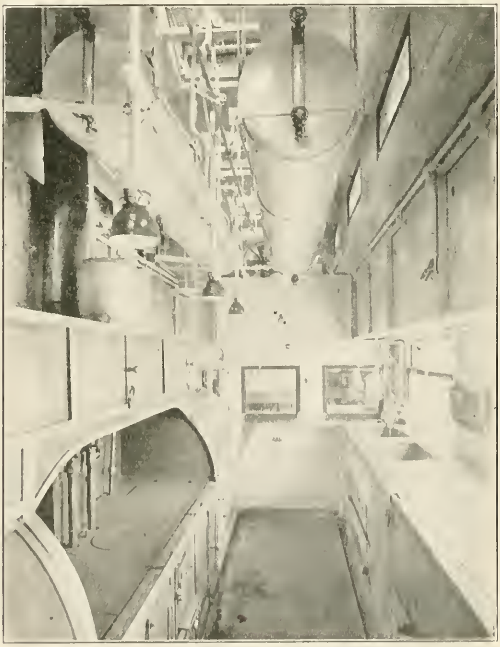
Santa Fe Acquires Eight All Steel Dining Cars

Length Over End Sills is 80 ft. 6 in. and Total Weight 171,000 lb.; Dining Room 38 ft. 8 in. Long Seats 36

THE Atchison, Topeka & Santa Fe has recently received from the Pullman Company eight all steel dining cars. The cars are without vestibules, are 80 ft. 6 in. long over the end sills and weigh 171,000 lb. The dining rooms are 38 ft. 8 in. long and have a seating capacity of 36 at six single and six double tables. The tables are spaced 6 ft. 5 in. apart from center to center, which is 2 in. greater than the spacing on the older diners of this road.

Essentially the design of these cars is the same as that of the other all steel equipment of the Santa Fe, the first of which was built in 1914.* The underframe is designed to carry the load and consists of fish-belly center sills built up of plates and angles, channel side sills, and bolsters and cross bearers built up of channel pressings and cover plates. One of the principal differences in the design of the present cars is the use of structural channel sections for the side sills replacing the built-up sections employed in the first steel coaches. The body frame members are largely of pressed steel. The corner posts and side plates are rolled Z-sections, with the balance of the side posts and cripples of pressed Z shapes. The belt rail is a continuous piece of 4-

Daylight View of the Dining Room

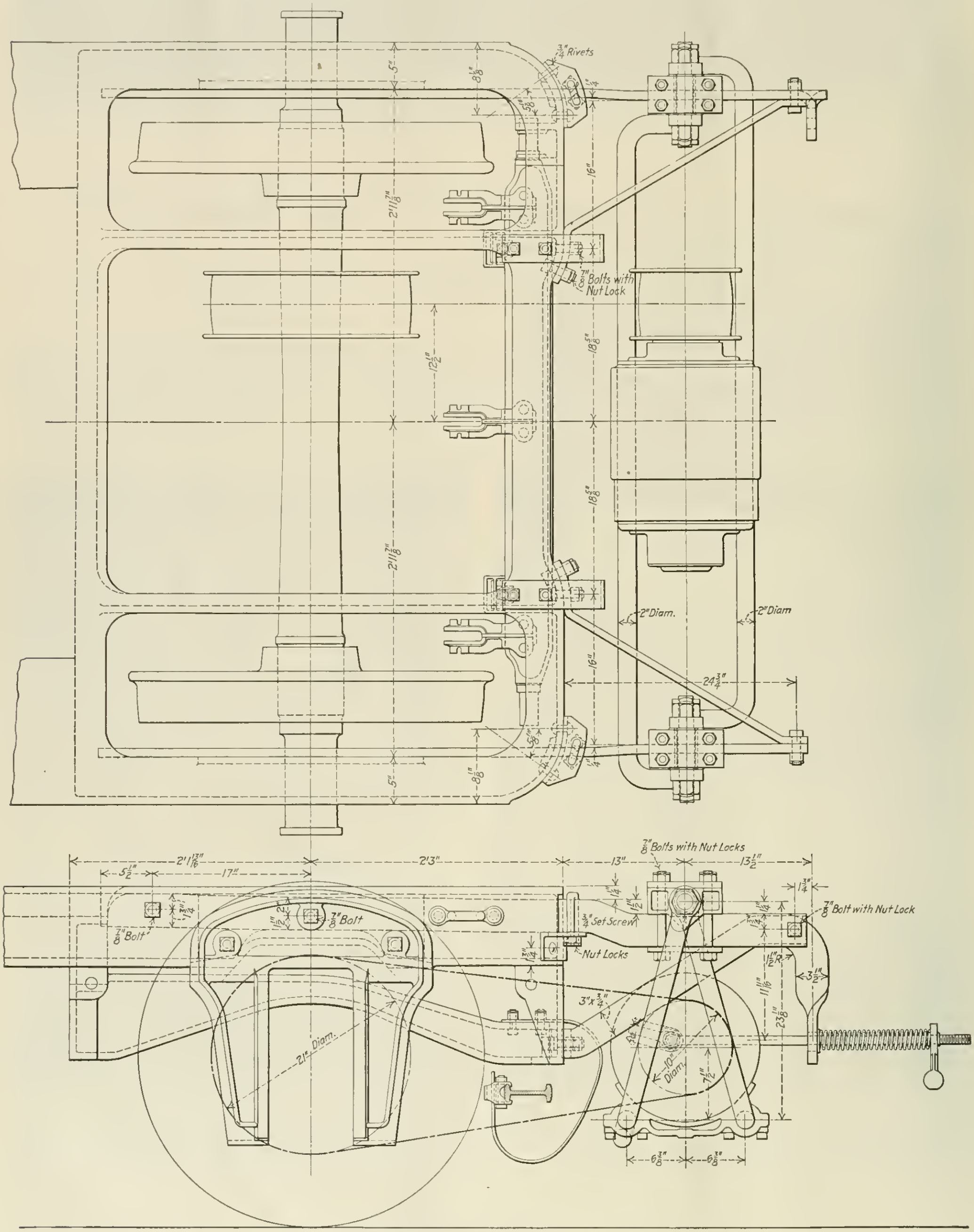


The Kitchen, Looking Toward the Pantry

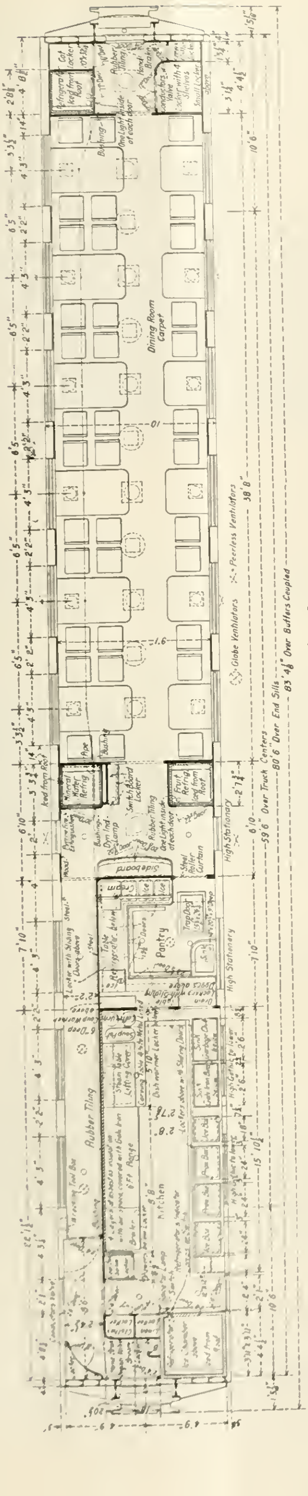
* See the *Railway Age Gazette*, Mechanical Edition, for January, 1915, page 21.

in. by 1½-in. rectangular section, with pressed Z-section window sills, the deck sill a special angle pressing with long horizontal flange and the deck plate and carlines of pressed channel section, the latter with closed ends. The sides of the cars are sheathed with ⅛-in. steel sheets.

The entire car body is insulated with a ½-in. layer of Insulite applied between the posts and carlines against the outside sheathing and roof sheets. The underframe is covered throughout with a floor of No. 16 galvanized steel, which is coated on both sides with Lucas car roof cement.



Truck Suspension for Car Lighting Generator



Floor Plan of Santa Fe Dining Cars

On this is laid the Insulite, the top of which is covered with a heavy coat of petroleum asphalt, mopped on hot. The floor is then laid on transverse nailing strips of yellow pine. The dining room floor consists of a single thickness of 7/8-in. tongued and grooved yellow pine flooring. A double floor of the same material is laid in the kitchen while the single wood floor in the corridor is covered with Flexolith and surfaced with 1/4-in. rubber tiling. The thickness of the nailing strips in the kitchen and corridor is reduced so that the surface of the floor is flush throughout the car. The kitchen floor is surfaced with sheet copper with all joints and nail heads soldered.

The interior finish of the dining room is of wood throughout and is built up of five-ply veneer Mexican mahogany. At all bearings, both on the sides and ceiling, the wood is backed with heavy canton flannel to prevent creaking. The steel interior finish in the kitchen, pantry and hallway is of 1-16-in. sheet steel, and is backed with one course of No. 12 fireproof duck secured to the sheets with glue.

The arrangement of facilities in the car is clearly shown on the floor plan drawing. There are four refrigerators iced from the roof, the largest one located in the kitchen at the end of the car. Two of the others are located against the partitions at the kitchen end of the dining room, one on either side of the car, and the third against one of the partitions at the opposite end of the dining room. In addition to ice boxes in the kitchen and pantry, a large ice box for meat storage is located under the car, to which access is had through a trap door in the pantry floor.

Side doors with 2-ft. 1-in. openings are located on either side of the car 4 ft. 4 1/2 in. back from the end. The door from the corridor into the kitchen is directly in line with these doors. The outside door on the kitchen side is in two sections arranged so that the upper section may be opened independently of the lower.

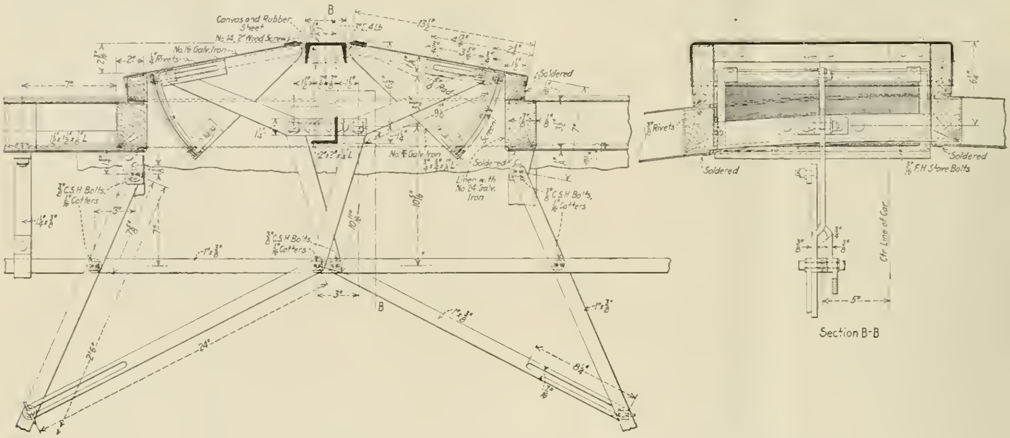
Power for the electric lights and fans is provided by the U. S. L. axle light system, with truck suspended generator. This truck suspension, which is of Santa Fe design, is shown in one of the drawings. It has few wearing parts and its strength and the security with which it is attached to the truck are attested by the fact that no failure resulting in the loss of a generator has ever been reported. The cradle is of triangular form and is suspended by a single hanger pin at each end. The suspension is secured to the truck frame by two 3 1/2-in. by 1-in. steel bars passing through cored openings in the ends of the truck frame and bolted to the inside face of the side rails. Where these bars emerge from the frame openings they are secured by clamps to angle brackets riveted to the frame casting. The inner ends of the bars bear upward against the flange of a frame cross member, thus relieving the bolts of shear. The suspension bars are braced laterally against the truck frame end rails.

The dining room is lighted by six center fixtures and six fixtures in the ceiling of each lower deck. Safety lamp fixtures are used throughout; those in the center are enclosed in 12-in. bowls and those on the side in 8-in. bowls. Five ceiling fans, of the revolving shutter type, are placed between the ceiling lamps.

The cars are heated by the Vapor Car Heating Company's thermostatically controlled vapor system and three types of ventilators are used. The dining room is served by four Peerless ventilators opening through the deck sash, and two of these ventilators are also located about the hall between the dining room and pantry. Globe ventilators are placed in the roof above the corridor and the pantry, two in the corridor and one in the pantry.

Five adjustable ventilator hatches with hinged covers of the type shown in one of the drawings, operating as a unit, are placed in the center of the roof over the kitchen. The hatch openings are 16 in. wide and when the covers are fully raised, each provides a direct screen covered outlet of about 77 sq. in. at either end. The hatch covers of each ventilator are hinged transversely at the center and are operated separately, depending on the direction in which the car is running.

The cars are carried on six-wheel cast steel trucks, located 59 ft. 6-in. apart, center to center, with 5½-in. by 10-in. journals and a wheel base of 11 ft. They are fitted with Barber roller center plates and side bearings, and Simplex clasp brake rigging. The airbrake equipment is of the Westinghouse UC type providing at 60 lb. cylinder pressure a braking power of 90 per cent.

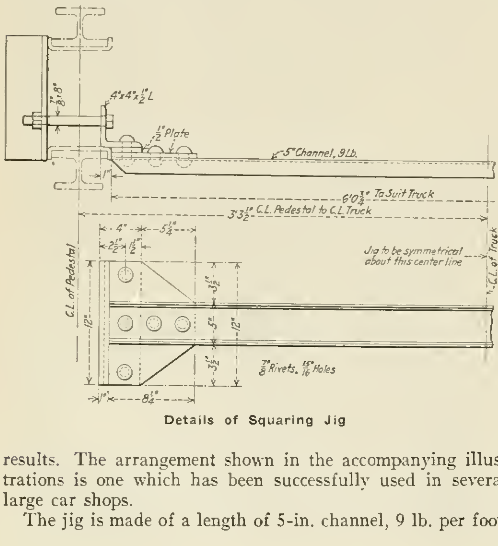


Fine Ventilators of This Type are Placed in the Roof Over the Kitchen

Squaring Jig for Car Trucks

By E. A. Miller

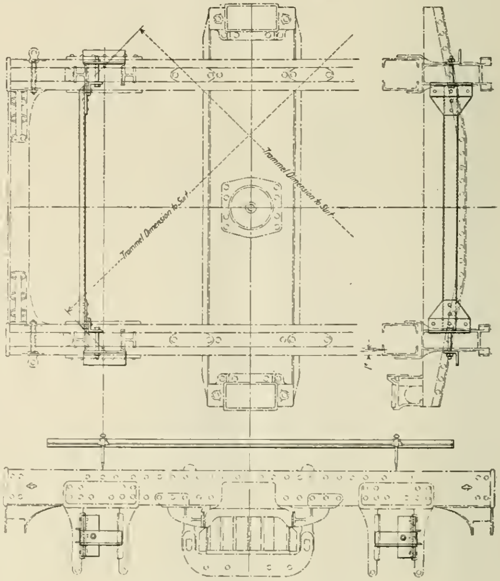
In erecting passenger car trucks it is essential that the side frames be lined up square so that the pedestal jaws are in the correct position. As this is an important job and often takes considerable time, several devices have been designed on different roads to facilitate the work and secure accurate results. The arrangement shown in the accompanying illustrations is one which has been successfully used in several large car shops.



Details of Squaring Jig

The jig is made of a length of 5-in. channel, 9 lb. per foot, having two pieces of ½-in. plate and a 4 in. by 4 in. by ½ in. angle riveted to each end as shown in the detail drawing. It is clamped at the ends by a ⅞-in. bolt and a piece of 4 in. by 4 in. by ½ in. angle which sets across the pedestal legs. Two jigs are required for a four-wheel truck. The length can be arranged to suit the design of truck and pedestals.

These jigs are used in building new trucks or in repairing old ones when the end rail is to be renewed or reriveted, being applied to the pedestals and loosely bolted as shown in the large drawing. The frames should then be pulled square by means of chains with turnbuckles across diagonal corners, making the trammel distances across the opposite corners equal.

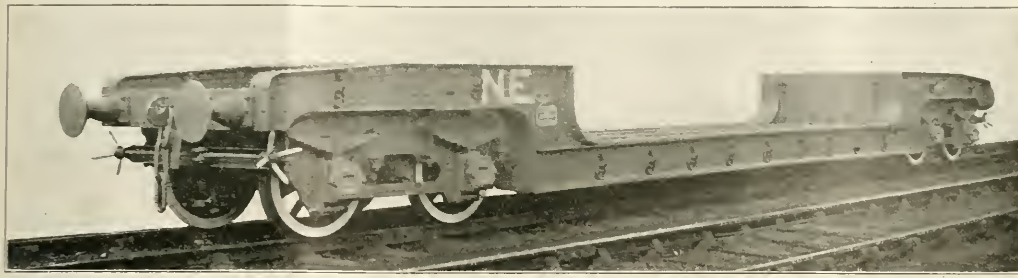


Application of Jigs to a Truck

After the frames have been pulled square and the bolts in the end of the jig tightened up, the rivet holes in the end rail connections should be reamed true and the frames riveted.

Some British Well Cars

SPECIAL forms of freight cars are much more frequently employed in Great Britain than in this country. Of such cars those of the well or gap type are often used to transport heavy or bulky machinery. The accompanying photographs show three forms of well cars built by Stableford & Co., Coalville, for the North Eastern Railway, according to designs of Sir Vincent L. Raven, chief mechanical engineer of the road.



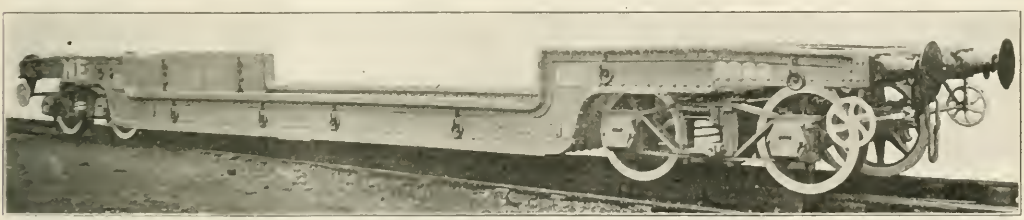
50 Ton Car with 25 Ft. Well

The 50-ton car is 48 ft. 8 in. long over the end sills, 7 ft. 9 in. wide and has a well 25 ft. long. The height when unloaded is 4 ft. 8 in. at the truck and 2 ft. 2 in. at the center. The side sills are built up of two 5/8-in. plates with 3½ in. by 3½ in. 11 lb. angles at the top and bottom with 12 in. by ½ in. cover plates. The two intermediate sills are composed of one 5/8-in. plate with 3½ in. by 3½ in 11-lb. angles at top and bottom on both sides and 8 in. by ½ in. cover plates. In the well portion all sills are built up of two 15 in. by 4 in. 42 lb. channels with 12 in. by ½ in. cover plates. The trucks are of unusual design and have both outside and inside bearings, the former being 5 in. by 10 in. and the latter 5½ in. by 10 in. Semi-elliptic springs are used on both the outside and inside journal boxes. The wheels are steel tired, 37 in. in diameter, the wheel base 5 ft. and the distance between centers of trucks 38 ft. 6 in. The drawgear pulls on three 9½-in. diameter, India-rubber springs back of the end sil]; the side buffers also contain India-rubber springs. Screw type hand brakes, for each truck separately, can be operated from the ground by the hand wheels shown near the car ends.

The 40-ton car with a 34 ft. 6 in. well is 55 ft. 6 in. long over end sills, 8 ft. wide and 45 ft. 6 in. between centers of truck. The height at trucks is 4 ft. 0¾ in. and 2 ft. 4¾ in. at the center. The side sills are built up of two 15 in. by 4 in. 42 lb. channels and 12 in. by ¾ in. plates at top and bottom. There are no intermediate sills, the side sills being joined by two fixed and nine adjustable cross bars formed of 5 in. by 5 in. 24 lb. I-beams. The trucks are of the diamond arch bar type with 33-in. steel tired wheels and 5 ft. 6 in. wheel base. The journals are 5 in. by 10 in. The drawgear pulls on the body bolsters through India-rubber springs composed of two sets of four each.

40 Ton Car with 34 Ft. 6 In. Well

The 40-ton car with a 25 ft. well is 46 ft. long over end sills and 8 ft. 4 in. wide. The height at the trucks is 4 ft. 1⅛ in. and 2 ft. 6 in. at the center. The frame is constructed of ¾-in. plates stiffened by 4 in. by 3 in. 13½-lb. angles and 7 in. by ¾ in. plates at top and bottom. The trucks, which are spaced on 36-ft. centers, the draft gear and many details are the same as on the longer 40-ton car.



40 Ton Car with 25 Ft. Well

Recent Decisions of the Arbitration Committee

(The Arbitration Committee of the A.R.A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Requirements of Class E, Rule 112

New York, Chicago & St. Louis cars No. 5784 and No. 7426 were destroyed on the Philadelphia & Reading February 6, 1921. The owner furnished an appraisal to the latter road under Class E, Rule 112. The Philadelphia & Reading contended that the cars should be appraised under Class F. The cars had metal draft sills weighing 34.4 lb. per ft., which were not fitted with continuous cover plates. The third paragraph under Class E, specifies not less than 8 in. continuous metal draft members of not less than 18 lb. per ft. per member, securely fastened to wood center sills of not less than 4-in. by 8-in. sections. On these cars the 34.4-lb. sills replaced the wood center sills and were not directly attached to the remaining wood sills. The New York, Chicago & St. Louis contended that, since the metal sills had 6-5/16-in. flanges with lateral supports well within the maximum of 20 times the width of the flange and extra wide bottom tie plates between the lateral supports, the metal sills were in effect securely fastened to wood sills of greater than the required section and would not buckle between supports under fair usage.

The Arbitration Committee decided that as the construction of the cars did not conform to any of the preceding classes in the table under Rule 112, the settlement should be made under Class F, as stated in note 1 under the rule.—*Case No.* 1217, *N. Y. C. & St. L. vs. P. & R.*

Kicking Cars Without Rider Protection a Handling Line Risk

Atlanta, Birmingham & Atlantic flat car No. 5404 was broken in two in a repair yard of the Indiana Harbor Belt when four cars were kicked against the string in which it was standing, on November 11, 1920. The car was old and the broken sills were decayed. The Indiana Harbor Belt claimed that the car was damaged in ordinary switching. The Atlanta, Birmingham & Atlantic contended that the kicking of cars in switching movement caused "impact other than that occurring in regular switching" and that the handling line was responsible because no rider protection was provided when the damage occurred.

The Arbitration Committee sustained the contention of the car owner.—*Case No.* 1224, *Indiana Harbor Belt vs. Atlanta, Birmingham & Atlantic.*

Responsibility for Damage to Car Under Footnote to Rule 43

Norfolk & Western car No. 19234 was found in damaged condition in the Madison, Ill., yard of the St. Louis Merchants' Bridge Terminal Railway on March 5, 1921. The Norfolk & Western was requested to furnish disposition for the car under Rule 120, but the car owners declined to authorize disposition until the Terminal Railway had furnished a statement showing the manner in which the damage to the car occurred, according to the intent of the footnote under Rule 43. The Terminal Railway Association was unable to furnish definite information as to the circumstances under which the damage occurred, other than the fact that the car was found in a damaged condition between two other cars, neither of which showed evidence of damage or rough handling.

The Arbitration Committee decided that the note under Rule 43 requires the handling line to submit a report showing the circumstances under which damage to the extent testified occurred, if it is claimed to have been under conditions of ordinary handling. As the St. Louis Merchants' Bridge Terminal Railway is unable to furnish this information it must assume responsibility.—*Case No.* 1219, *Norfolk & Western vs. St. Louis Merchants' Bridge Terminal.*

Responsibility for Missing and Damaged Parts of Car Body

Gulf & Ship Island gondola car No. 748 was offered to the owner in interchange by the Mississippi Central on November 26, 1920. The car inspector for the Gulf & Ship Island refused the car because of a number of missing side and end planks and side stakes. The Mississippi Central refused to issue a defect card and made the repairs in its own yard. Bill for the repairs was refused by the owner on the ground that the delivering line was responsible under interpretation No. 6, Rule 32, known theft of parts of car on the handling line. The Mississippi Central received the car in interchange properly side carded for bad order home movement, and claimed that the car was a converted flat car, the side stakes of which were not bolted to the sills and the planks spiked to the stakes.

The Arbitration Committee decided that there was no evidence of unfair usage under Rule 32, the owner accordingly being responsible for the repairs.—*Case No.* 1227, *Mississippi Central vs. Gulf & Ship Island.*

Incorrect Inspection Report Given Car Owner Under Rule 120

Gulf & Ship Island flat car No. 1092, was removed from service for heavy repairs at the Albuquerque, New Mexico, shop of the Atchison, Topeka & Santa Fe on December 14, 1920. On receipt of inspection report and request for disposition under Rule 120 the owner authorized the Santa Fe to load this car on another and ship it home, freight collect, rendering a bill for the cost of loading. When the car reached home the owner had a joint inspection made which indicated the need for considerably less work than that shown on the original inspection report rendered by the Santa Fe. Later, another joint inspection by a representative of the Santa Fe and of the car owner again disclosed that a number of parts reported defective on the original inspection were in sufficiently good condition not to require renewal. The Gulf & Ship Island claimed that the bill for loading the car should be cancelled and that the Santa Fe should pay the freight charges for the shipment of the car from Albuquerque, New Mexico, to Gulfport, Miss. The Atchison, Topeka & Santa Fe claimed that, since the Gulf & Ship Island did not avail itself of an opportunity for a joint inspection before shipment of the car, and that, since Rule 120 provides for no other course than to dismantle or repair, making the loading and shipment of the car a matter of accomodation to the car owner, the latter should assume the responsibility for the loading and transportation charges.

The Arbitration Committee decided that, since the joint inspections indicated an incorrect original inspection report, the Santa Fe cancel its bill for cost of loading and pay the freight charges.—*Case No.* 1222, *Gulf & Ship Island vs. Atchison, Topeka & Santa Fe.*

Denver & Rio Grande Western 70-Ton General Service Gondola Car

70-Ton D. & R. G. W. General Service Gondola Car

High Capacity Car of Unusual Design Adopted by a Western Road for Miscellaneous Bulk Freight

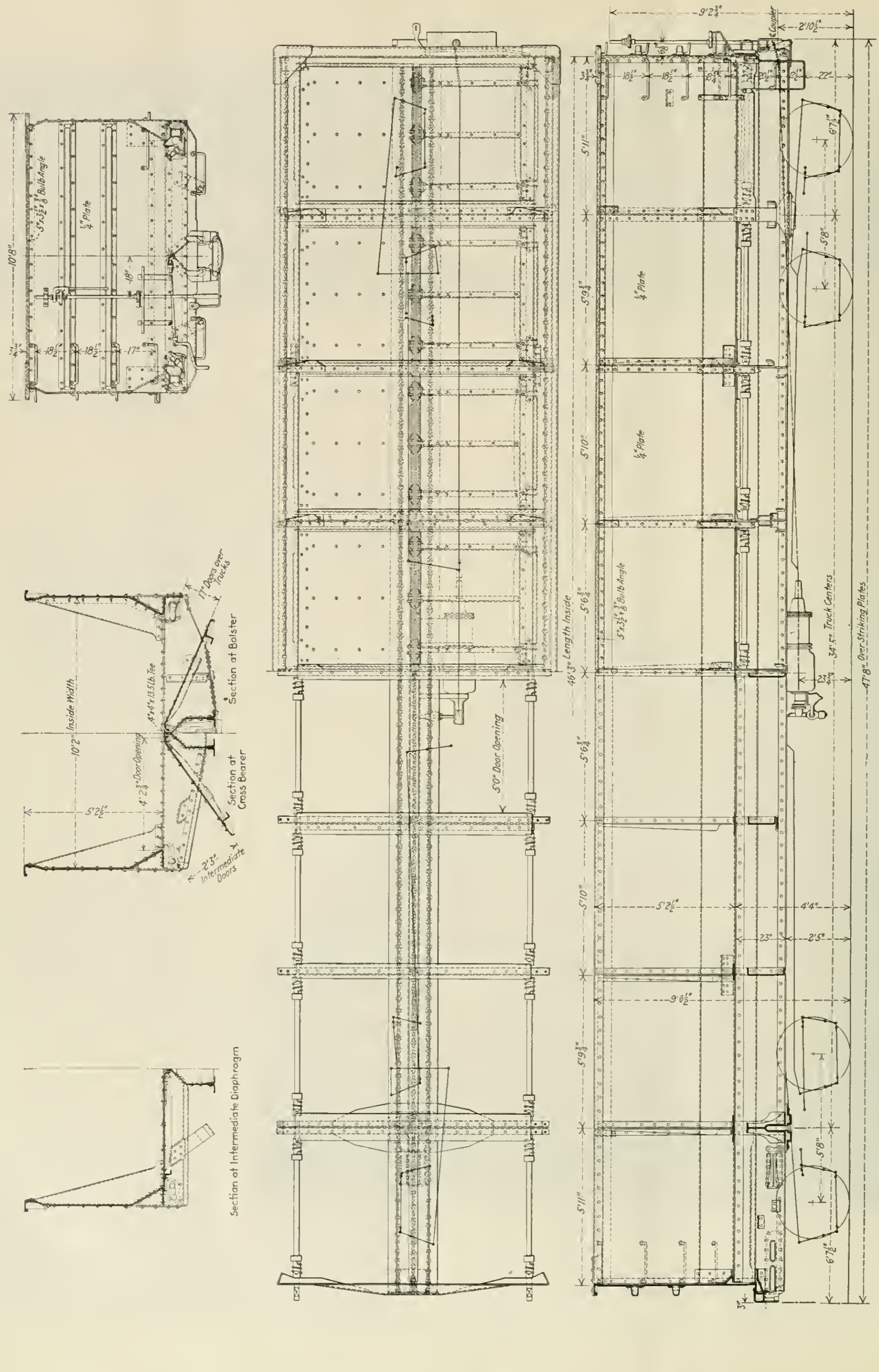
THE Denver & Rio Grande Western has recently received from the Hegewisch plant of the Pressed Steel Car Company 700 gondola cars which are of more than ordinary interest as they are of a larger capacity than has been used hitherto on any Western road, are of a relatively low light weight in proportion to the load carried and embody features of design which make the car suitable for handling various kinds of bulk freight. The cars primarily are intended for transporting coal but can be used for ore, coke, lumber or any kind of freight that can be handled in open top cars of either the drop or solid bottom types. There are 16 drop doors with large openings and side discharge. When the doors are closed the bottom is level and smooth. Provision is also made for temporary side stakes and racks should they be required for light materials. The length inside is 46 ft. 3 in., the width 10 ft. 2 in., and the depth from top of sides to floor 5 ft. 2½ in., which gives 2,400 cu. ft. capacity. The height from the top of the rail to the top of the car side has been kept quite low, being only 9 ft. 6½ in.

Interior of Car Showing Gussets, Doors in Open Position

Construction of Underframe

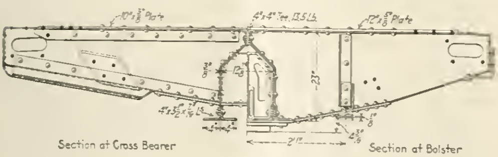
The center sill is of the A-frame type, 23 in. deep, composed of two ⅜-in. web plates spaced 12⅞ in. apart at the bottom and brought together at the top with a rolled 4 in. by 4 in., 13.5-lb. tee riveted between. The bottom edge of each web plate is reinforced with two 4 in. by 3½ in. by 7/16 in. angles. The center sills have an area and ratio of stress to end load 15 per cent in excess of the present A. R. A. recommendations, the center sill area being 34½ sq. in. and the ratio .0425. The sills are continuous from end to end and are heavily reinforced at the end with a steel striking casting for the coupler horn.

The body bolsters are built up with the underframe, each being formed of four pressed steel plates ¼ in. thick with wide flanges placed back to back and a cast-steel center



Side Elevation, Plan, End View and Sections of Denver & Rio Grande Western 70-Ton Gondola Car brace between the center sills. The bolster is reinforced by a 12 in. by 5/8 in. cover plate on the top and a 3/8 in. plate, 23 in. wide on the bottom to which the cast steel center plate is attached. The side bearings are spaced 4 ft. 2 in. between centers and consist of hardened steel plates, a clearance of 1/8 in. being allowed between the side bearings on the body bolster and those on the truck. Jacking plates are riveted to the outer ends of the bolsters. The construction of the bolster is shown in the drawing below.

Pressed steel shapes, 1/4 in. thick, also are used for the two cross-bearers and the intermediate and center diaphragms as well as for the short diaphragms placed between the center sills. The crossbearers are reinforced by a 10 in. by 3/8

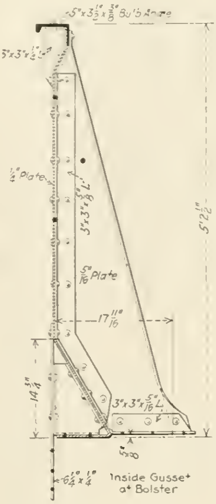


Sections at Cross Bearer and Bolster

in. cover plate and a 3 in. by 3 in. by 1/4 in. angle at the top and a 6 in. by 7/16 in. plate and a 3 in. by 2 1/2 in. by 1/4 in. angle at the bottom. The three diaphragms, at the center and between the bolsters and side bearers, have 7 in. by 3/8 in. cover plates.

Side and End Construction

The side is of a particularly rigid construction. The 1/4 in. plates are reinforced at the top with a 5 in. by 3 1/2 in. by 3/8 in. bulb angle, and the top of the side is set in, which, in conjunction with the bulb angle, forms a box construction, adding stiffness to this part of the car. It will be noted from the illustrations that there are no outside stakes, the side being braced vertically on the inside with gusset plates located at each of the cross members of the car. The gusset plates are flanged on the inside vertical edge to form a flat bearing surface for long materials. The bottom of the side is sloped in to the edge of the door and then bent back in a horizontal plane to make this part of the car self-clearing and to add stiffness. With this construction it is possible to obtain the required cubic capacity with the least height and length of car as the side sheets can be brought out to the clearance line. The gussets are provided with holes for the attachment of temporary inside stakes for securing racks when light material is carried.

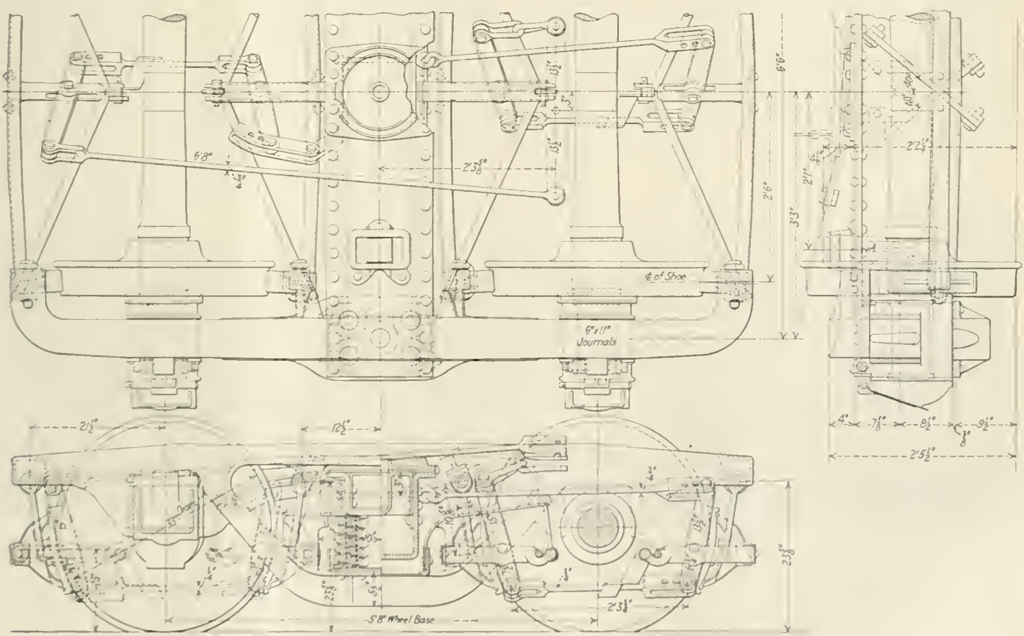


Inside Gusset at Bolster

The end is thoroughly braced by 5 in. by 3 1/2 in. by 3/8 in. bulb angle at the top and two horizontal U-shape braces extending from side to side of the car and is also provided with an inside slope sheet at the bottom to make this part of the car self-clearing and to increase the strength.

Doors and Operating Mechanism

The door openings are 5 ft. wide and 4 ft. 2 3/4 in. from the center sill to the sloping side sheet, thus forming practically



General Drawing of Four-Wheel Truck with Clasp Brake the entire floor area. The discharge opening of the eight doors in the center portion of the car is 2 ft. 3 in. and of the eight doors over the trucks, 17 in. The discharge area is thus 146.7 sq. ft. The doors are hinged to the center sills and when dropped form a ridge sloping from the center of the car to both sides, thus providing for the discharge of the lading to both sides and clear of the track. A slight elevation of the track is sufficient to provide complete clearance of the lading, such as coal, ballast, sand or similar material so that the car can be dumped quickly and moved away without further work.

The door operating mechanism is of the Lindstrom-Streib design. This provides for the support of the doors by the operating shafts which run longitudinally through the car on either side. These shafts are connected by two ordinary chains to each door. The operation of opening the doors is simple and consists merely of rolling the shaft out from under them, which is done by means of the operating socket located at the corner of the car with the use of a crowbar or piece of pipe, thus allowing the doors to drop and discharge the lading. Heavy supports or stops are provided in the underframe which absorb the shock from the dropping of the doors when opened, and support them in the proper position while the lading is being discharged. The doors are closed by revolving the shaft in the opposite direction, the chains winding on worms attached to the shaft raising the doors until they are in the closed position, when by continued turning of the shaft it rolls under the doors and supports them directly, relieving the chains of all strains. At no time is there any load on the door chains, except the weight of the doors while they are being closed. The operating socket, located at the corner of the car, is absolutely "fool-proof," it being impossible to transmit any of the force of the dropping load to the operator while dumping the car.

CAPACITY, DIMENSIONS, WEIGHTS AND PROPORTIONS

Capacity:	
Stencilled, nominal	140,000 lb.
With 10 per cent overload	154,000 lb.
Cubic capacity, level	2,400 cu. ft.
Dimensions:	
Length over striking plates	47 ft. 8 in.
Coupled length	50 ft. 2 in.
Truck centers	34 ft. 5 in.
Truck wheelbase	5 ft. 8 in.
Height, rail to top of car side	9 ft. 6½ in.
Height, rail to top of floor	4 ft. 4 in.
Height, rail to center plate bearing	2 ft. 2⅜ in.
Height, rail to underside body side bearing	2 ft. 6 9/16 in.
Length, inside	46 ft. 3 in.
Width, inside	10 ft. 2 in.
Depth, inside	5 ft. 2½ in.
Width, outside, extreme	10 ft. 8 in.
Weights:	
Light weight of car	55,500 lb.
Loaded with 10 per cent overload	209,500 lb.
Proportions:	
Weight loaded per foot coupled length	4,175 lb.
Rail load per axle, loaded	52,375 lb.
Per cent revenue load of total weight	73.5

To resist abuse to which the doors are often subjected in loading they are made of ¼-in. pressed steel plates, rigidly braced with three 3 in. by 2½ in. by ¼ in. angles and one 4 in., 8.2 lb. Z-bar and hinged to the center sills with heavy steel hinges and cast steel hinge butts. To meet the railroad company's requirements the doors are fitted up tight in order to retain fine coal and very fine ore.

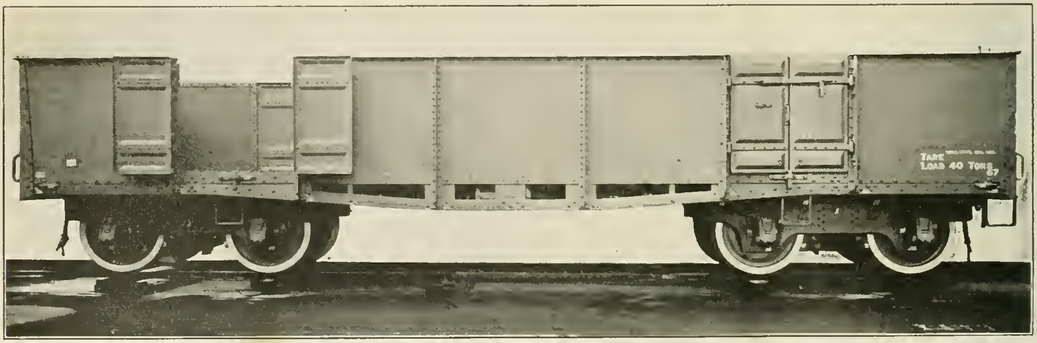
Four-Wheel Trucks Equipped with Clasp Brakes

The four-wheel trucks have a wheel base of 5 ft. 8 in., rolled steel wheels, and 6 in. by 11 in. journals. The cast steel side frames are of the Vulcan-Floyd type made by the American Steel Foundries. The truck bolsters are of the pressed steel bath-tub type made by the Pressed Steel Car Company, as are also the brake beams. The trucks are equipped with drop forged center plates and Stucki roller side bearings.

As there are severe grades on portions of the road, particular attention has been given to the brake rigging. Instead of using the single brake which is practically universal for freight equipment, a clasp brake has been adopted. Brake beams of the A. R. A. No. 2 plus design are used for both the inside and outside brakes. They are suspended from extensions cast on the side frames by 1 in. hangers with forged eyes. The outside brake beams are retained in place by a third point support resting on the bottom brake rod and the inner beams by a spring attached to the spring plank.

The brakes are operated by the Westinghouse Air Brake Company's equipment, KC-1012, with 10-20 lb. retainers, and the hand brakes by the Perfection brake ratchet device. The braking power is 80 per cent of the light weight of the car based on 60 lb. cylinder pressure. All parts, however, are designed of sufficient strength to withstand a brake cylinder pressure of 80 lb.

Among other specialties used are type D couplers, Miner A-18-S friction draft gear, Farlow attachments and Imperial centering and uncoupling device.



40 Ton Coal Cars for the Chinese Government Railways

The Pekin-Mukden Line of the Chinese Government Railways has received recently from the Metropolitan Carriage, Wagon & Finance Company, Birmingham, England, several hundred gondola coal cars of 40 tons capacity. These cars are built of mild steel throughout with the exception of the underframes which are of Sandberg's high resistance steel—80,000 lb. to 90,000 lb. tensile strength—which made it possible to dispense with trussing and saved considerable dead weight. As the light weight is only 38,000 lb. the revenue load is 70 per cent. of the total, a good figure considering the size of the wheels.

These cars are 38 ft. long inside, 9 ft. 5 in. wide and 4 ft. 6 in. high, giving a capacity of 1,610 cu. ft. or 40 long tons. Two pressed steel side doors are provided on each side. The trucks are of the pressed steel type with 42½ in. steel-tired disc wheels, the truck wheel base being 6 ft. and the distance between centers of trucks 26 ft. The journals are 5 in. by 10 in. Semi-elliptic springs are mounted over the journal boxes.

The couplers are of the Janney automatic type that are fitted with India rubber springs. A hand brake of the screw type with shoes on all wheels can be operated from the end. Power brakes are not used.

Periodical Repacking of Journal Boxes

A Plea for Observance of the 12 Months' Requirement Removed from the Interchange Rules in 1921

By E. W. Hartough

THERE are very few roads that at some time have not had an epidemic of hot boxes. These epidemics affect the train service so seriously that every officer from the general manager down, becomes interested, with the result that a campaign is started all along the line to reduce the evil.

During these campaigns some car foremen resort to the old practice of applying free oil to every journal box, while others, to get around this prohibited practice, have a small piece of very oily packing placed alongside of each journal; still others do a little better by repacking every box that looks old and worn out. Thousands of bearings that are still good for long service, are removed and the stock of bearings is soon exhausted. At such times additional men are employed as oilers, but, having little experience in looking after such work, they are a menace rather than a help. Some car foremen try to lay the trouble to the new bearings they are receiving, to poor waste, or poor oil.

Every fair-minded man must admit that these periods of hot-box trouble are solely the result of continued neglect of the journal boxes. It is needless to describe in detail all the defects that produce a hot box; suffice it to say that the periodical repacking of the boxes will prevent these epidemics.

It is a well known fact among railroad men that, after long service, the packing that touches the journal becomes glazed and prevents enough oil getting to the journal to lubricate it properly, and it is reasonable to believe that when an oiler is over-rushed with work, the packing in every box is not properly stirred up. A close investigation will show that the packing in only a few boxes is stirred the full length of the journal, and that it is almost impossible to do this without repacking the box.

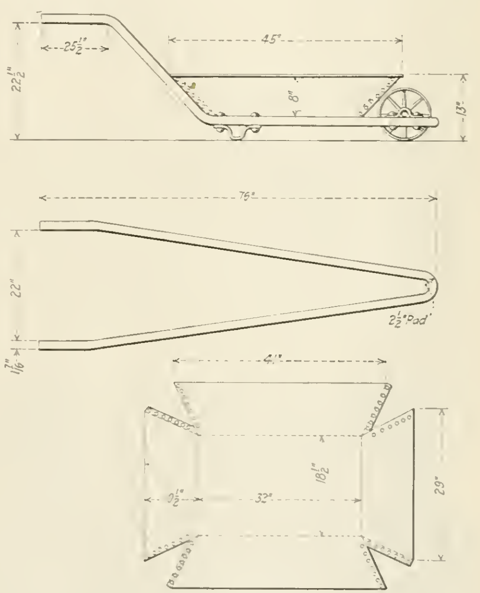
At first it was a difficult matter to get every road to consider the importance of repacking the boxes. At many places there were no renovating plants to take care of the old packing or to furnish enough of it to carry on the work. Through ignorance a great deal of the old packing was destroyed, and the foreman was censured for using so much oil and waste, but points with adequate means for renovating the packing found in a short time that it did not require as much new oil and waste as formerly. Experts in lubrication tell us that it requires months for waste to become thoroughly saturated with oil, and for this reason renovated packing contains more oil than new packing.

The packing of a journal box is exacting work. Every foreman should see to it personally that the men doing this work thoroughly understand how it should be done, and they should be held responsible for any failure caused by poor work. When a man is not properly instructed, he not only wastes a lot of packing but saturates his clothing with oil and soon acquires a dislike for the work.

The packing iron and hook should be of the standard size and pattern and made of the best steel, so that they will not bend when they are used to pry out the packing. The journal box packer should also be furnished a long narrow wheelbarrow with flaring sides, that can be run under any journal box. It should have room in one end for the old packing, at the same time holding sufficient renovated packing in the other end to fill the four boxes on one side of a car.

A strong and neat looking barrow can be constructed by using an old piece of 1¼-in. brake pipe for the handles, and riveting together several pieces of old car roofing for the body. Bearings for a standard 20-in. barrow wheel are riveted to the handles as shown in the drawing. To allow for all the bends in the pipe, the pipe should be 13 ft. long, and it should be bent before the holes are drilled in it for the axle clips, and the legs. The sheet for the body should be 39 in. wide by 52 in. long. The corners of the body are riveted together with seven 3/16-in. rivets in each corner, and the clips, legs and body are riveted to the handles. Wooden handles may be driven into the open ends of the pipe.

The renovating plant should have two wide doors with



Barrow for Handling Journal Box Packing to and from the Car

their thresholds level with the walk or runway, and so situated that the man returning with the old packing will not interfere with the man coming out of the plant with a supply of renovated packing. There should be an ample supply of the barrows so that the man tending the plant can have one loaded and ready every time another is returned. The tender should put the old packing in the renovating vats and he should load the barrows, because he should be the best judge of the quality of the material.

Little progress will be made if the packer is equipped with nothing but a bucket to hold the packing, and a light hook which will not withstand prying and requires a man to hook the packing out of the box a little at a time. This is discouraging and no one can keep even reasonably clean under such conditions.

Much can be said about stenciling cars that are repacked. The stencils should be made of tin or stiff fiber board and not out of flimsy material. They should be made by a regular stencil cutter and not by the oilers; the brushes should not be those which have been discarded by the painters; clean white-lead should be used rather than a lot of skin or dried out paint—the refuse from the paint shop. The old stenciling should be painted out in time for it to dry so that the new stenciling can be placed on the same spot.

There has been a great deal of discussion about how many boxes an oiler should repack in a day of eight hours. Sometimes a man has averaged two cars an hour, but if 64 boxes have been repacked correctly, a very fair day's work has been done. Should a man repack only five or six cars a day the company will not be losing anything on his work.

It is impossible to estimate the saving that the former packing rule effected for the railroads. Where a road was having 50 to 100 hot boxes in 24 hours before this rule went into effect, the number has been reduced to 10 or 20 a day. When all the delays occasioned by having to set out cars with hot boxes is considered, together with the wear and tear on the equipment, it is evident that a substantial saving has been made by giving more attention to the repacking of the journal boxes. Someone has estimated that it costs $100 to stop a train of 75 or 100 cars and set out a bad-order car,—the majority on account of hot boxes. Stopping a train that is running 18 to 20 miles an hour and delaying it long enough to set out a car, couple the train together again, test the air-brakes, and accelerate it to 20 miles an hour, puts 3,000 or 4,000 tons of freight 10 or 20 miles behind. From 30,000 to 60,000 ton-miles has been lost to the railroad company.

The wear on from 600 to 800 brake shoes and an equal number of wheels is no trifle and the strain and wear on 200 draft gears is also an appreciable item. Every time a car is switched the body of the car is more or less racked,—it is a little nearer to being worn out than it was before. It costs money to compress air and every time the brakes are set unnecessarily there is a waste of air. When a bad-order car is set out some one must be sent from the nearest repair point to make the repairs. In some cases a train must make an unnecessary stop to let him off, and another train must stop to pick him up. A train must also stop to pick up the car after the repairs have been made. Then the delay to the car must be considered. When all these items are added there is no doubt but that in many cases the total cost of one hot box will be well over $100.

A certain percentage of wrecks are due directly to burned off journals, and if this percentage has been reduced by giving the journal boxes more attention it is a big point in favor of the packing rule. The amount of money lost in a few such wrecks would go a long way towards paying for repacking the boxes which might have prevented them, to say nothing about the possible injury or loss of life to the trainmen.

If every car passing over the repair tracks were repacked when needed the number of hot boxes could be further reduced. While some of the roads are still enthusiastically observing the requirements of the rule, others have lost their keenness and are not doing as well as formerly. It might be advisable to restore the charges for this work, but to put them under the head of "Delivering Line Defects." This would wake up some of the indifferent roads and cause them to do their share or pay for their neglect. At any rate the rule could be made to apply to the cars repaired on repair tracks. If the boxes were not repacked when due no bill could be rendered. This would not be too severe on anyone.

Doubtless many boxes will run longer than 12 months without repacking, although it does not pay to take the chance, as heretofore. Journal bearings are expensive, and their service can be materially lengthened by repacking every accessible box within the 12 months' period required in the 1920 rules. Not a single car on the repair tracks should be overlooked, as that is the best place to do the work.

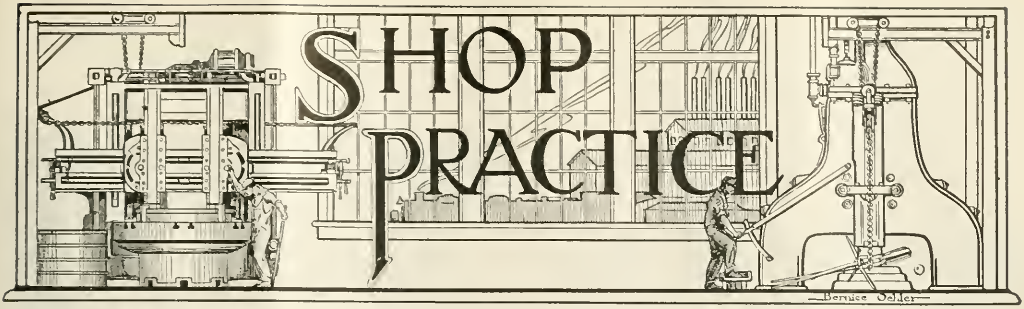
When any box is found hot due to bad packing, every box on this car should be repacked.

The requirements of the rules that dust guards be renewed every time the wheels were changed, is not being lived up to and this results in hot boxes. This matter should be given more attention, because repacking a box with a worn dust guard will not insure its running a year without getting hot. Perfect lubrication cannot occur when the top of the packing is covered with dust soon after it is placed in the box. All missing or defective journal box lids should also be renewed.

It is remarkable how long car journals carrying heavy loads will run without heating. No other piece of machinery can compare with them. It is also remarkable how soon a journal can be burned off after it once starts heating. But journals will not run forever without attention and it is taking chances to run them more than a year without repacking. Whatever may have been the difficulties of enforcing it, there can be no argument as to the value of the 1920 rule with respect to the repacking of journal boxes. Disregarding a duty that is so important should not be tolerated.

Latest Design of Edwards Gasoline Motor Passenger Car

The Chicago, Burlington & Quincy has recently placed in service a gasoline motor car 32 ft. 7 in. long and weighing 19,000 lb. It contains a passenger compartment seating 39 and a baggage compartment in which there are folding seats for six additional passengers. It is driven by a 60-h.p. Kelly-Springfield motor.



High Points at Reading Locomotive Shops

Second Installment Giving Details of Modern Spring Shop, Hydraulic Press and Erecting Shop Work

Part II

DURING the Railroad Administration considerable difficulty was found in getting locomotive and tender springs and it was decided to build a small spring shop and install some modern spring-making machinery. Accordingly, an addition was made to the southwest corner of the blacksmith shop (see Fig. 1), providing a well-lighted room of ample size to handle the work. This spring shop was equipped with an R. D. Wood spring stripping machine, a banding and assembling machine of the same make, a home-made spring forming machine, necessary furnaces, oil baths, steam hammer, etc. Two jib cranes in conjunction with pneumatic hoists facilitate handling the heavy springs. A testing machine located in the stock shed is used to test the springs after being assembled. All Philadelphia & Reading locomotive and tank springs are now repaired at this point, the number handled annually being about 5,000. The stripping, assembling and testing machines are illustrated in Figs. 15, 16 and 17 respectively.

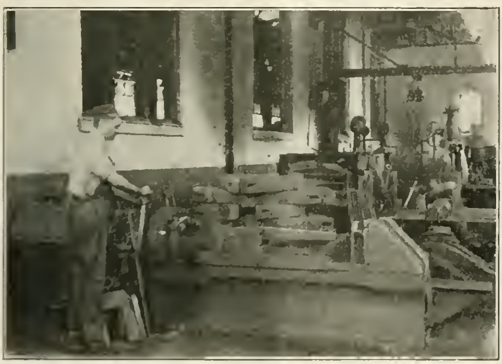


Fig. 15—R. D. Wood Hydraulic Machine Used for Stripping Springs

Springs as received are first put in the stripping machine (Fig. 15) when operation of the plunger, by means of the operating lever shown, quickly forces several of the leaves through the band and enables defective or broken leaves to be removed. New leaves of the proper section and length are then cut from new spring stock. After being heated in the furnace to a temperature of 1,200 deg. F., the leaves are taken out, given the proper camber and quenched in oil at about 900 deg. F. They are allowed to cool in the oil.

Both new and old spring leaves are assembled in the proper order on the assembling machine table (Fig. 16), operation of the control valve forcing out a plunger by means of air pressure in the cylinder at the right. This compresses the spring leaves holding them in position while the spring is revolved from the horizontal to the vertical plane and the heated spring band applied. The spring is then turned back to the horizontal position, air pressure being released and the band adjusted to the center of the spring. Both springs and band are then placed under the main portion of the machine when successive operation of the two main horizontal and vertical plungers compresses the heated band firmly

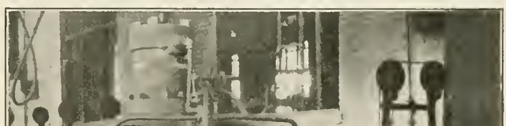


Fig. 16—Springs Are Assembled and Banded on This Machine

around the spring leaves in accordance with the usual practice.

A Riehle testing machine has been adapted to the testing of these springs as shown in Fig. 17. The capacity of the machine is 50,000 lb., springs being tested as follows: Take for example a 42-in. spring with 23 plates, made of ½-in. by 5-in. stock. This spring must carry 30,000 lb. at ¾-in. set. The height under 26,000 lb. is 13-7/16 in.; under 27,000 lb., 13⅜ in.; under 28,000 lb., 13-5/16 in., and under 30,000 lb., 13¼ in. The free height is 14 in. If a spring does not come up to these required specifications, it is sent

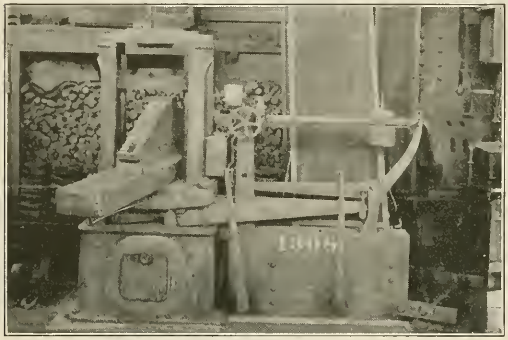


Fig. 17—Reihle Testing Machine Adapted for Springs

back for retempering. Coil springs are also made at this shop, the machine for shaping the coils being also home-made. One of the largest coil springs handled is that used in the expansion steam joint on Mallet locomotives, the spring being made from 1¼-in. stock. The diameter of the coil in this case is 18 in. and its free height 12 in.

Hydraulic Press Work in Boiler Shop

Obviously with the large amount of locomotive repair work centralized at Reading, it is necessary to have a large and well-equipped boiler shop. Perhaps the most distinctive feature of the boiler shop at Reading is the R. C. and W. H. Wood, 500-ton hydraulic press used for forming steam domes, flue sheets, throat sheets, door sheets, cylinder head casings, air reservoir heads and steel car parts, such as bolster center plates, draft arms, end sills, side sills, etc. Six men

Fig. 18—Car of Steel End Sills Leaving Boiler Shop

are required for the efficient operation on this press. A complete set of dies has been developed for the work and wherever enough parts are to be formed, the dies are assembled in the press and the various operations carried through on a number of pieces of stock with very satisfactory results both as regards the quality and cost of the work. The location of the steel car shed within a comparatively short distance of the boiler shop is an important advantage as the heavy hydraulic press is particularly adapted to forming pressed steel shapes and not many steel car shops have such machines available.

A car of end sills, for example, is shown in Fig. 18 just leaving the boiler shop for the steel car shed. The dies for forming these sills are shown in Fig. 19 and their arrangement, assembled in the hydraulic press, in Fig. 20. These end sills are made of ¼-in. steel plate which is cut out to the proper size and shape and heated in a furnace adjacent to the press. With the flanging dies in the proper

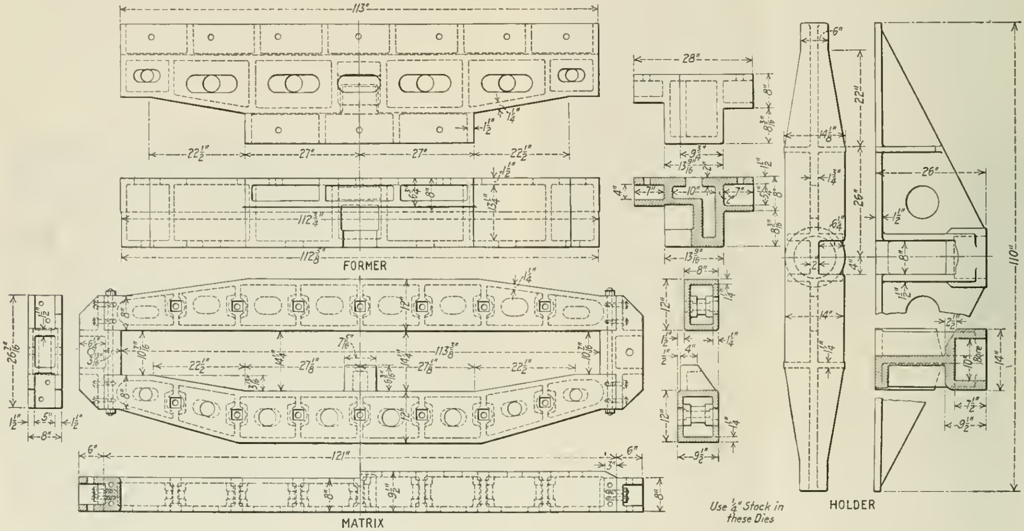


Fig. 19—End Sill Forming Dies

position each plate is then transferred to the press, properly alined, and one stroke of the press forms the entire sill with the exception of turning down the back flange. Referring to Fig. 20, the lower platen is the one which moves as the press is operated, the matrix and holder being firmly bolted to it. The former with its backing plate is solidly bolted to the top platen.

As in the case of most automatic and production machinery, this 500-ton press cannot be equipped with dies

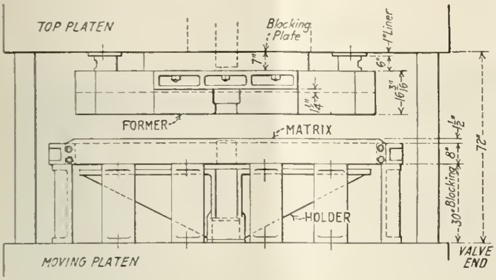


Fig. 20—Arrangement of Forming Dies in 500-Ton Hydraulic Press

properly alined without considerable effort and time spent on the operation. As a result, it would not pay to use the press for two or three parts. A certain number of parts must be made in order that the saving may balance the cost of setting up the dies. Any parts made in excess of that number represent an increasingly large profit.

Many other pressed steel parts besides end sills are made under this press, a group of smaller parts being shown in Fig. 21. These parts include diaphragms for steel car center sills, side stakes for low side gondola cars, protection plates, draft gear stops for steel cars and air reservoir heads. The press is one of the busiest tools in the Reading shops,

Fig. 21—Miscellaneous Small Pressed Steel Parts

so much so in fact that it is often difficult to get necessary straightening and other similar work done. Perhaps the most impressive work done under this hydraulic press is the manufacture of steam domes which, for one of the heavy class locomotives, are 23 in. high with a diameter of 31½ in. These domes are made of 1¼-in. stock, requiring five operations under the press.

Erecting Shop Work

Referring to Fig. 1, the method in which locomotives are turned on the two turntables and shifted into the respective erecting shops will be evident. Cranes are provided to move each locomotive to its permanent position while in the shop, with auxiliary cranes to handle the relatively lighter parts. A view looking down the east erecting shop is shown in Fig. 22. Each engine requiring heavy repairs is stripped of brake rigging, spring rigging, binders, etc., and unwheeled 10 hours after being received. Running boards, piping and small parts not requiring repairs are stored in covered pits between the engines. The wheeling and unwheeling gangs work on a second shift which saves almost two days in handling the locomotives. The motion work and parts are stripped and sent to the lye vat in the north end of the stock shed for cleaning. Driving wheels which are particularly dirty or those suspected of having cracks are also put in the big vats.

Special attention is paid to truing the pedestal faces and squaring frames at Reading as it is believed that the accuracy of this work has a big effect in reducing the number of broken frames and wheels developing sharp flanges. The driving box work and lining shoes and wedges also receive special attention. When ready to wheel, one of the heavy cranes lifts the locomotive and moves it out of the way while the driving wheels are being put in the correct position on the pit track by one of the lighter cranes. The locomotive is then moved back over the wheels and lowered into place. After being wheeled, the binders applied and the wedges set up, the wheel centers are trammed as a check on the accuracy of squaring shoes and wedges.

Each of the four erecting shop gangs has specialists to

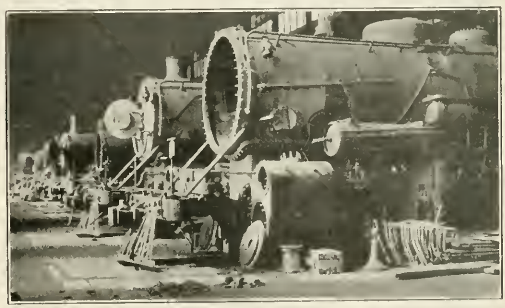


Fig. 22—Partial View of East Erecting Shop

handle particular phases of the work. For example, one man on each side of the shop is responsible for the cylinders. He inspects for cracks, calipers and bores the cylinders and valve chambers. Other men are available to help out when for any reason there are an unusually large number of cylinders to bore. All motion work and parts are returned to the engine 10 hours before it is due out. Weekly meetings enable the foremen to keep in touch with the progress of the work and decide on the locomotives going out in the ensuing week.

The general practice in welding frames at Reading is to use acetylene which has been done for a long period of time with few failures. Two hundred frames on Philadelphia & Reading locomotives have been acetylene welded with not over five failures out of the whole number. This work comes under the direction of G. L. Young, boiler shop foreman, who also furnished the photographs shown in Fig. 23 and the data on cylinder welding. As will be noted in Fig. 23, the cylinder and valve chamber were both broken to such a degree that repair by welding or any other method seemed hopeless. The following method of procedure, however, resulted in a successful weld.

The edges of the cylinder were beveled to 45 deg. and patterns of wood made, conforming to the parts removed. Patches were then cast, being beveled and fitted to the cylin der and held in position by a ring. A brick furnace was built around the cylinder and in order to give draft for preheating, the bottom row of bricks was spaced 1 in. apart, 6 in. being allowed between the furnace wall and the cylinder. About one half of a barrel of charcoal was placed in the furnace and when the charcoal was thoroughly lighted, more was added until half the cylinder was covered. Then a piece of asbestos was placed on top of the furnace with holes punched in it to give draft.

The cylinder was allowed to reach a dark red heat, enough brick then being removed from the front and side to allow the welders free access to the job. The welders began at the bottom of the V, fusing the bottom first, at the same time heating the sides and bringing them to a point of fusion. Cast-iron filler rods, 3/8 in. in diameter, were used, care being taken to raise all impurities to the top of the weld where they could be floated off. The weld was kept at a high temperature so the cooling process would not take place too fast. Just enough flux was used to dissolve impurities. After the weld was completed, the bricks were replaced in the openings, the furnace again filled with charcoal and left to burn out which required about 24 hours. When the fire was out the bricks were removed. The cylinder was then machined and made ready for service, the total saving over the cost of a new cylinder being estimated at $336.91.

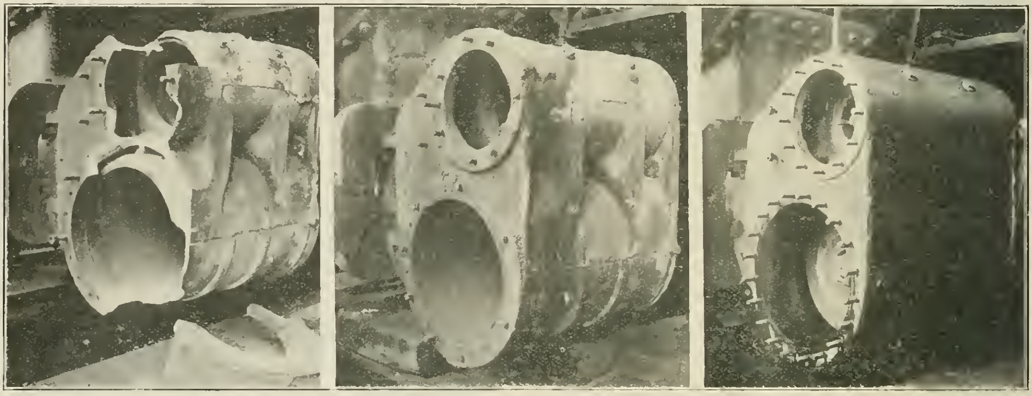


Fig. 23—Views of Cylinder Before and After Welding—Reading Shop Men Are Proud of This Job

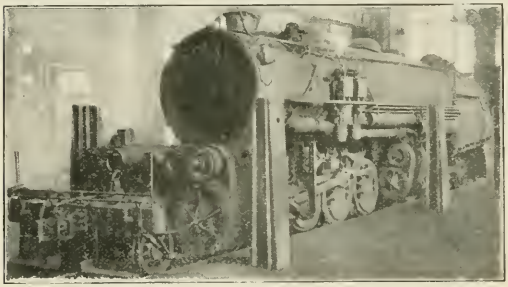
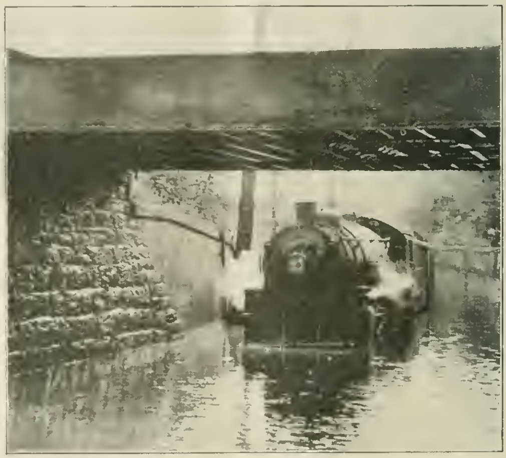


Fig. 24—Whiting Hoist Used for Wheeling and Unwheeling Mallet Locomotives

This work was done by the oxyacetylene method. The material used was as follows: 2,021 cu. ft. of oxygen, 1,923 cu. ft. of acetylene, 225 lb. of cast-iron welding rods. Three operators were employed so they could relieve each other on account of the intense heat. The lower left corner of Fig. 23 shows one of the patches which was applied. This is considered one of the most difficult and incidentally most satisfactory cylinder welding jobs ever done in Reading shops.

Thirty-one of the locomotives owned by the Philadelphia & Reading are of the Mallet type. All these locomotives are being maintained at the Reading shops. This work is done in the north machine shop by a special gang which works in two eight-hour shifts. The Whiting hoist, illustrated in Fig. 24, is used for wheeling and unwheeling these locomotives, an operation which can be performed quickly and efficiently by this means. After the brake rigging, spring rigging and binders are down, the locomotive is simply hoisted high enough to allow the pony trucks and driving wheels to be run out underneath. The locomotive is then lowered on blocking and necessary repairs to the frame, cylinders and boiler are made while the driving wheels, boxes, rods and motion work are being cared for in the machine shop. It will be noted from Fig. 24 that the locomotive is lifted at six points of support by a six-jack hoist, enabling the Mallet type locomotive with its long wheel base to be handled.



N. Y. C. Train 59 Near Syracuse, June 11

Practical Suggestions for Developing Foremen

Foremen Should Be Encouraged to Study Technical Articles, Visit Shops With Advanced Practices and Give Executive Duties Preference Over Desk Work

By an Ex-Foreman

THE spot light at the present time appears to be turned on the railway foreman. The foreman is a top sergeant of industry, sometimes exercising that authority and sometimes (it is to be regretted) bossed by his command. He must get equipment out on time no matter if material is not at hand. He must see that each man works industriously throughout working hours, needing several pairs of eyes for that purpose. He must attend to desk work, listen to grievances and settle disputes. He must be a practical machinist, boilermaker, blacksmith or car builder, an executive, a judge and a hustler. If he worked 24 hours a day, including Sundays and holidays, he could still find things needing his attention. The above description may be slightly overdrawn but it still holds much of truth.

Trained Foremen—A Vital Necessity

This article affords positive evidence that the author is an experienced railroad man and knows whereof he speaks.

He says that foremen are largely self-trained. Admitting the truth of this statement, we believe that railroad managements can and should do far more than they ever have to encourage and develop their supervisory officers.

Is there any practical reason why foremen should not be relieved of signing material slips, time cards and other details, devoting themselves to their real duties of supervising men? Read the author's suggestions.

With so many demands on his time, how can the foreman attend properly to executive duties? My advice is: Relieve the foreman of all possible work that detracts from his legitimate duties of supervising his department in an effective, economical manner. Give him a chance to plan better methods for doing the work. Educate him as to the best and most economical shop practices, encouraging the development of his own ideas. Send him out to other shops, not necessarily railway shops, but manufacturing plants where he can see advanced practices. As a general rule, manufacturers turn out work quicker and more economically than railway shops owing to the incentive of competition. From these outside shops many good points can be gathered and if a foreman can not absorb enough ideas on a trip to more than remunerate the railroad for his personal expenses, he is not a good observer.

Visit Up-to-Date Railroad and Industrial Shops

It is safe to say that practically every machine tool builder will extend the glad hand to visiting railway foremen. The value of the latter's visits consists not only in seeing machines that would be economical for railway shops, but more in seeing how the other fellow actually does the work and the general system in each shop. The manufacturer points out the good features of his machines and in turn profits by picking up little pointers concerning the special requirements for railway work. In each company special methods will be noticed which may impress the foreman as being adaptable to his work. For example, the writer once saw the operation of grinding crank shafts for automobiles direct from the rough drop forgings. This is not a railway job but, seeing it done by grinding was an eye opener and indicated the great possibilities of grinding.

In a motor truck factory the system of gaging and specializing was looked into. Motor trucks are not car or engine trucks, but looking into the general methods adopted by that company showed the possibilities for railway work. Some of these methods have been acted on and some are stored away in the brain for future use.

In a prominent toolmaker's catalogs will be found this notice: "We are always ready and glad to show our works to those who contemplate purchasing machinery or who are interested in machine shop or foundry practices." That company does not make railway equipment, but a demonstration of its methods of grinding, milling and measuring the various parts of its machines is an education in itself.

It must not be thought for a moment that, owing to the high grade of work turned out by industrial concerns, they have a monopoly of all the good workmen. *They appear to have the happy faculty of making a fair workman turn out first-class work.* This is a point worthy of study by all foremen.

Each railway shop will have certain points, tools and devices of special merit and probably a few antiquated methods. One caution should be observed. Don't let the visiting foreman go to the poorer shops as there is the possibility of his coming back very conceited and telling how much better work is done in the home shop. The management does not want to be told what it already knows. See that the foreman goes to the best railway or outside shop available.

Study Trade Papers and Technical Articles

In the line of education, trade papers and books on shop and railway subjects should be at the disposal of foremen. The costs will be repaid several times over. I would like to see a copy of the *Railway Mechanical Engineer* handed to each railway shop foreman every month. No one maintains that each reader from hostler foreman and car inspector to general foreman will find articles in each number written for his especial line of work, but certain articles will bear directly on the work of each and may be acted on at once or possibly later. On one occasion the writer read an article relating to a certain operation. About two years later conditions were such that this information could be used and as a result, the output of certain machines was doubled. One machine and man now turn out the same work as two by previous methods. That trade paper cost $3.00 per year and saved the company a like amount each four hours that the work was on the machine.

The duties of a foreman are principally to see that work is done in the most approved manner, on time and, if possible, a little better and cheaper than the other shop. He should see that each man attends to his duties and does an honest day's work, in addition showing the workmen by actual example, if necessary, how to do their work a little better and quicker. Don't think for a moment that most workmen will, in the long run, object to doing work quicker or better by an improved method, providing it can be done without extra effort on their part. In fact the American workman has a great amount of pride in doing good and speedy work and only needs to be shown where the methods may be improved. This is the opportunity of the foreman who has seen work turned out in the best shops and read trade papers. He will be in a position to tell and show the workman what are the greatest cutting speeds for the planer or lathe on each job; the feeds to be employed; speeds for drilling; how to grind a knuckle pin; how to avoid a lot of hand filing that only wears the man out so he can not work to good advantage during the latter part of the day; in fact, how to help the workman and not drive him. To do these things the foreman must be relieved from all extraneous duties.

Foremen Should Be Relieved of Details Such as Signing Material Requisitions and Time Slips

In line with this suggestion the question may be asked, "Why should the foreman make out or sign storehouse orders? Why are written orders from the shop necessary?" The goods handled by the stores department are all sold to one customer; i.e., the shop. The storehouse employee probably knows the material requirements as well as the foreman and should let a workman have a new crank or crosshead pin on verbal request, making a record for the necessary accounting and not bothering the foreman. The storehouse man will soon be in a position to tell as well as the foreman when workmen are drawing too much material. In fact it is a question if the workmen will abuse this privilege to any extent.

Railway shop material is largely special and not of enough value to be attractive or salable, especially when made from iron or steel. A workman will not steal crank pins or axles. He may take ten penny nails to mend the home fence but foremen's requisitions will not stop this practice among railway workers. Where giving out brass parts, files, hammers and other tools that could be disposed of at a profit, insist on the worn out part being returned, or in the event of additional parts, the storekeeper can keep an eye on the requirements. In other words, the storekeeper should keep the shop supplied and not bother the foreman to look after what are really the storekeeper's duties.

Why should the foreman be required to certify to the time of each man and job? In most manufacturing concerns this is done by the time clock. A clerk at the foreman's desk makes out the necessary order cards for the week. When a job is started, the order card is punched in the time clock. When completed, the order is again punched, the elapsed time showing all that is desired for ordinary purposes for either day work or piece work. This in any shop will relieve the foreman of a large amount of routine work. The argument may be advanced that the foreman should go over all time or order cards to see that charges are correct. The question is: Where can the foreman best observe the time for any particular job? He can sit down at his desk and finger over several hundred cards, tax his memory and rack his brain as to what should have been the proper time or charges, or he can try to remember previous costs and, should the time or cost look excessive, get after the workmen and raise a row after the damage is done. If relieved of routine details, however, he can spend most of the time about his department seeing that the workmen are on their jobs and preventing too much lost time or excessive costs before they occur. Plainly the latter is the more desirable plan.

Certain articles made in railway shops may be classed as manufactured material, such as bolts, forgings, crosshead pins, etc. These are generally made on shop orders, the cost being computed by the accounting department. The foreman is always interested in these costs. Why should not the cost of all these articles be made up monthly, also the costs for previous months, and given to the foreman? Should the costs of any particular article go up, he will naturally look for the reason and try to apply a remedy. If able to reduce costs on the next job, he will be pleased and have an incentive for more reductions, especially when given encouragement from higher up. Many a dollar has been saved in railway shops by showing comparative costs, by a few complimentary words, and by one department in friendly rivalry with other departments.

Foremen Are Largely Self-Trained

The master mechanic or general foreman is generally too busy to spend much time training foremen and, unfortunately, it is generally up to each foreman to train himself. This takes time. A man can not be expected to step right out from his lathe or bench and become a first-class gang foreman, jump up the ladder to assistant foreman and then give another spring to a full-fledged foreman without an apprenticeship in each of these places.

When starting in a new gang foreman, he should be coached by his superiors in the best methods of getting out work, keeping what shop records are necessary and maintaining discipline. In addition he should make an occasional visit to other shops. The gang foreman, as a raw recruit when visiting other shops, should be requested to make written reports on what he may see in order to ascertain what kind of an observer he is and if he has the ability to detect quickly shop operations that may be of value. A man who is quick to detect a good device for turning out work will generally develop into a valuable man in the way of introducing labor-saving devices. In order to have a check, it is advisable to have him go to a shop well understood by the home management so that his ability to observe and absorb good points may be judged. The new gang foreman should also have access to literature on shop subjects as mentioned above. The foreman should coach his assistants, point out articles that are of interest, have him read and also explain them. This is a good way to find out if the new man understands an article.

Lectures at Foremen's Meetings Helpful

A large amount of good may be done by getting the shop foreman and assistants together and listening to short talks on shop subjects. These talks may be by one of the shop organization or by experts from outside. A number of concerns, manufacturing machine tools, shop appliances and general railway supplies, have in their organizations good speakers who will give lectures on subjects relating to their products. The writer has listened to several lectures or, more properly speaking, informal talks by these people. The agreeable surprise was the fund of information given concerning their shop operations which was adaptable to railroad shop work. Much good can result from talks of this nature.

The shop foreman as a general rule graduates from grade or high school and shop apprenticeship courses. His chances for higher education along mechanical or supervisory lines are slim except in the college of hard knocks. He is generally tied up in one location and, without seizing the opportunity to broaden out by reading technical papers and visiting other shops, the chances are that he will cut but a narrow swath. It should be remembered that the foreman directs the spending of many a dollar. His proper training and development are vital to the best interests of himself and the railroad which employs him.

Pneumatic Power and Transmission Losses

A Detailed Study of Methods for Locating and Stopping Air Losses Common in Railroad Shops and Yards

By B. C. Bertram
General Locomotive Inspector, Erie, Youngstown, Ohio

Compressed air is a power medium virtually inseparable from railroad and industrial shop operation. A limited knowledge of thermodynamics, however, has prevented in some instances a correct understanding of the cost of compressed air and the necessity for rigid economy in its consumption. Authorities on the subject differ considerably as to the actual cost of coal and water consumed in compressing air. Estimates range from three to five cents per 1,000 cu. ft. compressed to 100 lb. per sq. in. The computations in this article are based upon the conservative basis of three cents per 1,000 cu. ft. of free air compressed.

On account of its peculiar adaptability, the use of compressed air as a power medium has been widely extended and it is, in fact, practically indispensable for the operation of riveting hammers, rivet breakers, flue welders, forming machines, testing devices and various other machines usually found in railroad shops. The result is that air lines are being constantly extended and air-consuming appliances added, often without consideration of compressor capacity.

With the extension of air lines and added appurtenances, the possibility of leakage and transmission losses are increased and this article undertakes to point out some of the losses resulting from defective air lines, hose, tools and other equipment, based on exhaustive tests and an intensive study of the applications of compresed air power in railroad shops.

Monetary losses resulting from air leakage, illegitimate uses of compressed air and carrying an insufficient pressure on the shop lines are astounding, and yet it is a matter which is seldom given serious consideration. Of these three conditions the latter, no doubt, occasions the greatest loss since it affects production directly; that is to say, the efficiency of all air tools generally varies directly with the pressure of the air which operates them, most tools being designed to operate with 100 lb. pressure.

In this article are selected from wide and varied experiences five concrete examples of air losses, representative of many that may be found in railroad shops throughout the country. While these losses may be exceptional in some phases, on the whole it is safe to say that parallel cases may be found in a great many other railroad shops.

Air Losses in Large Terminal Yard

No. 1. The first case deals with a condition which arose in a large terminal yard where switch operations were being seriously hindered. Trains were frequently delayed on account of insufficient air presure, preventing successful operation of the electro-pneumatic switches and making it necessary to bar the switches over by hand. A peculiar condition in the case was that, although an average pressure of approximately 112 lb. was being constantly maintained at the point of compression, the pressure at the terminal tower located 1,500 ft. from the compressors ranged as low as 60 lb., the variations of pressure at the terminal tower bearing no relation to the pressure maintained at the compressors.

The fact that it was possible to maintain a constant and adequate pressure at the point of compression gave positive assurance that the trouble was in the transmission lines. This being established the problem of locating the trouble was rather a difficult one on account of the air lines being underground from two to five feet. Air gages were placed on the line at several different places between the compressor room and the terminal tower and, by special arrangements, readings were taken simultaneously at these different points covering a period of two hours. From the readings, by noting the amount of drop in pressure between the different points where gages were located and by isolating certain sections of the line, it was possible to locate the largest leaks. The record of the test and explanation of locations are shown in Table I:

TABLE I—PRESSURE DROP BETWEEN COMPRESSOR AND TERMINAL TOWER BEFORE LEAKS WERE STOPPED

Time	Pressure in Pounds at Location							Total Drop
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	
2:00 p. m.	80	84	84	87	88	104	112	32
2:10 p. m.	82	85	85	86	88	107	112	27
2:20 p. m.	80	84	84	86	88	106	115	35
2:30 p. m.	80	84	83	87	88	104	111	31
2:40 p. m.	80	80	82	86	88	104	110	25
2:50 p. m.	80	82	82	86	88	105	113	33
3:00 p. m.	79	80	79	82	85	97	109	26
3:10 p. m.	74	75	75	78	80	96	109	28
3:20 p. m.	73	75	76	78	80	95	111	28
3:30 p. m.	75	75	77	80	81	97	110	27
3:40 p. m.	75	75	77	78	81	96	109	31
3:50 p. m.	75	75	77	80	81	97	110	29
4:00 p. m.	75	76	77	80	81	96	110	28
Average	78.4	79	79.7	80.2	84.4	99.8	111	28.8

Explanation of Locations:

Location No. 1—At terminal tower, about 1,600 ft. from compressor.
Location No. 2—Opposite tower, 1,500 ft. from compressor.
Location No. 3—200 ft. east of tower or 1,700 ft. from compressor.
Location No. 4—On second line 1,100 ft. from the compressor.
Location No. 5—On second line 800 ft. from the compressor.
Location No. 6—On second line 300 ft. from the compressor.
Location No. 7—At compressor.

Referring to Table I it will be noted that the drop in pressure between the compressor and the terminal tower averaged 28.8 lb. The test was made during periods of minimum consumption, which is responsible for the pressure being higher at the terminal tower than during rush hours or at a time of maximum consumption. It will also be noted that the greatest drop in pressure occurred between Locations 5 and 6 and between Locations 6 and 7.

The facts shown by this test resulted in several sections of pipe being uncovered and examined, revealing a deplorable state of deterioration, the pipe having been in the ground for approximately nine years subject to the chemical action of the cinders in which it was embedded. The ultimate result was that all cross lines in the entire yards were renewed. It has now been several months since this work was completed and air troubles are a thing of the past. Figs. 1 and 2 are submitted to show the pressures at air compressors and terminal tower, respectively, before and after these leaks in the transmission line were located and stopped.

From Fig. 2 it will be noted that the pressure at the terminal tower is practically equalized with that at the compressor room and any variation in pressure is noticeable on both charts. The prime object of making these tests and repairs was to eliminate the trouble experienced in switch operation, but by accomplishing this the economy effected is worthy also of serious consideration and the following data will no doubt prove interesting:

Average air consumption each 24 hr. day before repairs...	1,291,832 cu. ft.
Average amount of air consumed each 24 hr. day after repairs..	841,085 cu. ft.
Average amount of air conserved each 24 hr. day after repairs..	450,747 cu. ft.
Average amount of air conserved in one year	151,022,655 cu. ft.
Percentage of capacity of compressors used before repairs...	69-2/5 per cent
Percentage of capacity of compressors used after repairs....	47-4/5 per cent
Cost of coal and water used in compressing 450,747 cu. ft. of air per day	$13.52
Economy effected in one year........................	$4,934.80

It is obvious there were other economies derived from the decrease in the speed of the compressors such as less lubrication, less wear, less coal handling, etc. The overhead charges, not being materially changed.

Shop and Steel Car Yard Losses Reduced

No. 2. It has been found that in shops with an abundance of compressor capacity, the tendency is to be extravagant in the use of air; that is, *where no trouble is experienced from lack of air pressure very little attention is paid to ordinary air leaks*, unless, of course, they should assume alarming proportions. The second case referred to is one where this condition applied.

In this particular shop were located a 1,250 and a 2,500 cu. ft. capacity air compressor. A pressure of 100 lb. was maintained, but with some difficulty, it being necessary to run both compressors night and day. During periods of maximum consumption the compressors were run at their maximum speed, the power plant being sorely taxed to furnish sufficient boiler capacity.

In these shops and car yards were found hundreds of air line leaks besides 130 defective air hose, all of which

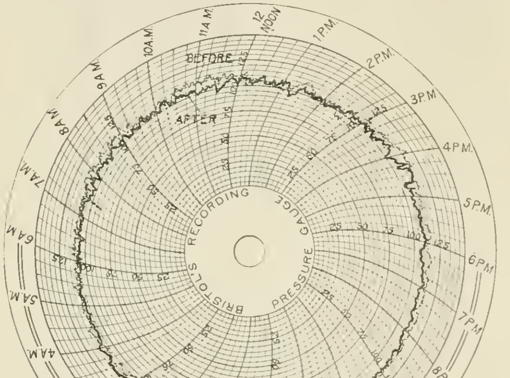


Fig. 1—Recording Chart Showing Final Stage Air Pressures at Compressor Room

were repaired as soon as the work could be accomplished. The result was that one compressor was able to furnish sufficient air, the large compressor being run days and the smaller one nights. Moreover, one boiler was cut out and the program for additional boiler capacity then under advisement was taken off the slate.

The economy effected in this instance was not derived from increased production since there was in the first place no lack of air pressure, but was derived from the economy in coal and water.

The following figures were compiled from the data taken during the tests made at that time:

Average pressure maintained before repairs	100.03 lb.
Average pressure maintained after repairs...	101.27 lb.
Average air consumption in each 24 hr. day before repairs.	1,334,502 cu. ft.
Average air consumption in each 24 hr. day after repairs..	1,068,552 cu. ft.
Average air consumption in each 24 hr. day after repairs.	265,950 cu. ft.
Amount of air conserved in one year..........................	97,071,750 cu. ft.
Cost of coal and water in compressing 265,950 cu. ft. of air a day	$7.98
Economy in coal and water per year......................	$2,912.70

There were, of course, other economies effected by eliminating the operation of one compressor and one boiler which it has been difficult to capitalize in dollars and cents.

No. 3. The third proposition deals with a situation where a large steel car yard was experiencing serious trouble

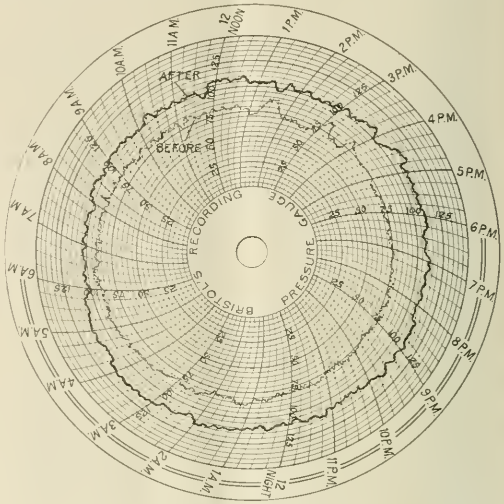


Fig. 2—Terminal Tower Air Pressures Before and After Stopping Transmission Line Leaks

from insufficient air pressure, which ranged only from 40 to 60 lb.

Investigation developed that there were several bad leaks in the air lines, etc., but the principal trouble was due to serious defects in the air compressor, necessitating extensive repairs. After the various defects were remedied, the maximum pressure of 100 lb. was easily maintained and with a slower speed of the compressor. The increased pressure was directly responsible for the immediate increase in production of five cars a day without any additional expense to the railroad.

It would be quite difficult to capitalize the real and entire economies effected by this increase in air pressure, but it is obvious that it would greatly eclipse the savings set forth in the two previous cases where the principal economy was derived from the savings in air consumption.

No. 4. Great economy was effected in a shop at another point where low air pressure was causing endless trouble. In this particular situation one large air compressor furnished air to the back shops, roundhouse and steel car yard.

A test made at the time showed the following interesting and instructive results: All air-using tools and facilities were put in operation simultaneously. At once the pressure dropped to zero as far as practical efficiency was concerned. Analysis of air-using facilities resolved them into two general groups. One included those used in regular daily routine of operations; the other, those that were in the nature of occasionally used facilities, including unloading fuel oil, elevating sand, sand blasting, setting tires and welding flues. In the latter group, while properly belonging in Group 1, were included several air-using furnaces in the car yard.

Analysis of demand developed that a pressure of from 90 to 100 lb. could be maintained when using all the facilities of Group 1 to capacity; operating in addition any one of the facilities named in Group 2 immediately brought the pressure down to about 70 lb.; operating any two of them brought the pressure down to 50 lb. or less; and using any three of them in addition to the daily routine facilities brought the efficiency of the whole operation practically to zero.

By special arrangement with the shop supervision a very conclusive and interesting test was made after the necessary extensive repairs had been accomplished, a constant pressure of 100 lb. being easily maintained.

By carefully prearranged plans, at a certain time in the day every available air-consuming device in the shops and car yard was put into service simultaneously using the maximum amount of air. This included tire setting, sand blasting and, in fact, all operations included in Groups 1 and 2. Throughout this test a pressure of 94 lb. was maintained. This is significant since it is obvious that the existing conditions during the test would never be paralleled in every day practice.

In addition to the increased efficiency which resulted, the management worked out a schedule whereby certain operations, such as elevating sand, unloading fuel oil, etc., was done during periods of minimum load. This arrangement added materially to the successful operation of the plant. The resulting increase in production in this plant saved thousands of dollars a year.

No. 5. Perhaps the greatest saving effected in any shop was in the case where, due to an erroneous opinion, it was thought that the compressors were no longer able to supply an adequate air pressure and for this reason five booster pumps were installed, four in the boiler shop and one in the tank shop.

Air was taken from the shop line at 65 or 70 lb. pressure and boosted by the air of five 9½-in. Westinghouse air compressors to 100 lb. It developed that after all the defective lines and other leaks about the shop had been repaired and necessary repairs made to the compressor the compressor could easily maintain the requisite 100 lb. pressure, the booster pumps being discontinued. It has now been over two years since this took place and the booster pumps have long since been taken out of the shop.

Tests show that it costs about $5.40 each eight-hour day to operate a 9½-in. air pump. It is obvious, therefore, that in this instance a saving was effected of $27.00 a day, or $8,262.00 a year, figured on the basis of 306 working days. It will be found in the majority of instances where booster pumps are employed that if exact and systematic methods be employed in stopping air leakage and illegitimate uses of compressed air, the compressor will be capable of maintaining the desired pressure.

Illegitimate and Extravagant Uses of Air

The subject of the illegitimate and extravagant uses of compressed air is one on which volumes could be written and space would not permit the recording of all the bad practice seen daily in railroad shops throughout the country. However, a few of the more common abuses follow:

An instance was noted in a large power house where one man was employed almost constantly scaling the inside of the drums of a battery of water tube boilers. It was necessary to have some means of keeping the atmosphere inside the drums cool. To accomplish this a ½ in. air hose directed a constant jet of compressed air through the manhole in the end of the drum. Investigation developed that the amount of air consumed in an eight hour day cost in coal alone $5.92 and that the same results could have been obtained with a 16-in. electric fan at a cost of $.096.

At another point it was noted that an engineman in the roundhouse took occasion to blow off the jacket, running boards and cab floor of his engine with compressed air, a more or less common practice to which little attention is ever paid. In the four minutes air was being used in this operation, 764 cu. ft. were consumed, or about 12 per cent of the capacity of the compressor. As it happened, this particular shop was suffering from a lack of sufficient air pressure.

In another shop an air blower was used in firing up locomotives for the trial trips. Approximately 61,800 cu. ft. of air were consumed each time an engine was fired up. Further investigation developed that within 20 ft. of the air valve where the house was connected, there was a live steam line and the change was made at once to the steam blower.

Frequently air engines are employed to perform work which could be acomplished from the shop line shaft. All kinds of contrivances have been made from steam cylinders of 9½-in. Westinghouse pumps, consuming thousands of cubic feet of air a day at an enormous expense to the railroad company.

Electric motors, running warm, have been found with an air hose playing a constant jet of air on them to keep them cool. Electric welded parts are sometimes cooled off with air in order to machine them quickly. This is accomplished but often at the expense of ineffective air tools, due to decreased shop air pressure.

It should also be remembered that whenever the safety valve on an air receiver is heard blowing, it means just so much money wasted. This is something which can

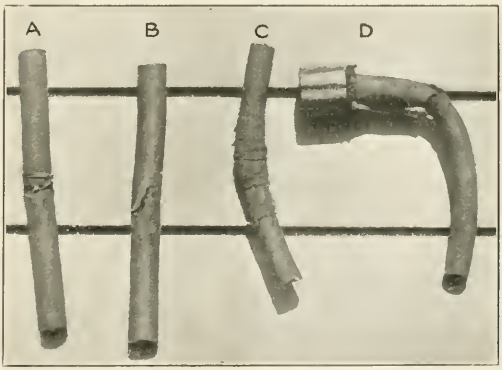


Fig. 3—Four Common Examples of Defective Air Hose

be observed daily in nearly every railroad shop in the country, especially during the lunch hour.

The use of open air jets instead of vacuum cleaners for cleaning carpets and cushions in car yards, air jets for blowing scale off hot iron which is being drawn out under steam hammers, air jets on emery wheels, etc., are all expensive practices. Air jets are not designed for cleaning the floor or blowing dust off clothing. The use of compressed air in furnaces and forges where a fan blower could be utilized should not be tolerated.

Chips are also often blown off machine tools using compressed air. This practice should be forbidden since it not only wastes the air, but often blows chips into oil holes causing bearings to start cutting.

Defective Air Hose a Source of Great Loss

A large proportion of the waste of air in shops is usually caused by carelessness on the part of the workmen in making hose connections. In many shops an active campaign has been conducted to educate the workmen along this line. Also, the practice of wrapping air hose in an endeavor to stop a leak should never be attempted since usually the sound of the escaping air is only muffled and the actual leak still exists. Numerous hose have been wrapped with tape, string, wire, rope, burlap, pieces of handkerchiefs and, in fact, an endless variety of things in an effort to stop the leaks.

In some shops water hose is being used for air. This hose is not designed to carry the heavy presure and no end of trouble results. A three-ply hose is best adapted for air pressures up to 100 lb. Fig. 3 shows sections taken from defective air hose, and defects of this nature are very common. Specimen A, Fig. 3, is one which was wrapped with a copper wire in an effort to compress the fracture in the hose. This wrapping stopped considerable of the leakage but compressed the hose to such an extent that the flow of air was greatly restricted, seriously affecting the efficiency of the air motor.

Specimen *B* in the photograph shows a fractured hose with a wrapping of string removed. The leak in this hose was not overcome by the wrapping but the sound of the escaping air was somewhat muffled as is usually the case in wrappings of this kind. Specimen *C* indicates the usual wrapping of adhesive tape, which is no doubt the most effective of any wrapping. Even with this method, however, the leak is only stopped temporarily since the air pressure soon forces itself between the hose and the tape and while the leakage is distributed between the layers of tape and is not so noticeable, the fact still remains that the loss of air is usually just as great.

Any effort to overcome a leak in an air hose by exterior wrapping is just as ineffective and impractical as putting a blow-out patch on the exterior of an automobile tire. The reason for this is that the rubber is flexible and the air pressure passes through the fracture, forcing its way be-

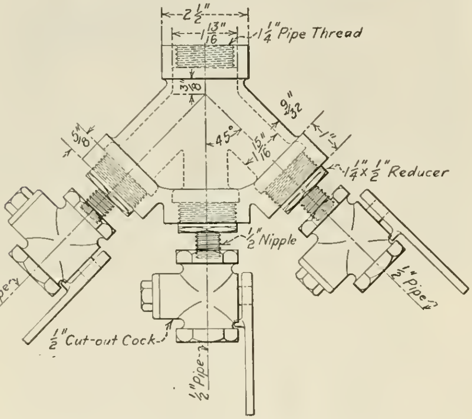


Fig. 4—Double Y Branch Fitting Provides for Three Connections and Prevents Kinking the Hose

tween the hose and the wrapping by compressing the hose and escaping at the end of the wrapping.

It was also found that in the majority of shops the cut-out cocks to which hose were connected usually were arranged horizontally, causing the hose to bend sharply just at the end of the inserted nipple. This abuse, illustrated at *D*, Fig. 3, usually causes a fracture of the fabrics at that point and it has been found much more satisfactory to have hose connections in a vertical position or at an angle of 45 deg. so that the hose will hang straight down or assume a long, gradual curve to the floor.

A double Y branch fitting (Fig. 4) shows an ideal arrangement when fitted up with three ½-in. cut-out cocks. This permits of three hose connections feeding from one main without restricting the flow of air or interfering with the efficiency of the air appurtenances.

In many railroad shops and roundhouses workmen are allowed to retain the air hose in their tool boxes indefinitely. Where this is the practice it has been found that invariably, for lack of periodical and systematic inspection, the hose are in bad shape. Due to indifference or a feeling on the part of the workman that he prefers his own hose, he hesitates to exchange it at the toolroom for another when it develops a defect and this is responsible for the wrapping, etc. It has been found good practice to have the hose returned to the toolroom when not in use or turned in for inspection at least once a week.

Other abuses of air hose consist of allowing them to remain about the floor when not in service, one end being usually attached to a cut-out cock. This condition has frequently been noted in boiler shops particularly, trucks being run over the hose and boiler sheets, scaffolding and other heavy material falling or resting upon them.

Test Air Lines Periodically for Leakage

A periodical inspection of air lines is most essential. Leaks in back shop air lines can usually be detected when

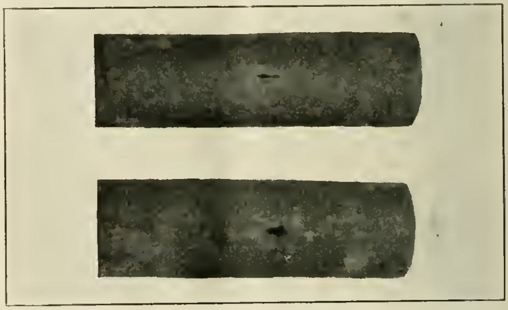


Fig. 5—Examples of Corrosion in 3-In. Overhead Air Line in Roundhouse

machinery is not running and the shop is quiet. It is difficult, however, to detect leaks in the overhead lines in the roundhouse due to the usual noises of the blowers and escaping steam. The chemical action of the gases and condensed steam cause these lines to deteriorate very rapidly and frequent and careful inspection is necessary.

Air should be shut off from sections of the shops where it is not required and from all the shop lines at night or days when shops are not operating. Valves should be installed in suitable locations, so that different sections of the shop can be isolated to facilitate repairing the air lines.

Outside lines should, if possible, be kept above ground. It is frequently found that air lines are buried from six inches to three feet deep, making inspection practically impossible, and specific instances have been known where leaks of such a magnitude as to practically tie up the shops for air were unnoticeable from the surface of the ground.

Where necessary in car or terminal yards to run pipes under the tracks, it has been found good practice to have them boxed in, the top of the box being level with the surface of the ground. The box also protects the pipes, preventing to a great extent detrimental chemical action due to cinders. Exposed lines should be equipped with sufficient expansion joints to allow for the expansion and contraction, usually spaced 300 ft. apart.

In the inspection of air lines the magnitude of some of the defects discovered have been startling. Fig. 5 shows holes in a 3-in. overhead roundhouse line, responsible for thousands of cubic feet of air being wasted each day. This particular line carried an air pressure 24 hours a day. (*This article will be continued next month with a discussion of compressor losses in power plants.*)

Principles of Oxyacetylene Fusion Welding
Part 5—Welding Cast Iron, Continued

By Alfred S. Kinsey*

After making welds in cast iron, as described in this article last month, the next step is to determine if the welds have been made as nearly perfect as possible. This is especially important in some cases where the welds are subjected to more or less severe stress in service.

14. *Examination of Weld.*—After a cast iron weld is completed and cold, if it is of much importance it should be examined for porousness and other defects. It should not be assumed that because the joint has been reinforced all has been done that is possible to insure a good strong weld. After the metal is cold the surface of the weld might be chipped with an air chisel or hand chisel sufficiently deep to remove the thin harder surface here and there over the weld. This will lay bare the upper metal of the weld and expose any porousness or blow-holes which may have developed. If such defects are found they may be due to the following: (a) Too liberal use of flux. (b) Not enough

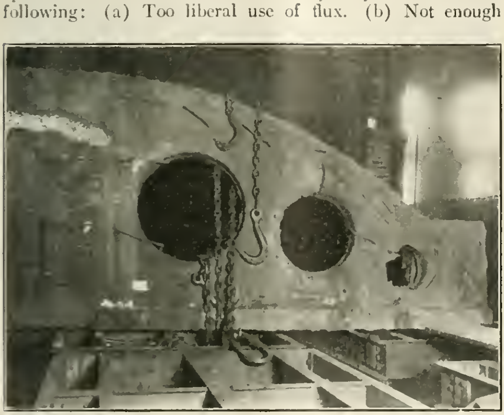


Fig. 1—A Typical Iron Casting Welded by the Oxyacetylene Torch

puddling of the molten metal with the welding rod. (c) Improper adjustment of the torch flame. (d) Allowing the weld to cool too quickly. A good welder can avoid all of these weaknesses. If the weld contains blow-holes or shows general porousness, the surface should be chipped deeper until good homogeneous metal is found, and then the joint should be rewelded. If the defects appear to go entirely through the joint the whole weld should be chipped out, and the job done over with greater care. The weld should also be examined for small shrinkage cracks both in the joint and particularly adjacent to the weld on both sides. These cracks may not be due to welding at all. They may have been caused at the foundry when the casting was made, by improper cooling, poor venting of the sand mold, improper ramming of the sand, poor mixing of the metal in the cupola, improper balancing of the chemical elements, carbon, silicon, manganese, phosphorus and sulphur, or from some other cause. Sometimes these cracks will not show on the surface until the casting is heated red hot a long time afterwards, as in welding, and then they are often charged to the welder. Sometimes too hasty cooling in the foundry when the casting was made, may set up strains in it which later will be developed into cracks by the vibrations forced through the casting in its use as would be caused, for example, by a locomotive in its cast iron cylinders as they are continually jarred in service. If the iron casting to be welded is hollow and it is possible to temporarily seal its openings, a good way to locate porousness, blow-holes or small cracks is to put an air pressure in the casting and then brush soap water over the surface to be tested. Any leakage will show as soap bubbles. The air pressure should be about the same as the working pressure on the casting. In the inspection of welds a small magnifying glass, say of from 5 to 10 powers, will be found of valuable assistance. The glass may be purchased in an optical supply store, and is not expensive.

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The Making of an Iron Casting

In order that an oxyacetylene welder may better understand the principles governing the making of a successful fusion weld of cast iron, if he is not familiar with foundry practice it will be of assistance to describe the casting of iron and the general properties of the metal.

Iron ore as taken from the mine is the source of the base metal for all the irons and steels of commerce. The ore is in the form of iron oxide; that is, the iron is saturated with oxygen, and in turn this iron oxide is intermixed with what is called the gangue consisting of silica, clay or lime-rock. Therefore two things must be accomplished to produce a good commercial metallic iron; i.e., remove the oxygen from the iron oxide and separate the silica, clay or lime-rock from the iron. It will be well to note that as iron comes to us saturated with oxygen, even though the oxygen is removed to make the iron useful, there is always a tendency of the iron to absorb oxygen (rust) and return to its original state as iron oxide.

The common method used to remove the impurities of iron ore is to put it in a big smelting furnace and melt it with coke or anthracite coal. The fuel contains a large percentage of carbon which on burning unites with the oxygen and burns it out of the ore. Then the gangue melts, floats to the top and is removed at the back of the furnace as slag. The pure metal is tapped from the front of the furnace and run into molds called pigs to solidify. These chunks of iron then are known as pig iron, and they are used for the manufacture of all irons and steels. Pig iron is made in five grades, dark gray, medium gray, light gray, mottled and white iron. The dark gray is the softest and most costly, while the white iron is the hardest and cheapest.

Now let us go from the ore smelting plant to the iron foundry. To make an iron casting the pig iron is thrown into a big vertical furnace in the foundry, called the Cupola, where it is melted by coke. It then is tapped from the cupola, run into a ladle and thus carried to and poured into the mold of the desired casting. This might seem to be a simple operation, but quite to the contrary, iron founding is one of the most difficult of trades (Fig. 1).

To make a good iron casting a pattern is necessary, which is usually constructed of wood. This pattern is then placed either in a wooden or iron flask or down in the sand floor of the foundry. If it is of moderate size, it will very likely be put in an iron flask. Then special molding sand is rammed about the pattern, the sides of the flask confining the sand within bounds. The pattern is removed from the sand, which may be easily accomplished even with a pattern as complicated as that for a locomotive cylinder, because it will be made as a "split" pattern of loose parts which may be removed separately from the sand mold without breaking it.

Now comes the particular part of the work. Every detail of the mold is carefully tooled by the molder and the face of the mold is coated with a black graphite to make the casting peel well, that is, draw from the mold without the sand sticking to it and leaving a rough surface. The mold is closed and the metal poured into it through an opening in its top called the gate. The pouring is called casting, which changes the name of the pig iron to cast iron. After the metal solidifies, the casting is dumped out of the sand mold and allowed to cool.

Let us now investigate the source of some of the troubles experienced by the oxyacetylene welder. If the molder rams the sand too hard, it closes up the pores of the sand mold so that gases from the molten metal cannot be properly released even through the main vent at the opposite end of the mold to the gate, called the riser, and the gases become entrapped in the casting thereby forming cavities which are called blowholes. A casting in service may break because of these blowholes, and the welder finds their surfaces so hard that he wonders what to do with the job. The blowholes should be melted well back into good metal and then filled with the proper cast iron welding rod.

A welder may have to weld a casting constructed of thick and thin parts (Fig. 2). He may take the proper precautions to preheat and unheat the casting, but when the job is done a crack is found through one of the thin sections of the iron, and the failure is usually charged to improper preheating. It may have been due to careless foundry prac-

Fig. 2—Cast-Iron Table of Boring Mill Saved by Welding

tice when the casting was made. As a rule iron castings are dumped from their sand molds while still red hot, and then, of course, the thin parts of the casting cool much more quickly than the thick ones. This may not cause any perceptible difference in the strength of the casting, but if a casting has only just solidified in the sand mold and it is dumped while bright red hot, the uneven contraction in the thick and thin parts will surely set up strains which almost but not quite crack the thin parts. Then when the oxyacetylene welder has to weld that casting the heating required will be sufficient to release the locked-up strains and a crack appears, which was due to careless founding and not to poor welding.

Again, a casting similar to the above may have been allowed to cool to a supposed safe dark red before being dumped, but it was winter time and the casting was molded near an outside door and uncovered there. Then the cold air caused such rapid cooling that unequal strains resulted. If these internal strains would always show themselves as cracks when the casting was machined, it would avoid many broken cylinders and other kinds of castings, and also make the work of the welder much more successful.

Another explanation of the unexpected cracked casting at the end of a good welding job is that sometimes the corners of the casting are left too sharp. This will cause a crack to appear through the corner which is almost always due to poor crystallization. This will be explained in detail in another chapter. A casting should never have sharp corners The patternmaker in the wood shop should see that the corners of the pattern for the casting are well rounded, called filleting. This will provide for proper shape of corner for the casting to ensure good crystallization and the iron will

Fig. 3—Use of Preheating Furnace During Welding of Cast-Iron Piston

be just as strong there as in any other part of the casting. Such filleted corners rarely ever cause the welder any trouble (Fig. 3).

Sometimes a welder when at work on new castings, supposed to be of exactly the same composition, may find some of the castings much harder to weld than the others. This is probably due to a change in the proportion of the chemical elements of the iron, which change may be due to the fact that the iron for the hard casting was the last drawn from the cupola, which is always the poorest in quality owing to the more unfavorable melting conditions in the cupola at the end of the heat. This last run of iron usually loses its softening carbon and silicon before it is poured, and hard castings result. The welder may have trouble with such castings because the metal is harder to flow with the torch, and the usual welding rod is really not of proper composition to make a soft weld, its silicon being too low. In such a case the welder should not use the regular welding rod, but should try to get a strip of what is known as high silicon iron from the foundry to serve as the filling metal.

There are other conditions which a welder has to meet in the welding of some iron castings. Sometimes the mold of a casting is not properly gated. Then after the molten metal has been poured into the mold it is not properly vented at the top, and the gases cause the upper layer of metal to boil which leaves it in a porous brittle condition. Strains are thereby set up in the upper part of the metal which cause no particular trouble until the surface is heated red hot, say by a welder. Then the strains let loose unevenly and the casting will be warped or bowed. Of course, even the welder himself may think he is responsible for the warping of the casting, but the fault really originated in the foundry.

Again the welder may have trouble in welding cast iron due to carelessness at the cupola in the foundry. The limestone flux used in the cupola primarily to collect the slag of the molten iron, also serves as an absorber of the sulphur in the iron and the coke fuel. A mistake in the use of this flux will sometimes cause the sulphur to segregate in the iron casting. Then when the welder meets these patches of high sulphur iron he will have the greatest difficulty to make a good weld, and he will wonder why part of the casting welded so easily while other parts seemed so different. It is almost impossible to make a good weld of sulphurized cast iron. About the best thing to do to such a job is to use a pure wrought iron welding rod instead of the regular welding rod. The pure iron rod being very low in sulphur tends to absorb some of the sulphur of the cast iron as the two metals are melted and run together, leaving a somewhat neutralized mixture of sufficient strength and fusion qualities to make a satisfactory weld.

We have thus given some illustrations of the source of weaknesses in some iron castings which may cause trouble for the oxyacetylene welder. They are intended merely to

Fig. 4—Welding Cast-Iron Base of Power Hammer

help him to better understand the problems he may meet in the welding of this metal. He must not forget that most iron castings have been properly made and that therefore there seldom are any good reasons why a welder should not make a good cast iron weld. The poor castings are the exception, not the rule (Fig. 4).

Chemical Nature of Cast Iron

It will be well to remember that the principal difference between cast iron and all the other irons and steels is the amount and proportion of the same chemical elements of the metals. An oxyacetylene welder of experience with cast iron knows that the metal will act strangely at times under the welding torch, while on other occasions it will melt and flow without any difficulty. This often is due to the chemical composition of the iron.

There are five chemical elements in all irons and steels; namely carbon, silicon, manganese, phosphorus, sulphur. A glance at the percentage composition of the typical irons and steels will show how much they are alike in chemical elements and still how very different they are in physical nature.

	Wrought iron	Machinery steel	Tool steel	Malleable iron	Cast iron
Carbon	.04	.15	1.00	2.25	3.25
Silicon	.05	.01	.15	.60	2.25
Manganese	.04	.50	.45	.20	.80
Phosphorus	.15	.07	.03	.15	.30
Sulphur	.02	.05	.03	.06	.08
Pure iron	99.70	99.22	98.34	96.74	93.32
Total	100.00	100.00	100.00	100.00	100.00
Tensile strength (lb. per sq. in.)	50,000	55,000	100,000	45,000	20,000

It will be seen that just by changing the amount and proportions of the chemical elements the pulling strength, called tensility, is greatly affected. For example, notice the loss of tensile strength between tool steel and cast iron of from 10,000 to 20,000 lb. per sq. in. due principally to increasing the amount of carbon and silicon. Just so these elements vary and affect the different grades of cast iron as the following table will show:

	No. 1 iron	No. 2 iron	No. 3 iron	No. 4 iron	No. 5 iron
Carbon (graphitic)	3.50	3.00	2.50	2.00	.20
Carbon (combined)	.15	.40	1.50	2.00	3.80
Silicon	2.40	2.50	.70	.60	.40
Maganese	.30	.70	.30	.70	1.00
Phosphorus	1.25	1.00	.25	.20	.04
Sulphur	.02	.02	.01	.08	.02
Tensile strength	15,000	20,000	40,000	25,000	18,000
Color of fracture	Dark gray	Medium gray	Light gray	Mottled.	White

The tensile strength of cast iron gradually increases from 15,000 lb. per sq. in. for No. 1 to 40,000 lb. for No. 3, and then decreases to 18,000 lb. for No. 5 iron. This is due to the relative proportions of graphitic to combined carbon.

By referring to the last table it will be seen first that there are five different grades of cast irons, and second that some are much stronger than others. Besides the hardness of these irons varies considerably, No. 1 being the softest, and the others increasingly harder up to No. 5 which is hardest of all, and too hard to be machined.

No. 1 iron is used for castings which must be very soft and do not require high tensile strength. Castings for electrical machinery are a good example.

No. 2 iron is stronger and harder than No. 1 iron, and would be found in castings for bed plates of machinery, brake shoes, general machinery, castings not subject to high strains, ornamental castings and the like.

No. 3 iron is still harder and has the highest tensile strength of all. It is used for locomotive and other high pressure cylinders, automobile and gas engine cylinders, high pressure pipe, flywheels, pulleys and other castings requiring the highest strength with good machinability.

No. 4 iron is getting a bit too hard for being machined. It is of good composition for car wheels, jaws for crushing machinery, hydraulic cylinders and for castings of hard wearing surface and of good strength.

No. 5 iron is very hard and is used for castings, which must resist wear, like balls and shoes for polishing mills.

Now it will be seen that all iron castings are not alike, as welders sometimes think, and to make successful cast iron welds requires that the chemical composition and physical strength of each casting should be given consideration.

In a Paper on Turbine Gearing, read before the Liverpool Engineering Society, S. B. Freeman explains that there have been attempts to harden the materials from which gears are cut. Grinding to correct deformations caused in hardening is the penalty. Since helical wheels cannot conveniently be ground, the straight spur tooth must be adopted. Large wheels cannot be ground at all by reason of technical difficulties. Methods of hardening the teeth locally by oxyacetylene or electric arc heating and rapid quenching are also being tried. The most common defects so far experienced in forged steel have been inadequate heat treatment and slag inclusions.—*The Engineer.*

Fuel Economy from Old Power Plant Equipment*

By A. R. Mumford

Assistant Fuel Engineer, United States Bureau of Mines

The fuel economy of a power plant may be better than its anxious friends realize. A watchful superintendent of a government plant, knowing that improvements in plant equipment had been made since his stokers were installed, was almost persuaded to substitute a new type. The Bureau of Mines was asked to ascertain the actual performance of the old stokers and found the plant already doing from three to five per cent better than promised for the new equipment.

The value of accurate knowledge of plant performance, and the need of equipment to weigh and measure quantities is thus demonstrated. The boiler and stoker efficiency was found to be 75 per cent, and the overall efficiency of the boiler, stoker, and economizer was 78 per cent. Both records are high, and are to be attributed to care in operation, to good working condition of the plant, and to the low rate of evaporation, which was only about two-thirds of the boiler's rated capacity.

Description of Plant Test

The plant tested consisted of two Babcock & Wilcox boilers fired by means of overfeed stokers and equipped with a fuel economizer in the uptake. The boiler supplied steam to two large water pumps. One of these pumps was operating continuously, the other being used only intermittently.

The results of the tests, appended in the table below, were computed from readings collected over a period of 100 hours, from 8 a. m. Monday, May 30, to 12 noon Friday, June 3, 1921. The flue gas losses were determined by analyzing gas samples and observing gas temperature for 20 hours with one water pump running, and for 16 hours with two water pumps running.

The coal was weighed in large truck loads and it was brought from the storage space.

The water, fed to the boilers through the economizers, was metered by a Neptune water meter as it left the feed pump. The meter was tested before and after tests by weighing water passed through it. The meter was read every hour both day and night. The temperature of the water as metered was read every four hours during the test from a thermometer inserted in the feed pump suction line. The temperature of the water as it entered the economizer and as it entered the boiler, after passing through the economizer, was observed every 30 minutes each day and every four hours each night, by means of thermometers inserted at corresponding points in the boiler feed line. The pressure of steam in the boilers was read every hour both day and night.

The level of the water in the boilers was brought to the same point at the end of the test as it was at the beginning.

The temperature of the gases leaving one of the boilers was measured by an exposed copper-constantan thermocouple which was inserted into the center of the opening through which the gases left the boiler. The proximity of the two banks of boilers at the plant made it impossible to place a thermocouple in the corresponding position on the other boiler. This temperature was recorded every 30 minutes.

The temperature of the gases leaving the economizer was measured by two exposed copper-constantan thermocouples inserted at the vertical center and spaced equally across the width of the opening through which the gases left the economizer. These temperatures were recorded every 30 minutes during each day, and their average was taken as the temperature of the gases leaving the economizer.

*Report of investigation by the Bureau of Mines, Department of the Interior.

Samples of gas were drawn from each of the points at which temperature measurements were made; that is, one sample as the gases left the boiler and one as the gases left the economizer. The samples were drawn continuously over half-hour periods during each day and analyzed in a water Orsat.

The coal samples were obtained from a pile made by throwing one shovelful aside for every 20 that were thrown into the weighing car. This pile was reduced by crushing and quartering to the three five-pound samples sent to the chemical laboratories of the bureau at Pittsburgh for analysis.

All of the ash removed from the furnace during the test was weighed and dumped in a single pile. This whole pile was reduced by crushing and quartering to the three five-pound samples on which the analysis was made.

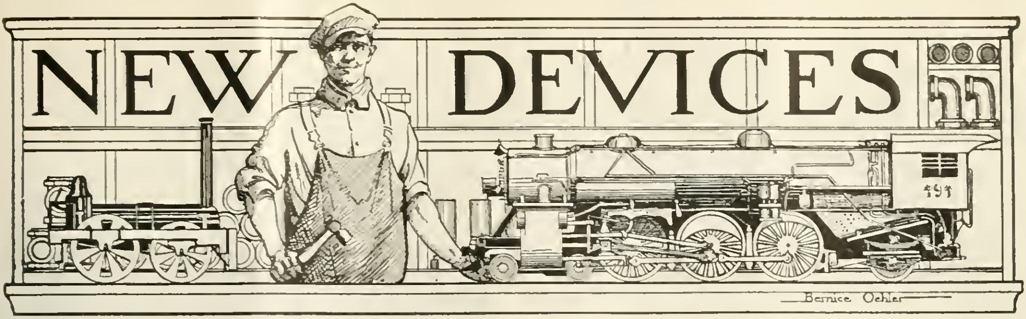
The average figures and the results of the test are given in the following table:

RESULTS OF TESTS OF TWO BOILERS AND ECONOMIZER

	General Particulars—Equipment	
1.	Type of boilers	Babcock & Wilcox, water tube
2.	Type of economizer	Green fuel economizer
3.	Type of stoker	Overfeed
4.	Heating surface, each boiler	2,058 sq. ft.
5.	Heating surface, both boilers	4,116 sq. ft.
6.	Heating surface, economizer	1,843 sq. ft.
7.	Grate surface, each stoker	45 sq. ft.
8.	Grate surface, both stokers	90 sq. ft.
9.	Production of draft	Chimney
	General Information	
10.	Duration of test	100 hrs.
11.	Duration one pump and auxiliaries running	49⅔ hrs.
12.	Duration two pumps and auxiliaries running	50⅓ hrs.
	Coal	
13.	Total coal fired	88,000 lb.
	Ultimate analysis coal as fired:	
14.	Hydrogen	4.5 per cent
15.	Carbon	86.1 per cent
16	Oxygen and nitrogen (by difference)	6.3 per cent
17.	Sulphur	.6 per cent
	Proximate analysis coal as fired:	
18.	Moisture	2.3 per cent
19.	Volatile matter	17.0 per cent
20.	Fixed carbon	72.2 per cent
21.	Ash	8.5 per cent
22.	Calorific value	13,900 B.t.u. per pound
	Ash and Refuse	
23.	Total removed	6,700 lb.
24.	Carbonaceous content	19 per cent
25.	Earthy matter content	81 per cent
	Flue-Gases and Air	
	Composition, per cent by volume, dry.	
	Gases leaving boiler No. 1, average for test:	
34.	Carbon dioxide	10.9 per cent
35	Oxygen	8.6 per cent
36.	Carbon monoxide	0.6 per cent
37.	Nitrogen	80.5 per cent
	Gases leaving economizer, average for test:	
36.	Carbon dioxide	9.6 per cent
47.	Oxygen	10.0 per cent
48.	Carbon monoxide	0.0 per cent
49.	Nitrogen	80.4 per cent
	Excess air:	
52.	In gases leaving boiler No. 1, average for test	66 per cent
55.	In gases leaving economizer, average for test	86 per cent
	Temperatures:	
58.	Gases leaving boiler No. 1, average for test	455 deg. F.
61.	Gases leaving economizer, average for test	327 deg. F.
62.	Air in fire-room	84 deg. F.
	Feed Water and Steam	
63.	Total water fed to boiler	906,800 lb.
64	Total water fed to boiler per lb. coal as fired	10.3 lb.
65.	Steam pressure	154 lb. per sq. in.
66.	Temperature of water entering economizer	171 deg. F.
67.	Temperature of water entering boiler	211 deg. F.
68.	Heat transferred to 1 lb. of water in economizer	40 B.t.u.
69.	Heat transferred to 1 lb. of water in boiler	1,016 B.t.u.
70.	Heat transferred to 1 lb. of water in boiler and economizer	1,056 B.t.u.
	Rates	
71.	Coal fired per sq. ft. grate per hr	9.8 lb.
72.	Water evaporated per hr	9,068 lb.
73.	Heat transmitted per sq. ft. boiler heating surface per hr	2.2 B.t.u.
74.	Heat transmitted per sq. ft. economizer heating surface per hr	0.2 B.t.u.

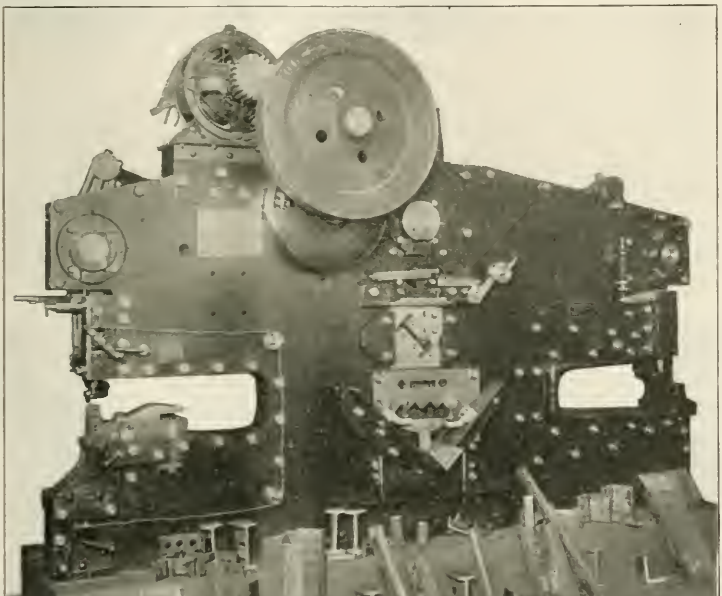
Heat Balance, Boilers and Economizer, Per Lb. Coal as Fired

		B.t.u.	Per cent
75.	Heat absorbed by boiler (and thermal efficiency boiler only)	10,460	75
76.	Heat absorbed by economizer	410	3
77.	Heat absorbed by boiler and economizer and overall—thermal efficiency	10,870	78
78.	Heat lost in dry gases leaving economizer above fire-room temperature	1,260	9
79.	Heat lost in steam in flue gases leaving economizer above fire-room temperature	470	3
80.	Heat lost by not burning carbon monoxide	0	0
81.	Heat lost in carbonaceous matter in ash and refuse	160	1
82.	Radiation loss and errors	1,140	9
83.	Total (Items 77-82) and calorific value of coal	13,900	100



Triple Combination Punch and Shear

THE combination punch, plate shear and bar, angle and tee cutter, illustrated and known as the type Bluefg, is being introduced to the railroad field by Henry Pels & Co., Inc., New York. This machine has given satisfactory service in various industries throughout the world and is accompanied by the strongest guarantees as to capacity, quality of material and workmanship. Owing to its heavy forged steel plate construction, the main frame is said to be absolutely unbreakable. This machine is particularly valuable for railroad as well as industrial shops because it will punch and cut boiler plate, shear rounds, squares, flats, angles and tees and bevel angles and tees from the smallest size up to the capacity of the machine, wholly without tool changes.



Pels Triple Combination Punch, Plate Shear and Bar, Angle and Tee Cutter, As Mounted on Special Foundation at Atlantic City Convention; Examples of Work in the Foreground

In addition, the Pels combination punch and shear will cut with interchangeable blades, beams and channels up to its capacity. Another important advantage is that three men can operate the machine simultaneously at its highest capacities without interfering with each other. Coping, notching and special punching attachments can be furnished as desired; also, blades for cutting rails or special shapes. The machine is made in nine sizes of any throat depth required.

When dull knives are used for cutting thin sheet steel, a greater stress is put on the machine than if a much thicker plate is cut with sharp knives. Sometimes a hard spot in the metal will cause the tensile strength to jump from 62,000 lb. per sq. in. to 100,000 lb. per sq. in. or over. This almost doubles the power required to shear the metal, and the forged steel plate frames of the Pels machines are designed to resist just such pressures. These plates are made up to 6½ in. thick.

In addition to a high quality frame, all gears of this machine are of steel with cut teeth. The pinions are machined from forgings. All bearings are bushed with phosphor bronze, being of ample size to carry the load without undue unit pressure. Ball or roller bearings are used where necessary. All working parts are forgings, the shafts being of crucible steel of generous dimensions. The main shafts have ring oilers and many of the eccentrics run in oil. Taper gibs are provided with easy adjustment to take up wear. No cast-iron parts are used in this machine.

It is obvious that the combination of so many functions in a single machine without tool changes is a great time-saving feature. A large proportion of locomotive and car repair work, for example, cannot be finished in a single operation. A plate usually has to be sheared and punched and then an angle, tee, or beam cut to go with it. These operations can all be performed on the Pels machine without losing time and effort in going to three different machines.

Overhead Crane with Double Hoist and Turntable Trolley

THE transverse type of locomotive repair shop offers economical use of the floor space, is convenient to work benches along the building walls and facilitates the floor traffic for handling material. The locomotives are placed on the transverse tracks either by means of an outside transfer table, which requires almost as much ground space as the shop itself, or by overhead traveling cranes of the double trolley type, which in turn necessitate a building high enough so that one locomotive can be carried above the others. In the longitudinal shop the locomotives are handled by two single trolley cranes and to economize on space the buildings should preferably be high enough to clear the tracks for carrying the engines to their different locations.

A type of overhead crane which makes it possible to combine the advantages of both types of shops has recently been developed by the Shaw Crane Works of Manning, Maxwell & Moore, Inc., New York. The photographs show a crane of this type installed at the River Rouge repair shop of the Detroit, Toledo & Ironton. The shop is narrow, the crane having only a 56-ft. span, and the engines are brought in on a longitudinal through track, running along one side of the building. For practical reasons the engines, or boilers as the case may be, must be placed crosswise while undergoing repairs, and it is necessary to turn them through 90 deg. This has been done heretofore by the use of two overhead cranes, a scheme which is both cumbersome and hazardous.

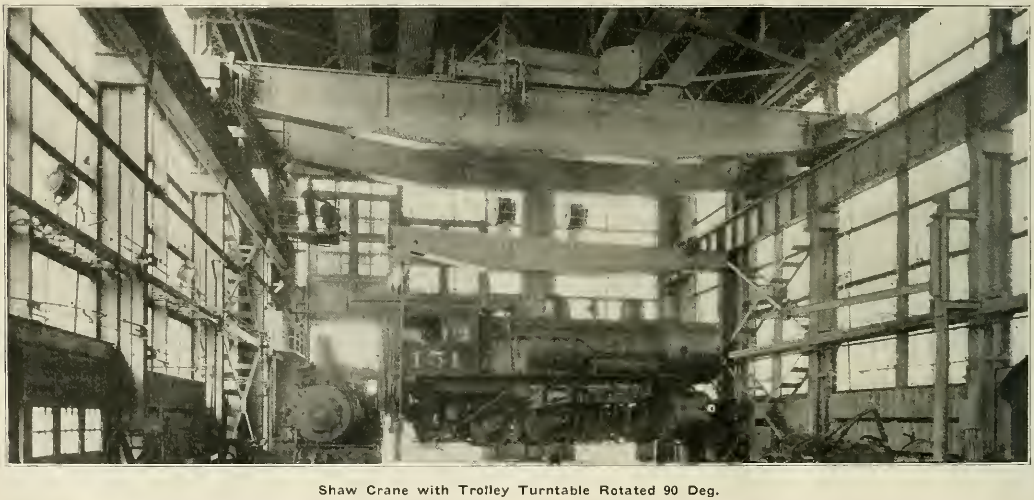
In the Shaw crane the problem has been solved by incorporating a turntable in the crane trolley so that the crane has four different movements, i.e., hoisting, cross travel, longitudinal travel and horizontal rotation. Thus it is practical to lift the engine off the longitudinal track, carry it down the shop and swing it into transverse position wherever there is a vacant repair pit. At no time is it necessary to lift one engine above another.

A crane of this type saves the wasteful use of ground space for a transfer table on the one hand or on the other hand the heavy and costly building necessitated if provision is made for handling one engine above another. The turntable crane trolley consists essentially of two parts, one upper revolving frame and one lower or trolley frame proper. The upper frame carries the hoisting machinery only. Two sets of ropes, spread seven feet apart and both operated on the same drum, carry a lifting beam which is provided with adjustable slings to accommodate different sizes and shapes of engines or boilers. This lifting beam is easily detachable and by substituting a short beam with a simple hook in the

Lifting the Locomotive from the Longitudinal Track

center, the crane may be converted into a standard traveling crane. On the under side of the revolving frame is attached a combination ring gear track and roller path, which in turn rests on conical rollers set in the lower or trolley frame. The lower frame also is provided with horizontal guide wheels to keep the roller path central. The revolving frame is turned by a motor mounted on the lower frame, which drives a large pinion meshing in the ring gear of the roller path, through a bevel and spur gear train. The lower trolley frame is equipped with the customary motor driven cross travel machinery. The crane bridge is practically standard.

Each set of falls has a lifting capacity of 50 tons and



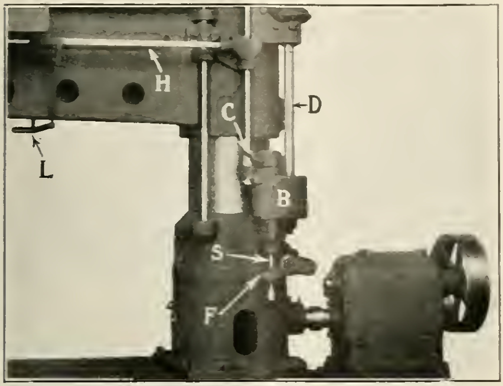
Shaw Crane with Trolley Turntable Rotated 90 Deg.

crane occupies practically no more room than a standard three movement crane and the cost is but little greater.

By reference to illustration it will be noted that the the turntable has a rotative speed of 1½ r.p.m. The crane shown is not equipped with an auxiliary hoist, but this can be included.

Power Column Clamp Applied to Radial Drill

In drilling at the extreme end of the arm on a large radial drill, it is inconvenient for the operator to leave his place and tighten the swinging column at each shift of the drill. Extra steps must be taken and the operator's attention is distracted from the drilling operation under way, with a resultant slowing down of production. To overcome this difficulty and make its radial drills more flexible and readily controlled, the Dresses Machine Tool Company, Cincinnati, Ohio, has brought out a power column clamping device. This device does not interfere in any way with the downward movement of the arm on the column and it is operated mechanically without the necessity of pneumatic hose or pipe connections.



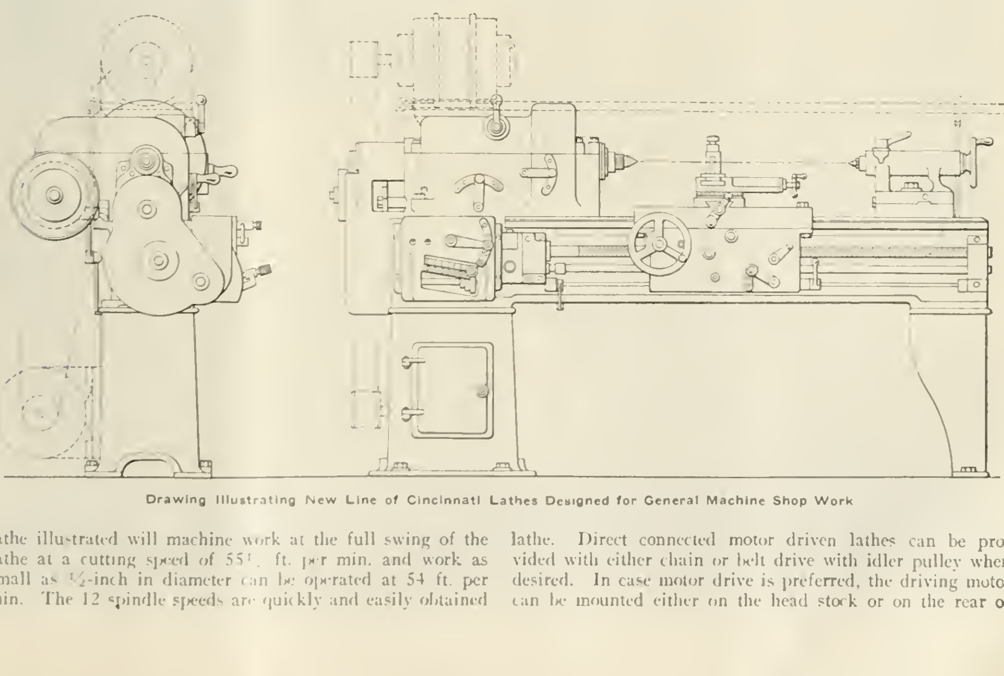
Dresses Radial Drill Equipped with Power Column Clamp

The illustration shows the rear of a Dresses radial drill with the new power column clamp applied. The device is attached to the lower bearing bracket of the vertical driving shaft *D* which furnishes the power. The shaft extends through the oval box *B* and, by means of friction clutches driven indirectly, the screw *S* below the box runs right or left-handed. On this screw works a nut to which is attached fork lever *F*. The hub of this lever is tapped and works on the column binding screw.

The engagement of the friction clutches in connection with the screw is accomplished by cam *C* on top of the box. This cam is operated by a splined vertical shaft, illustrated, a pair of bevel gears and horizontal shaft *H* which extends to a bearing on the extreme end of the radial arm. Shaft *H* is operated by lever *L* and connecting links which are attached and move with the drilling head. The friction clutches are self releasing and also slip at either end of the tightener levers, this movement preventing breakage.

Adaptable Quick Change Geared Head Lathes

Two views of the latest type of quick change geared head lathe, made by the Cincinnati Lathe & Tool Company, Cincinnati, Ohio, are shown in the illustration. Machines of this type are furnished in sizes from 16-in. to 30-in. swing. Perhaps the most distinctive feature is wide adaptability in general machine shop work. The 16-in. lathe illustrated will machine work at the full swing of the lathe at a cutting speed of 55$\frac{1}{2}$ ft. per min. and work as small as $\frac{1}{2}$-inch in diameter can be operated at 54 ft. per min. The 12 spindle speeds are quickly and easily obtained by adjusting the three handles shown in front of the head. The range is from 13.5 to 400 r.p.m., all speeds being in geometrical progression. It is said that the full range of these speed changes can be made in a length of time not exceeding 12 seconds.


Drawing Illustrating New Line of Cincinnati Lathes Designed for General Machine Shop Work

Whenever desired, an apron control is supplied with this lathe. Direct connected motor driven lathes can be provided with either chain or belt drive with idler pulley when desired. In case motor drive is preferred, the driving motor can be mounted either on the head stock or on the rear of the cabinet leg. When the lathes are supplied for single pulley belt drive direct from the line shaft, a rod is provided as shown at the top of the lathe or a handle for stopping and starting.

The powerful but sensitive disc clutch with brakes supplied in the new Cincinnati lathes has a neutral position which disconnects the spindle from all gearing, thus obviating the fly wheel effect of having heavy gears attached to the spindle. This feature is an important time saver while centering irregular work in the chuck, or in machining small parts where the chucking time is a large factor.

Surplus power to drive the lathes is insured at all times. For example with the 24-in. lathe, a 7½-h.p. motor is recommended, but with sufficient belt tension the lathe will absorb 15 h.p. under heavy cuts. Other sizes are in the same proportion, high power being developed and making the lathes adaptable to the more or less heavy duty encountered in railroad machine shop work.

Ball Bearing Universal Saw Bench

DESIGNED for ripping, cross cutting, dadoing and other accurate woodworking operations, the universal saw bench, illustrated, has been brought out recently by the American Saw Mill Machinery Company, Hackettstown, N. J. The bed of this machine is cast in one piece with a partition just behind the saws. This forms a bin for the saw dust with an opening for the exhaust pipe. A large door provides easy access to the saws. The table tilts to 45 deg. and has a scale showing the exact angle. The stationary section of the table is graduated for ripping up to 22 in. wide. The traveling section of the table runs on ball bearing rollers or can be locked in place. A lever moves it out 2¼ in. to provide space for the dado head.

The ripping gage will admit work up to 22 in. wide and has a 9-in. travel on a rack and pinion, allowing it to be quickly and accurately adjusted. The fence tilts to 45 deg. and angles to 35 deg.

A mitre cut-off gage can be used on either side of saw as the stationary and traveling tables are both provided with slots. It can be locked to the traveling table and move with it if desired. Graduations are provided to 60 deg. in both directions. The gage is equipped with a yoke for working on both sides of the saw. An adjustable stop gage is attached to the cut-off gage and is provided with a finger which clears the work when trimming.

The frame carrying the saws is heavy and mounted on a large shaft which revolves in bearings in the bed. A strong support is given to the saw frame by placing one of these bearings outside of the saws. Saw mandrels are accurately ground and mounted in ball bearings. Saws up to 14 in. in diameter may be used, a 14 in. saw projecting above the table 3½ in. A universal adjustable saw guard is furnished.

Hand wheels for tilting the table and for revolving the saw frame are located in the most convenient positions. The countershaft may be placed on the floor or underneath the floor. The loose pulley for the countershaft is fitted with roller bearings. The belt compensating device is provided with idler pulleys running in ball bearings. The equipment furnished includes one 14-in. cut-off saw, one 14-in. rip saw, a countershaft and belt shifter, ripping gage, mitre cut-off and stop gage, wrench, extension for mandrel to carry 2-in. dado with 1½-in. hole and a saw guard. This machine can also be furnished with babbitted bearings instead of ball bearings.

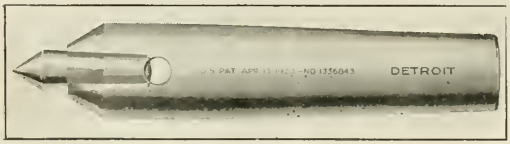
The floor space required is 48 in. by 44 in. and the size of the table 44 in. by 38 in. The tight and loose pulleys are 10 in. by 4½ in.; recommended speed, 750 r.p.m. The mandrel pulleys are 4 in. by 5 in.; recommended speed, 3,000 r.p.m. The power consumption of the machine is from 3 to 5 hp.

American Ball Bearing Universal Saw Bench

High Speed Inserted Point Lathe Center

THE inserted point lathe center, illustrated, is made by the Detroit Twist Drill Company, Detroit, Mich., and consists of two parts, a high speed steel center or point, and a sleeve of hardened carbon steel. The sleeve which serves as the holder is not subject to wear, and is permanent. The center fits into the tapered hole of the sleeve which takes up all wear, thus insuring accurate alinement and rigidity at all times. Both the hole and the center are ground to a Morse taper.

Only 10 sec. are required to change a point which can be done without removing the sleeve from the machine. This feature saves much valuable man and machine time. The high speed steel point has a long life, outlasting from 10 to 100 carbon centers and, when a new point is required, its cost is less than that of salvaging the ordinary center.

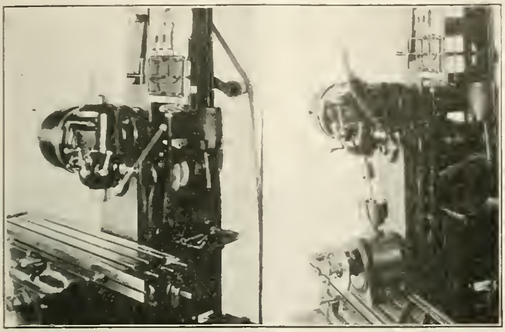


Detroit Lathe Center with Inserted High Speed Steel Point

Inserted point centers eliminate delays and shut downs due to burned and frozen points: reduce point grinding on the part of high-priced mechanics; permit the operation of lathes and grinders at continuous maximum speed, and cut the time for changing centers to an absolute minimum. The Detroit inserted point center has proved its value by extended tests.

Universal Milling and Drilling Attachment

A COMBINATION universal milling and drilling attachment valuable in tool rooms having considerable angular milling work to do has been developed recently by the Rockford Milling Machine Company, Rockford, Ill. This attachment is of substantial proportions as indicated in the illustration, being designed to stand up under heavy cuts.



Two Views of Rockford Universal Milling and Drilling Attachment

Four clamping bolts are provided to hold the attachment rigidly to the face of the milling machine column. There are two graduated bases at right angles to each other, both of which can be swiveled through 360 deg., this construction making the spindle completely universal.

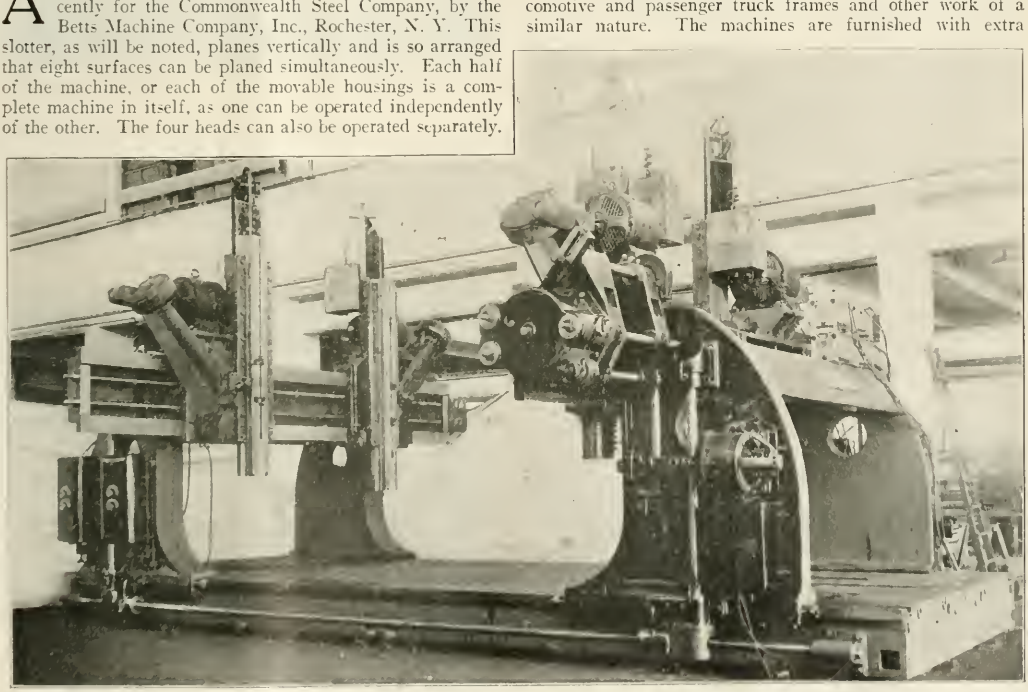
The drive is by means of a geared connection from the back of the main spindle through a driving sleeve substituted in place of the overhanging arm. From this sleeve the drive is transmitted through bevel gears, driving a set of hardened steel bevel gears solidly mounted on a shaft and arranged to drive the attachment spindle. An additional advantage is afforded from the fact that the main spindle of the machine is left free to be used as desired. On many jobs it is possible to do milling with the cutter inserted in the main spindle of the machine and angular milling or drilling at the same time.

It will be readily apparent that the many combinations of milling and drilling operations possible with this attachment make it unusually adapted for die cutting and similar work.

Traveling-Head Slotter of New Design

A NEW type of traveling head slotter has been built recently for the Commonwealth Steel Company, by the Betts Machine Company, Inc., Rochester, N. Y. This slotter, as will be noted, planes vertically and is so arranged that eight surfaces can be planed simultaneously. Each half of the machine, or each of the movable housings is a complete machine in itself, as one can be operated independently of the other. The four heads can also be operated separately.

The machine is used for slotting and vertical planing locomotive and passenger truck frames and other work of a similar nature. The machines are furnished with extra



Betts Traveling-Head Slotter Equipped with Four Separately-Operated Tool Heads heavy beds of any required length, on which are mounted the heads, and along which the heads can be traversed or fed. The heads are equipped with cross rails on which the tool bar saddles are traversed and fed across the machine. Each saddle has a rectangular tool bar, driven by a spiral worm which engages a wide rack of coarse pitch on the back of the tool bar. The tool bars or rams are balanced by counterweights and the stroke of the bars on each head is electrically controlled, one waiting for the other at the end of each stroke.

Each saddle and tool bar is equipped with a separate reversing motor, driving through worm and worm wheel at an angle of approximately 45 deg. This type of drive has long been in successful use on certain types of Betts machines where the service required was unusually severe. Each head is equipped with a separate electric feed motor which transmits power to two non-revolving screws for feed and rapid traverse to the heads as well as to the saddles on the cross rail.

A Simple Instrument for Steel Treaters

IN heat treating steel, quenching should always take place at the lowest temperature at which the particular steel will harden and an instrument known as the Kritiskope, designed to indicate these temperatures has been placed on the market by Herman H. Sticht & Company, New York. When most tool steels are ready to normalize, anneal or harden, the steel becomes non-magnetic at the critical points and the Nilson Kritiskope is designed to utilize this characteristic.

The device consists essentially of a high grade permanent magnet located within the Kritiskope proper and used to magnetize an indicator, pivoted in a slot in the end in such a manner that ordinarily it remains in alinement with the permanent magnet. This indicator is attracted by any magnetized piece of steel being heated in the furnace and remains in contact with that steel when the Kritiskope is in close proximity.

In operation as the steel approaches the cherry red condition, the furnace door may be opened slightly and the Kritiskope inserted so that the magneto-sensitive end first touches the material and then is withdrawn a trifle. If the steel is still magnetic the indicator is seen to remain in contact with the steel. This operation may be repeated from time to time as the rise in temperature proceeds until the steel no longer attracts the indicator. The steel is then ready for the quenching or other cooling operation.

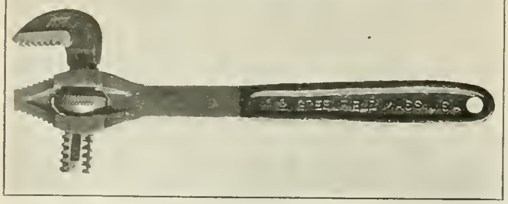
An important feature is the unique arrangement which guards against loss of magnetism. The indicator itself, which comes into direct contact with the heated steel is not magnetized and hence can be heated to a high degree without injury. This indicator receives its magnetization solely by induction from the permanent magnet. This magnet is protected against any undue rise in temperature by the special design of the Kritiskope and its thick walls. Since the instrument is exposed to heat for only short periods of time there is no danger of the permanent magnet being injured. The Kritiskope is furnished complete with extension rods

Nilson Kritiskope for Indicating Critical Points in Steel

and a hand protection shield. Advantages claimed for this instrument are that it is direct reading and indicates the condition of the steel; it does not require calibration, is not affected by vibration and is self contained, being free from any leads or electrical connections.

Pipe Wrench Designed for Difficult Corners

THE Little Giant pipe wrench, embodying several interesting new features, has just been put on the market by the Greenfield Tap & Die Corporation, Greenfield,



Little Giant Pipe Wrench Embodying New Principle of Design

Mass. This wrench has the "end opening" feature which is familiar to users of machinists' wrenches. Its application to pipe turning can readily be seen by a glance at the illustration.

One important advantage of the Little Giant wrench is the ease with which it can handle pipes in corners, close to walls, and similar confined places. The person using it can set it straight on the pipe as he would a pair of pliers, instead of having to fit the jaws on from the side. There are only three parts: a handle and jaw in one piece, which is drop forged and heat treated; a movable jaw, likewise drop forged and heat treated; and a hardened steel nut. In spite of the absence of springs the wrench is said to take hold and release instantly at the option of the user.

The new wrench has been designed for maximum strength, the 14 in. size having successfully withstood stresses in excess of 4,700 in. lb. without slipping or bending. Yet owing to the elimination of extra parts the wrench is relatively light in weight.

Another feature is the double set of teeth on the main jaw. The movable jaw can be engaged at the option of the operator with either of these sets of teeth with consequently lengthened life. On the large sizes, 14 in. and greater, two additional sets of teeth are provided, making four in all, and the movable jaw can be reversed to engage these additional sets of teeth, which are below the adjusting nut. This is very useful in connection with certain classes of work, beside tending to quadruple the life of the tool.

The Little Giant wrench is being manufactured in 8-, 10-, 14-, 18- and 24-in. sizes, of which the three smaller sizes are already on the market.

Universal Slitting Shear and Bar Cutter

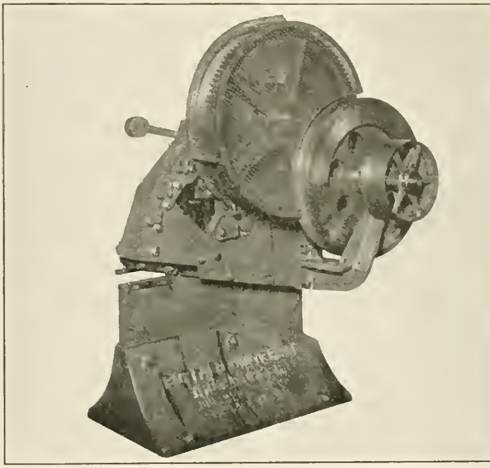
The Buffalo Forge Company, Buffalo, N. Y., has just placed on the market a universal slitting shear and bar cutter. The shear is equipped with 10-in. knives which will cut plates 1/2 in. thick, of any length and width, or 6 in. by 5/8 in. flats. The knives may be operated at the rate of 30 strokes per minute.

The bar cutter has standard five-piece knives which will cut the following: 4 in. by 4 in. by 3/8 in. angles, square; 3 in. by 3 in. by 1/4 in. angles 45 deg. mitre, left or right hand; 3 in. by 3 in. by 3/8 in. tees, square; round bars up to 1 5/8 in. in diameter; square bars up to 1 1/2 in.

With special knives, furnished by the Buffalo Forge Company, the bar cutter will take 5-in., 9.75-lb. beams and 5-in., 9.00-lb. channels, or any other rolled section having the same weight and area. One set of blades shears both channels and beams of the same size, a pair of knives being required for each size.

This machine has the Buffalo armor plate frame which is guaranteed unbreakable. Bearings are bronze lined. The drive shaft runs in oil-ring bearings. The gear and pinion are cut from semi-steel blanks. A feature of the machine is its cast iron base, which makes an expensive concrete foundation unnecessary.

The length of the entire machine is 5 ft. 4 in., the width 2 ft. 8 in. and the height 6 ft. 4 in. The total weight is 4,500 lb. Approximately 3 hp. is required to operate the machine at capacity. In railroad blacksmith and boiler shops especially, the new Buffalo universal slitting shear and bar cutter should prove a valuable machine for saving time and expediting the work of these two important departments.



Buffalo Universal Slitting Shear and Bar Cutter for Railroad Shops

Chain Screen Doors for Boilers and Furnaces

Recent developments in Wiegand chain screen doors, made by the E. J. Codd Company, Baltimore, Md., indicate that this device is of especial value in increasing the efficiency of furnace operation. The principal advantages of the chain furnace door are due to the fact that it is easily penetrable, affording an unhampered view of the interior of the furnace, and assisting materially in keeping heat in and cold air out. The door consists of a curtain of chain which effectively hinders the passage of gases, sparks and air. The loosely hanging strands of light chain are parted with ease and pressed aside by the tools or other objects projecting into the furnace only to fall together again and close the opening when the entrance has been effected. The operator is at the same time protected from the heat and can see what is going on in the furnace. It is said that fine coal and light shavings can be thrown through the chains from a shovel. When the screen is hit by the edge of the oncoming shovel, the chains swing inwards and upwards admitting the fuel.

Cleaning a Fire Through a Weigand Chain Screen Door

These chain screen doors are made in different types and with different methods of suspension for use on drop forge furnaces, annealing furnaces, electric furnaces and the furnaces of stationary boilers, etc. Wherever a furnace is kept at a high temperature and it is necessary to have a door for the feeding or manipulation of the contents, these auxiliary chain doors effect fuel economy, avoid damage and delay from chilling drafts to the furnace and contents and tend to provide the maximum possible efficiency, comfort and safety of the workmen.

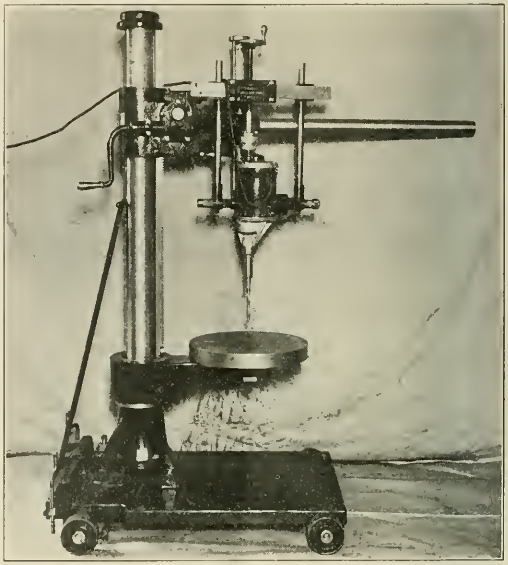
The door shown in the illustration is automatic in action, the chains rolling down over the main boiler door opening as soon as the doors are opened. On other types of furnace in which the door slides vertically, the protecting screen door is so arranged as to drop automatically and cover the opening as the door is lifted. Tubular ends are sometimes provided on the chains to prevent tongs and other tools from catching. In some screens these tubes form nearly all the screens, only enough chain being left at the top to give flexibility and visibility. The tubes in this case hang very close together and make a practically air-tight door.

Portable Electric or Pneumatic Radial Drill

An interesting design of portable radial drilling machine, known as the Lindhe portable radial has been placed on the market recently by Manning, Maxwell & Moore, Inc., New York. This machine equipped with an electric portable drill of suitable capacity is shown in the illustration. The tool is substantial in construction, consisting of a portable drill in a universal head, mounted on a radial arm capable of vertical adjustment on the column. The column swivels on a base rigidly attached to the truck which permits easy movement on the floor to various places where work is to be performed. The base is supplied with sliding bars, adjustable where the floor is not level; also offering a lock for the truck while the drill is in operation. The radial arm is movable on its brackets and can be swung in a full circle providing positions desired at any height or angle within its reach. An eyebolt in the top of the column affords means for lifting the machine with a crane.

The universal head, mounted on the radial arm and carrying the drill, will slide about and rotate around with the radial arm which furnishes additional movements for positions desired while drilling. The universal drill head has a feed screw for hand pressure while the drill is in operation, thus permitting full control. All of the above mentioned movable parts are provided with strong locking devices for securing them in position. All gearing is enclosed and dust proof, being self lubricating. The cross bar section on the universal head is provided with chains to furnish support should the work be heavy or if work is in an extremely remote position to the machine. The machine can be furnished with any make of electrical or pneumatic portable drill or with fittings so that the customer may attach his own drill.

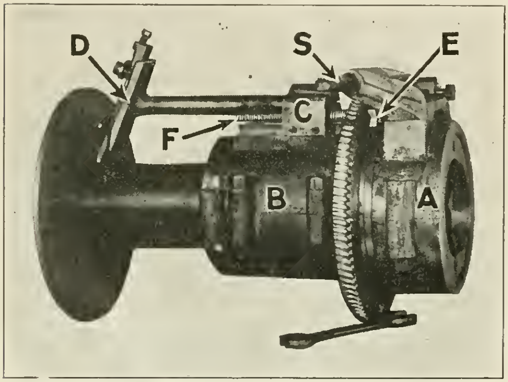
The base of the machine is 30 in. by 43 in., the extreme height of the drill above the floor being 5 ft. The radial arm is 4 ft. 6 in. long measured from the center of the column. The drill table is 18 in. in diameter which is also the distance from the center of the column to the center of the table. The diameters of the column, radial arm and wheels are 4½ in., 3 in., and 5 in. respectively.



Lindhe Portable Radial Equipped with Removable Electric Drill

Portable Locomotive Journal-Turning Machine

An ingenious portable device for turning locomotive driving axle journals which has received the approval of practical railroad shop men is shown in the illustration. The principal object of the device is to provide a portable machine for truing locomotive and car journals, crank-pins, etc. This tool can be applied without removing the wheels, an important advantage at points not equipped with sufficiently large lathes or powerful hydraulic presses. Other advantages are that the device may be applied to axles of different sizes and by means of an improved clamping arrangement, the machine is held concentric with the original journal.



Journal-Turning Machine Set Up on Axle Ready for Operation

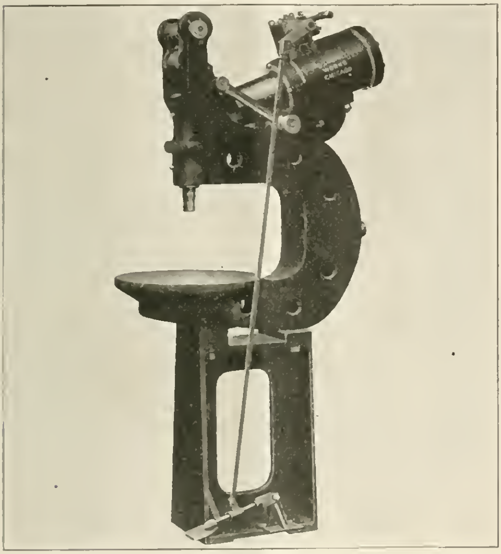
Referring to the illustration, the machine consists of a hollow stationary arbor *A* and a revolving tool arbor *B*, made in two parts for application to the axle with the wheels applied, and firmly held in correct alinement with each other by means of tongues and grooves and the necessary bolts. Tool arbor *B*, carrying the sliding tool post *C* and tool holder *D*, is rotated by means of a suitable electric or pneumatic motor attached to spindle *S* and transmitting power through a worm and the large worm wheel shown.

The feed for the cutting tool is obtained by means of star wheel *E*, direct connected to feed screw *F*. Every time the tool arbor revolves one point of the star engages a trip pin, giving the feed screw a partial revolution and advancing the cutting tool in proportion. Various types of tools may be employed in the tool arm *D*. A sliding tool post is provided with a clamp screw by means of which the tool is held in place.

Particular attention is called to the ingenious method by means of which this portable journal-turning tool is alined in the proper position and rigidly held in place. Taper keys on the inside of stationary arbor *A* are driven simultaneously by means of a wedge collar shown at the right end in the illustration. This wedge collar is threaded externally and runs in an internally threaded chamber in arbor *A*. The wedge collar is turned by means of a spanner wrench, revolution of the wedge collar setting up the taper wedges uniformly. Extension keys are also provided so that the machine may be fitted to axles of different sizes. Inasmuch as the tightening action of the wedges increases steadily throughout the entire length, there is no greater stress at one point than another. Pressure is applied uniformly and the machine is positioned concentric with the original journal. Both United States and Canadian patents on this portable journal-turning machine have been granted to Claude E. Marsh, Atlanta, Ga.

Pneumatic Toggle and Lever Press

A GENERAL utility press, operated by compressed air or steam, has been developed for the market by the Hanna Engineering Works, Chicago. The type used for compressing or packing is shown in the illustration. This press is arranged as required with various forms of platens, tables or work-supporting structures which make it especially adaptable to straightening, bending, forcing, forging and similar work.



General Purpose Press Made in Capacities from 15 to 200 Tons

The length of die stroke is variable. No more than the rated pressure is exerted by the die regardless of the amount of die travel. The connecting mechanism between the die and the actuating air piston, being a combination of toggle and lever, results in the air piston, while traveling at a uniform speed, imparting to the die a gradually decreasing speed. Increasing pressure relative to the movement and pressure of the piston is secured during the first portion of its stroke. A substantially uniform speed and pressure and uniform relation to the movement of the piston is obtained during the last portion of the stroke. The first portion of the die stroke (increasing pressure stroke) is from 1½ in. to 4⅝ in. long, depending on the pressure rating of the machine. The last portion of the die stroke (uniform pressure stroke) is from ⅜ in. to 1⅛ in. long.

This press is made in 10 sizes from 15 to 200 tons. It is portable in the sense that it can be moved without moving any auxiliary equipment. The floor space required is small. Manipulation of the operating valve is by hand or foot. The die is mounted on an adjusting screw. For bending and straightening operations this machine is well adapted since the pressure on the die builds up only as the air pressure builds up on the piston. It is possible then by throttling the air to bring upon the work just sufficient pressure to deflect the work the desired amount and then the pressure is released. If the die travel is stopped by the resistance of the work at any point within the uniform pressure stroke (anywhere beyond half piston stroke) the pressure on the die is a known predetermined amount in direct proportion to the air line pressure. Line air pressure is controllable by a pressure regulating valve within five per cent, thus affording ample control over the working pressures on the die.

Air Tight Cast-Iron Furnace Door

IT is impossible to secure maximum boiler furnace efficiency unless the amount of excess air is maintained within certain pre-determined limits. Leaks in the boiler settings around the furnace doors have a tendency to admit too much air which must be heated to a high temperature and escape through the stack, carrying away many valuable heat units.

Realizing the needs of stopping such leaks, the Conveyors' Corporation of America, Chicago, has developed a new 15 in. by 16 in. cast-iron door, designed to be air-tight and positively prevent the ingress of air or the leakage of gases. This door is especially suited for use on boiler furnaces, being designed for this particular service. It can, however, be used in any place where an air tight cast iron door is needed.

The door is substantially made of cast iron. All bearing surfaces are machined to make an air tight contact. Floating hinges, pivoted to the door at the center insure an even pressure over the door when it is closed and locked. The door can be provided with either of two types of locks—with a wing nut at the end of a hinge bar, or with a lever locking device which is recommended when the door is subjected to frequent opening and closing.

Doubtless Much Equipment manufactured is not ordinarily known about. How to select the best machine adapted to particular needs is a matter of engineering judgment gained through the experience of successful installations in other plants.

The man who buys on price alone doesn't always get what he thinks he does. Correct engineering analysis, a good machine, and subsequent service are worth a fair price. *Factory.*

GENERAL NEWS

The Ashley, Drew & Northern has announced that it will install oil burners on all its locomotives in the near future.

A screw coupling is still used on British rolling stock. According to a statement in the Engineer, London, there were 623 broken couplings on drawbars on passenger trains and 2,558 on freight trains in Great Britain during the first five months of 1922.

A report from Stockholm says that, after tests extending over 10 years, the Swedish State Railway Board has ordered from the Skandinaviska Kullagerfabriken 1,360 ball-bearing boxes for use on 140 wagons. The tests showed that the ball-bearing system possessed great advantages as regards safety in working, saving of power, economy in lubricants, and reduced supervision.

Bad Order Cars

According to the Car Service Division of the American Railway Association, bad order cars showed a reduction during the half month ended July 1 to 14.3 per cent of the total, as compared with 14.6 on June 15.

New Locomotives for Swiss Federal Railways

The Swiss Federal Railways have recently ordered from Swiss factories 20 electric express locomotives with a maximum speed of approximately 56 miles per hour. The locomotives will take about two years to build. During the next four to five years a total of about 100 new electric locomotives are to be built for the Federal Railways.

Roller Bearings for English Cars

The Great Eastern Railway of England has equipped a coach weighing about 60,000 lb. with a set of roller bearings in order that the design may be tested out in service and information obtained in regard to durability, reliability and wear. This bearing was designed by the mechanical department of the road under the direction of Sir Henry W. Thornton, general manager and engineer-in-chief. The rollers are said to be of a special steel, very hard but not brittle, which was developed during the war.

Westinghouse Ships Second Consignment for Chile's Electrification

A second train of electrical equipment for Chile, a part of the Westinghouse Electric & Manufacturing Company's $7,000,000 contract, left the company's East Pittsburgh plant last week.

This second train was dubbed the "International Trade Special." No locomotives have been shipped on this order as yet, however, but this movement will begin shortly. The contract calls for the delivery of 39 locomotives.

The equipment shipped in this consignment included 2,000 k.w. motor generator sets for installation in three sub-stations under construction at Vina del Mar, San Pedro and Llai Llai; transformers, switching equipment for three sub-stations, 15 lightning arresters, three switchboards of 20 panels each and 44 circuit breakers.

Unsafe Practices in Handling Explosives

Numerous important suggestions for avoiding danger from explosive and inflammable articles are contained in Bulletin No. 56, recently issued by the Bureau of Explosives. One of the most important matters discussed is the handling of casinghead gasoline. In spite of the wide publicity given to the dangerous character of this commodity after the disastrous explosions at Ardmore, Okla., in 1915, and at Memphis, Tenn., in 1921, three accidents occurred during May and June as results of failure to observe the rules of the bureau. The bulletin again calls attention to the necessity for relieving internal pressure through the safety valve before dome covers are removed and for cooling cars in case the pressure rises and gas is discharged through the valve. Other causes of accidents noted in the bulletin are the storage of black powder at too short a distance from a car storage yard and disregard of a smoldering fire while handling a car of naphtha involved in a wreck.

Freight Car Loading

A slight increase was shown for the week ended August 12. The total, 852,480, was an increase of 44,311 cars as compared with the corresponding week of 1921 and a decrease of 118,689 as compared with the corresponding week of 1920.

Engineering Societies to Be Represented at Brazilian Exposition

Calvin W. Rice, secretary of the American Society of Mechanical Engineers, has been appointed official delegate to the Engineering Congress to be held in connection with the International Exposition at Rio de Janeiro next month. In addition to the American Society of Mechanical Engineers, Mr. Rice will represent at the congress the Federated Engineering Societies, the American Institute of Electrical Engineers, the Enginering Foundation, the John Fritz Medal Board, the Engineering Division of the National Research Council, the Engineers' Club of New York City, and other organizations.

The Engineering Congress at this exposition is another phase of the worldwide engineering movement sponsored by leading engineers and government officials in the principal countries of the world. Mr. Rice, in addition to his work at the congress, will visit numerous South American engineering centers in behalf of the American Society of Mechanical Engineers and of organized engineering in general. His itinerary includes Rio de Janeiro, Buenos Aires, Santiago, Valparaiso, Callao, and Havana.

Transportation of Natural Gas Gasoline

The results of a study of the hazards involved in the transportation of natural gas gasoline, made by the Bureau of Mines, in cooperation with the Association of Natural Gasoline Manufacturers and the Bureau of Explosives, are given in a report by D. B. Dow, chemical engineer of the Bureau of Mines, which is now being distributed by the Association of Natural Gasoline Manufacturers, 821 Mayo building, Tulsa, Okla. The investigation was undertaken at the request of the Interstate Commerce Commission.

Several very disastrous explosions and fires have occurred in the shipment of natural gas gasoline. The Ardmore, Okla., explosion of September 27, 1915, in which 47 were killed and 500 injured, was the most disastrous. Shipping regulations designed to prevent such accidents have failed in many cases to accomplish their purpose, and new regulations have been proposed in the hope that accidents may be prevented in the future.

It was found that pressure developed in standard cars was much higher than pressure developed in insulated cars, particularly in summer months. Due to this difference in pressure, insulated cars are desirable for the shipment of natural gas gasoline, not only from the standpoint of safety, but also from the standpoint of economy.

Every effort should be expended in prevention of carelessness in unloading tank cars of natural gas gasoline. The men who have charge of unloading should be thoroughly instructed as to proper methods of procedure and be required to pass examinations as to their fitness for this work.

Baldwin Locomotive Works Issues Quarterly Magazine

Under the title "Baldwin Locomotives," the Baldwin Locomotive Works has published the first issue of a periodical devoted to the interest of transportation and motive power problems. It is intended to illustrate from time to time the newest types of locomotives constructed at the Baldwin Works and to present articles on technical or commercial subjects allied to transportation. The first issue, dated July, 1922, contains articles on the first uniform gage transcontinental railway in South America, on the lubrication of railway car journals, and on South American business. The locomotives described include the Consolidation type built for the Western Maryland, Santa Fe and Pacific types built for the Argentine state railways and also logging and tank locomotives. The interests of foreign readers have not been overlooked as some of the articles are published in both English and Spanish and the locomotive specifications are given also in French and Portuguese.

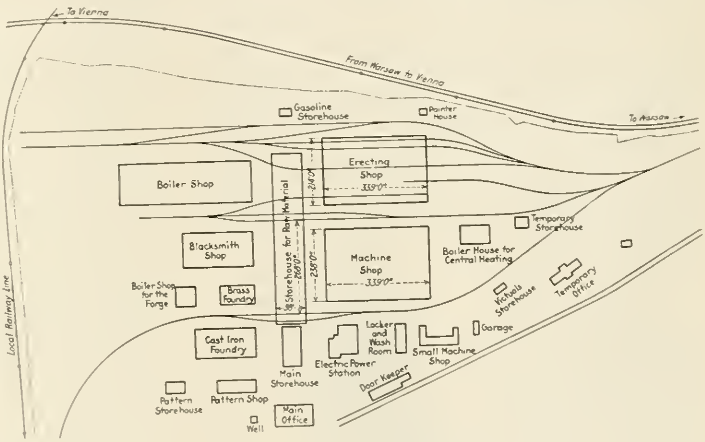
The First Locomotive Works in Poland

J. Dabrowski, Chrzanow, Poland.

One of the most important problems of the Independent Polish Government and of private industry has been to restore the railways and to increase the number of locomotives. This question became the more vital as the geographical situation of Poland makes it a natural mediator between west and east. For normal transport conditions there are necessary now about 3,000 additional new locomotives, the average number of locomotives needed for 1 klm. of railway track being in Europe about 0.4.

The First Polish Locomotive Works Ltd., Chrzanow, Poland, are really the first step in the development of this industry in Poland and they have received a government order for 1,200 new locomotives. The works in question are advantageously situated near the coal mines and industrial districts of Upper Silesia.

In proportions and arrangement the buildings are unlike the other plants completed during recent years in that country and they embody a number of features that warrant detailed consideration. The main buildings of reinforced concrete are spacious and secure an abundance of natural light by large windows and glass areas in the roof. The erecting shop has ground dimensions of 339 ft. 6 in. by 217 ft. 4 in. and consists of four parallel bays. The bay heights were determined very largely by the crane requirements. The main bay is equipped with a crane runway for two 50-ton cranes with top of rail 36 ft. 1 in. and two 10-ton cranes with top of rail 22 ft. 2 in. above the floor. The machine shop has ground dimensions of 339 ft. 6 in. by 238 ft. 2 in., is divided into seven



Plan of the Shops of the First Polish Locomotive Works

General View of the First Polish Locomotive Works

parallel bays and provided with six cranes ranging from 5 to 15 tons. The position of the other buildings relative to the whole plant is shown in the general plan.

As to the internal equipment of the shops it was the policy of the management to apply all technical improvements in both machine tools and working methods. Special machine tools, high speed steel, electric drive, interchangeability of parts, modern systems of shop management were taken into most careful consideration.

All electric current used in the shops is purchased from the neighboring electric power company being received as 22,000 volt 50 cycle, three phase alternating current, which is reduced by transformers to 380 volt three phase 50 cycle current. Rotary converters are also provided to supply 220 volt direct current which is used to operate the variable speed motors of machine tools. All cranes, except those of the cast iron foundry, are operated by alternating current.

The management of the works pays much attention to American industry and American methods of working and has active intercourse with many firms of this country. The present financial difficulties due to the low rate of exchange of Polish money do not permit the realization of many intentions. The first locomotives should be assembled this year.

The First Polish Locomotive Works is a private company with financial support of the Polish banks.

St. Louis Power Plant Will Use Pulverized Fuel

The Union Electric Light & Power Company, a subsidiary of the North American Company, has decided to adopt powdered fuel for its new $6,000,000 power plant now under construction in St. Louis. This plant, of which 60,000 kw. will probably be in operation next year, will have an ultimate capacity of 24,000 kw. and is to supply the increasing industrial and lighting load in St. Louis. The decision to adopt powdered coal as a fuel was made after extensive tests and investigations of stoker equipments and pulverized fuel equipments, including the plant of the Milwaukee Electric Railway & Light Company which has been using powdered coal for sometime with very satisfactory results. Investigation showed that for the conditions which would exist at the St. Louis plant powdered fuel, using mine sweepings, low grade and unmarketable coals, would be more economical than a stoker installation. In the event of emergency, from strikes or other causes, fuel oil may be used in the same furnaces without change

Labor Board Decisions

ONE ORGANIZATION TO REPRESENT EMPLOYEES.—For several years rules governing the rates of compensation and service of enginehouse employees and fuel handlers on the terminal division of the Boston & Maine have been made by agreement between the management and a committee affiliated with the Knights of Labor. Since September 1, 1917, the rules covering store department employees in oil rooms and enginehouse storerooms on the Boston Terminal have been negotiated between the management and a similar committee. Under Decision No. 119, and especially principle 15 in Exhibit "B" of that decision, the railway management, has considered as one class all laborers in and around shops, enginehouses and storehouses; and has found by vote of the employees that a majority of this class, taking the railroad as a whole, desired to have the United Brotherhood of Maintenance of Way Employees and Railway Shop Laborers represent them. The management accordingly proceeded to negotiate an agreement with a committee from that organization. The employees on the Terminal division contended that the separate agreement with the Knights of Labor should continue. The Labor Board decided that the management acted properly in negotiating an agreement with the maintenance of way organization. This decision, however, does not prevent employees from designating representatives of their choice to handle with the management matters affecting their wages and working conditions, provided such procedure is in conformity with the rules incorporated in the agreement entered into with the maintenance of way organization and the provisions of the Transportation Act.—(*Decision No.* 1121.)

Improved Condition of Palestine Railway System

Local communications have been greatly improved within the past year, and today Palestine enjoys probably the best railway, telephone and telegraph and mail service in the Near East, according to advices from the U. S. Shipping Board representative at Constantinople.

An efficient railway system in Palestine is a heritage of the war. In their military operations the British built the line from Kantara on the Suez canal to a point near Gaza, connecting there with the old pre-war narrow gage system. The gage was broadened and an extension built into Haifa. The system, now 500 kilometers in length, connects with the Egyptian State Railways at Kantara and with the Syrian railways in the north.

The motive power and rolling stock is in first-class condition. American locomotives built in 1918 for the British war department are used, having evidently been turned over to the Palestine railways. A few mountain saddle-tank type locomotives built in Leeds, England, have been added recently. A number of new passenger coaches from England, together with international sleeping cars afford good accommodations to travelers. Daily passenger and mail service are proving beneficial to business.

L. & N. W. Asks Employees for Suggestions

In a circular Arthur Watson, general manager of the London & North Western, asks employees for suggestions as to improved service and efficiency. The circular reads in part:

"It is further recognized that almost every railway employee has ideas concerning the management or working of his railway, but that there has existed a certain amount of diffidence, and in some cases, difficulty, in making known those ideas to some one in authority. Suggestions from the staff on all matters likely to promote the economical working of the concern or to increase the receipts are, therefore, welcomed. Such matters are:

(a) Any new method—mechanical or electrical—which it is believed will result in economy.
(b) The elimination of the waste of engine power, stores and materials.
(c) Improved methods of working trains or road vehicles and accelerating movement.
(d) Improvement in rolling stock and equipment.
(e) Improvements in passenger and goods station working.
(f) Improvements in stationery forms, office methods and equipment.
(g) The prevention of accidents.
(h) The improvement of relations with our customers and the securing of additional business to the company."

MEETINGS AND CONVENTIONS

Steel Treaters and Drop Forgers Will Meet in Detroit

Final arrangements are being made for the fourth international steel exposition and conventions of the American Society for Steel Treating and the American Drop Forging Institute to be held in the General Motors building, Detroit, Mich., Oct. 2-7.

The exposition will be the largest ever held as practically all of the floor space has been sold and many exhibitors who desired to be present cannot be accommodated. There will be quite a number of exhibitors not present at previous shows due to the fact that the Drop Forging Institute is holding its annual convention simultaneously and in the same building with the American Society for Steel Treating.

The General Motors building is especially adapted for exhibition purposes. In the large exhibition hall, there are 30,000 sq. ft. while the two wings on the same floor leading to the exhibition hall have 20,000 sq. ft. of additional display space. Arrangements have been made so that in one section of the hall gas furnaces will be in operation, while electrical furnaces and other equipment requiring power will be displayed throughout the hall. Practically all of the exhibits will be in operation.

At the three previous expositions held at Chicago, Philadelphia and Indianapolis, the attendance has been in excess of 10,000 and it is expected that because of the great interest in Detroit as a heat treating center as well as a market for steel products, the attendance will be in excess of 15,000.

C. I. C. I. & C. F. A. Convention

The annual convention of the Chief Interchange Car Inspectors' and Car Foremen's Association, which was to have taken place at Chicago, August 22-24, has been postponed and will be held at the Hotel Sherman, Chicago, November 6-8.

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

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City. 1923 annual convention; Denver, first Tuesday in May.

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

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

Division V.—Equipment Painting Division.—V. R. Hawthorne, Chicago. Annual meeting postponed.

Division V.—Purchases and Stores.—W. J. Farrell, 30 Vesey street, New York.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago. Annual convention will be held at the Hotel Sherman, Chicago, September 5-8.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, A. F. Stuebing, 2201 Woolworth Building, New York.

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

American Society for Steel Treating.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention and exposition postponed until October 2-7, 1922, Detroit, Mich.

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

Canadian Railway Club.—W. A. Booth, 53 Rushbrook St., Montreal, Que. Regular meeting second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal.

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

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo.

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. September 14 meeting postponed.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill. Annual convention November 6-8, Hotel Sherman, Chicago.

Cincinnati Railway Club.—W. C. Cooder, Union Central building, Cincinnati, Ohio. Regular meetings second Tuesday, February, May, September and November.

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

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich. The 1922 annual convention has been cancelled.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabash Ave., Winona, Minn. The 1922 annual convention has been cancelled.

Master Boilermakers' Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Regular meetings second Tuesday each month except June, July, August and September, Copley Plaza Hotel.

New York Railroad Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Regular meetings third Friday of each month, except June, July and August, at 29 West Thirty-ninth street, New York. Next meeting September 15. H. C. Pearce, director of purchases and stores, Chesapeake & Ohio, will present a paper on The Real Functions of the Department of Purchases and Stores.

Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Next meeting September 28, Fort Pitt Hotel, Pittsburgh. Paper on The Designing and Building of Steel Freight Car Equipment will be presented by J. A. Pilcher, mechanical engineer, Norfolk & Western, Roanoke, Va.

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

Traveling Engineers' Association.—W. O. Thompson, 1177 East Ninety-eighth street, Cleveland, Ohio. Annual meeting changed from September 12-15 to October 31 to November 3, 1922.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Regular meetings third Monday of each month, except June, July and August.

SUPPLY TRADE NOTES

T. H. Lange has been appointed traffic manager of the Pawling & Harnischfeger Company, Milwaukee, Wis.

G. S. Bigelow, Chicago, representative of the Mountain Varnish & Color Works, Toledo, Ohio, has resigned.

I. S. Kemp, formerly sales manager of the Vaughan & Bushnell Manufacturing Company, Chicago, has been elected vice-president of the Evansville Tool Works, Evansville, Ind.

James Kennedy, president of the Angus Sinclair Company, New York City, and managing editor of Railway and Locomotive Engineering, died suddenly at his home in New York City, on August 14. Mr. Kennedy was born in Forfarshire, Scotland, in 1850. He served his apprenticeship as a railroad machinist in his native land, and came to this country in 1868, and was later foreman of the Singer Machine Company, New York. He studied at night, and graduated from the old Thirteenth street high school, New York, in 1875. He again entered railroad service with the Lackawanna & Bloomsburg, now a part of the Delaware, Lackawanna & Western at Kingston, and was later foreman at Scranton, Pa. From 1879 to 1902 he was foreman at the New York Elevated shops in New York City. For the following year Mr. Kennedy was chief cashier at the Water Department of the City of New York, and in 1904 was deputy superintendent of elections. He contributed for many years to the railroad press, and in 1905 joined the staff of Railway and Locomotive Engineering, and became managing editor in 1911. He was the author of a number of handbooks on locomotive subjects.


James Kennedy

C. H. G. Larrimore has been appointed general manager of the Railway Audit & Inspection Company, Philadelphia, Pa., in charge of all operations, succeeding T. C. Cary, deceased.

G. E. A. Letourneau, manager of the Canadian Gold Car Heating & Lighting Company, Limited, 346 St. James street, Montreal, Canada, died suddenly at his home on August 5.

W. E. Farnan has been appointed director of the special committee on railroad lumber requirements of the Southern Pine Association, with headquarters at New Orleans, La.

Monroe L. Patzig, 206 Eleventh street, Des Moines, Iowa, has been appointed representative of the Conveyors Corporation of America, Chicago. Mr. Patzig's territory is in central Iowa.

Frank S. Martin, senior member of Frank S. Martin & Son, 25 Broadway, New York City, died on July 27. Francis A. Martin will continue to conduct the business under the present name, and with the same staff.

L. H. Matthews, for 19 years connected with the railroad department of Fairbanks, Morse & Co., has resigned to become Pacific Coast manager of the Chicago Metallic Packing Company, with headquarters at Los Angeles.

The Rome Wire Company, Rome, N. Y., has taken an interest in the Atlantic Insulated Wire & Cable Company, Stamford, Conn. The latter company will continue to manufacture its brands of high-grade rubber-covered wires and cables.

The Franklin Moore Company, Winsted, Conn., manufacturers of material-handling machinery for industrial plants, has appointed the Scheid Engineering Corporation, 90 West street, New York City, as its metropolitan and export representatives.

A. L. Roberts, formerly master mechanic of the Lehigh Valley Railroad, and recently chief engineer of the Atlas Crucible Steel Company, has been appointed sales engineer, railroad department, of the United Alloy Steel Corporation, Canton, O.

At a meeting of the directors of the Sharon Pressed Steel Company, Sharon, Pa., on August 9, L. B. LeBel, Edward O. Peck and Harold G. Mosier, of Cleveland, and A. E. Swan, of Sharon, were elected directors to succeed W. L. Ulmer, W. H. Watkins, L. L. Knox and W. J. Parker, retired.

The New York City office of the Chicago Flexible Shaft Company, Chicago, manufacturers of Stewart industrial furnaces, which has been located at 350 Broadway since it was established early in 1920, has been removed to 16 Reade street. The office, as before, is in charge of J. W. Lazear.

The King Pneumatic Tool Company has moved into a new factory at 1735 Armitage avenue, Chicago, with more than double the capacity of the former plant. The company manufactures molybdenum steel riveting hammers, chipping hammers, rivet cutters, electric drills, and a complete line of pneumatic tools and accessories.

J. J. Hennessy and Hugh Bonham have been appointed assistant superintendents of the lubrication division, railway traffic and sales department of the Texas Company, New York. Mr. Hennessy's appointment is for the eastern territory, with headquarters at New York City, and Mr. Bonham's for the western territory, with headquarters at Chicago.

Coleman Sellers, Jr., president of William Sellers & Co., Inc., Philadelphia, Pa., died on August 15. Mr. Sellers was in his seventieth year and had been ill for several months. His connection with the Sellers house began in 1873 immediately after his graduation from the University of Pennsylvania. After serving a practical course in the shops for several years, he took a position in the drafting room, of which he soon became the head. He was appointed assistant manager in 1887, becoming at the same time a director of the company. He was elected engineer in 1902 and president in May, 1905, which last office he held continuously until his death. He was a man of liberal ideas and while his principal inclinations and activities were in mechanical and engineering lines, he took keen interest in many other directions, scientific, literary, educational and the arts, and was active in the civic life of Philadelphia. He was long active in the affairs of the Franklin Institute, of which he was vice-president at the time of his death. He was a member of the Board of Commissioners of Navigation of Pennsylvania, to which he was appointed in 1907. He was active in the affairs of the American Society of Mechanical Engineers, the American Society of Naval Architects and Marine Engineers and the Engineers Club of Philadelphia, of which he was one of the founders. He was president of the Chamber of Commerce from 1909 to 1913. He served as chairman of the local draft board during the early stages of the war.


Coleman Sellers, Jr.

The Pressed Steel Car Company, Pittsburgh, Pa., has recently incorporated in Illinois the Pressed Steel Car Company of Illinois, capitalized at $5,000, and the Koppel Industrial Car & Equipment Company, also capitalized at $5,000. The parent company is a New Jersey corporation and the Koppel concern, a subsidiary of Pressed Steel Car, is incorporated in Pennsylvania.

The Tuttle Railway Supply Company, Inc., has opened offices in the Woolworth building, New York City, for the handling of railway supplies and specialties. This company has just been appointed the eastern representative of the Edward S. Woods Company, of Chicago. S. W. Tuttle, president of the Tuttle Railway Supply Company, Inc., was, some years ago, connected with the National Dump-Rodger Ballast Car Company, Chicago, in their shops, and for the past fourteen years has been connected with the American Car & Foundry Company, in the manufacturing, executive and selling departments.

The Air Reduction Sales Company, New York, has under way a program of plant expansion. Sites have been bought for an Airco acetylene plant at Birmingham, Ala.; an oxygen plant at Milwaukee, Wis.; and an acetylene plant and a calorene plant at Pittsburgh, Pa.; at the latter place the company recently completed an oxygen plant. Construction of the plant at Birmingham already has begun, and plans are well under way for putting up the plants at Milwaukee and Pittsburgh. In addition to these new plant installations, the company's facilities for producing oxygen from the air will be enlarged in Buffalo and Minneapolis. The estimated cost of the proposed improvements is over $500,000.

G. A. Blackmore, vice-president of the Union Switch & Signal Company, Swissvale, Pa., has been elected first vice-president and general manager. He entered the service of the Union Switch & Signal Company in July, 1896, and in 1901, he was made chief clerk of the engineering and estimating department at Swissvale. In July, 1904, he was transferred to New York, where he was engaged in work on the Interborough Rapid Transit Subways, the New York terminal of the Pennsylvania Railroad and other large signaling projects. In March, 1909, he was appointed assistant eastern manager, with headquarters in New York, and in April, 1911, was made eastern manager in charge of the New York, Montreal and Atlanta offices, and of sales and construction. He was appointed general sales manager of the Union Company in 1915, and his headquarters transferred to Swissvale, remaining in this capacity until January, 1917, when he was elected vice-president. He now assumes the additional duties of general manager.

G. B. Pierce, who has been connected with the Westinghouse Air Brake Company for the last 12 years as a mechanical expert, at the St. Paul office, has been promoted to air brake engineer and transferred to the Orient where he will act in that capacity both for the Westinghouse Air Brake Company and the Westinghouse Traction Brake Company, in a territory covering Japan, China, Manchuria and Korea. Early in September Mr. Pierce will sail for Japan to associate himself with W. G. Kaylor, manager of the Westinghouse Air Brake interests in the Orient, with whom he expects to make his headquarters in Tokyo. Mr. Pierce was formerly in railroad work. Having served as a fireman, he became an engineman on the Montana division of the Northern Pacific in 1901. He later served as acting road foreman of engines on the same division and for three years was a member of the local examining board on transportation rules at Livingston. In 1910 he left this road to join the Westinghouse Air Brake Company.

F. W. Carter, assistant manager of the heavy traction division, railway department, of the Westinghouse Electric & Manufacturing Company, has resigned to become president of the Louisville Frog & Switch Company, Louisville, Ky. Mr. Carter was graduated in electrical engineering from the Virginia Military Institute in 1912 and in the same year entered the employ of the Westinghouse Company on the graduate student course. Between 1912 and 1916 he filled several important assignments and then took up heavy traction work in the New York office. In 1917 Mr. Carter entered the first Plattsburg Camp and was ordered immediately to France, where he served with the Rainbow division until July 28, 1918, when he was severely wounded in action at Chateau-Thierry and later was honored with the D. S. C. After returning from the service Mr. Carter again entered the railway sales department at East Pittsburgh in charge of heavy traction negotiations. The Louisville Frog & Switch Company, of which Mr. Carter will be president, manufactures manganese frogs, crossings, switches, signals and other railway specialties.

TRADE PUBLICATIONS

Car Construction.—The Canadian Car & Foundry Company, Limited, Montreal, has issued bulletin No. F. 7, describing the steel pit flat cars and depressed center flat cars, each of 160,000 lb. capacity, recently built for the Canadian Pacific; also, bulletin No. P. 4, describing the Canadian Pacific all-steel combination mail and baggage cars.

Cast Iron Storage Tank.—The Conveyors Corporation of America, Chicago, has issued a new booklet describing its American cast-iron sectional storage tank which is designed for holding loose, bulky, dry materials for storage or transfer. The booklet is illustrated with engravings showing the tanks in use at a number of well-known plants. Diagrams give details of construction and a comprehensive table of weights and measures is included.

Powdered Coal Application.—A partial report of the meeting of the Engineers' Society of Western Pennsylvania held on February 1, 1921, and a complete report of the paper on Powdered Coal Equipment at Ford Motor Company Plant, presented at that meeting by H. D. Savage, has been published in a 15-page, illustrated booklet recently issued by the Combustion Engineering Company, New York. Typical steam flow, steam temperature and gas temperature charts are included.

Flood and Searchlights.—The Pyle National Company, Chicago has recently issued supplement 2, of catalog 101, illustrating and describing a series of flood lights and searchlights adapted to the lighting of yards, loading platforms, locomotive coaling operations and construction work and general roundhouse illumination. The bulletin includes a list of parts for this equipment and presents illustrations to show the application of the lights to various kinds of night work.

Locomotive Injectors.—A neatly arranged catalogue of 95 pages has recently been issued by William Sellers & Co., Inc., Philadelphia, Pa., in which its line of injectors and boiler attachments is described and illustrated in detail. The results of high pressure steam tests of a No. 10½, Class N, improved self-acting injector, which were outlined in the October 1906 Journal of the Franklin Institute, are contained in this catalogue, also a number of maintenance and repair hints.

Insulating and Soldering.—A catalogue supplement describing insulating and soldering compounds and announcing the extension of that line of products has been issued by the Westinghouse Electric & Manufacturing Company. The publication is known as 5-A, Supplement No. 2. The materials discussed in the supplement are baking and air-drying varnishes, insulating compounds, finishing materials, including paints, enamels, lacquers, etc., insulating glue, soldering flux, and lubricating oil.

Wrought Iron.—An interesting and well illustrated description of the manufacture of ordinary wrought iron and staybolt iron is contained in a booklet recently issued by the Penn Iron & Steel Company, Creighton, Pa. The book tells briefly the story of the first rolling of iron bars in America, which is followed by an account of the successive stages in the manufacture of the modern product. In addition to the illustrations of rolling mills and test pieces the book contains a table of the weights of round and square bars.

Fuel Oil-Burning Systems.—A new catalogue, consisting of three bulletins and describing mechanical fuel oil-burning systems and fuel oil burners in which the oil is atomized by low or high pressure air and steam, has recently been issued by the Schutte & Koerting Company, Philadelphia, Pa. The catalogue discusses thoroughly the installation, operation and maintenance of oil-burning equipment, its characteristics, requirements and functions, the relative merits of mechanical spray oil burners, the design, purpose and operation of air-control registers, oil-pumping outfits, duplex oil strainers and fuel oil heaters, the general requirements of steam boiler furnaces for burning oil, operation, inspection of the system, lighting the fires, air for combustion, indication of satisfactory operation, number and arrangement of burners, effects of carbon deposits and soot, etc. The catalogue is profusely illustrated and contains over 25 tables of important data compiled from authoritative sources.

EQUIPMENT AND SHOPS

Locomotive Orders

The Erie has ordered 30 Mikado type locomotives from the Baldwin Locomotive Works.

The Baltimore & Ohio has ordered 15 Pacific type locomotives from the Baldwin Locomotive Works.

The Polish State Railways have ordered 25 Consolidation type locomotives from the Baldwin Locomotive Works.

The Missouri, Kansas & Texas has placed an order with the Lima Locomotive Works, Inc., for 40 Mikado and 5 Pacific type locomotives.

The Illinois Central has given an order to the Standard Stoker Company for 25 stokers to be installed on the 25 Santa Fe type locomotives ordered recently from the Lima Locomotive Works.

The Louisville & Nashville has ordered 30 Mikado type locomotives from the American Locomotive Company. These locomotives will have 26 by 30 in. cylinders and a total weight in working order of 295,000 lbs.

The New York, Chicago & St. Louis, reported in the *Railway Mechanical Engineer* of July as having ordered 14 locomotives from the Lima Locomotive Works, has ordered five additional locomotives from the same builder.

The Union Pacific has ordered 55 Mountain type and 10 Mallet type locomotives from the American Locomotive Company. The Mountain type will have 29 by 28 in. cylinders and a total weight in working order of 345,000 lb. and the Mallet type will have 26 and 41 by 32 in. cylinders and a total weight in working order of 495,000 lb. The company has also ordered 15 2-10-2 type locomotives from the Baldwin Locomotive Works.

Locomotive Repairs

The New York Central is having repairs made to 50 locomotives of various types, at the shops of the Rome Locomotive Works.

Freight Car Orders

The Canadian Pacific has ordered 250 refrigerator cars from the National Steel Car Corporation.

The Jacob Dold Packing Company, Buffalo, N. Y., will build 35 refrigerator cars in its own shops.

The Wilcox Company, Chicago, has ordered 50 hopper cars from the Western Steel Car & Foundry Company.

The Philadelphia & Reading has ordered 100 refrigerator cars from the American Car & Foundry Company.

The Northern Pacific has ordered 1,000 steel center constructions from the Western Steel Car & Foundry Company.

The Texas Company has ordered five tank cars of 5,000 gallons capacity from the Pennsylvania Tank Car Company.

The Elgin, Joliet & Eastern has placed an order with the General American Car Company for 80 steel underframes.

The Manati Sugar Company, 112 Wall street, New York City, has ordered 50 cane cars from the Magor Car Corporation.

The Chicago, Milwaukee & St. Paul is reported to have placed an order with A. M. Castle & Co., Chicago, for 750 underframes.

The Chicago, Indianapolis & Louisville has ordered 300 composite gondola cars of 50 tons' capacity from the Pullman Company.

The Mathieson Alkali Works, New York, has ordered from the General American Tank Car Corporation, 20 tank cars of 15 tons' capacity, for carrying liquid chlorine.

The Warner Sugar Refining Company, New York, has ordered for the Miranda Sugar Company 150 cane cars of 30 tons' capacity from the Magor Car Corporation.

The Chesapeake & Ohio has ordered 50 refrigerator cars of 40 tons' capacity from the American Car & Foundry Company which will be built at the company's Berwick, Pa., plant.

The Polish Government has ordered 7,000 freight cars from the War Department of the United States Government. These cars were originally built for overseas service during the war.

Freight Car Repairs

The Boston & Maine is having 1,000 box cars repaired at the shops of the Laconia Car Company.

The Bangor & Aroostook is making heavy repairs to 250 box cars in its shops at Derby, Maine.

The Seaboard Air Line is having 900 box cars repaired at the shops of the Magor Car Corporation.

The Chicago & North Western has ordered repairs to 500 box cars from the American Car & Foundry Company.

The Chicago, Burlington & Quincy has ordered repairs to 500 gondolas from the Keith Railway Equipment Company.

The Indiana Gas & Coke Company has placed an order for repairs to 50 hopper cars with the General American Car Company.

The Central of New Jersey is having 200 steel hopper cars repaired at the shops of the Pressed Steel Car Company and 300 at the shops of the Standard Steel Car Company.

The Lehigh Valley has ordered repairs to 1,000 high side steel gondola cars. The order was equally divided between the American Car & Foundry Company and the Buffalo Steel Car Company.

The Missouri Pacific has placed orders for repairs to 2,500 freight cars as follows: American Car & Foundry Company, 1,250; Sheffield Car & Equipment Company, 1,000; and the Mount Vernon Car Manufacturing Company, 250.

The Chicago & North Western will have 500 box cars repaired at the shops of the American Car & Foundry Company. A contract has also been given for the repair of 1,000 box cars to the Western Steel Car & Foundry Company.

The Chicago, Rock Island & Pacific has placed orders with the Western Steel Car & Foundry Company for repairs to 400 wooden box cars, 300 automobile and furniture cars, 400 steel underframe box cars and 1,500 composite National dump cars.

The Grand Trunk is having 100 refrigerator cars repaired at the shops of the National Steel Car Corporation. This road is also having repairs made to 500 coal cars and 500 box cars; the order being divided between the Canadian Car & Foundry Company and the Eastern Car Company.

The Chesapeake & Ohio recently placed orders for repairing steel coal cars as follows: Illinois Car & Manufacturing Company, Hammond, Ind., 1,000 cars; Keith Railway Equipment Company, Hammond, Ind., 500 cars; American Car & Foundry Company, Huntington, West Va., 1,500 cars; and Richmond Car Works, Richmond, Va., 1,000 cars.

The New York Central is having 500 coke cars converted to gondola cars at the shops of the Ryan Car Company, Hagewisch, Ill.; 500 coke cars converted into gondola cars at the shops of the Buffalo Steel Car Company, Buffalo, N. Y., and 973 coke cars converted into 500 flat, 300 double deck stock, and 173 single deck stock cars at the shops of the American Car & Foundry Company, Detroit, Mich.; for the Pittsburgh & Lake Erie 1,200 coke cars are being converted into box cars at the shops of the Standard Steel Car Company, Newcastle, Pa.; 300 coke cars converted into box cars at the shops of the American Car & Foundry Company, Detroit, Mich.

Passenger Car Orders

The National Railways of Mexico have ordered 5 first-class and 10 second-class, narrow gage passenger coaches, from the Pullman Company.

The Canadian Pacific has ordered 15 baggage cars from the National Steel Car Corporation.

The Pittsburgh & West Virginia has ordered nine coaches, one passenger and baggage, two passenger, baggage and mail and two baggage cars from the American Car & Foundry Company.

Machinery and Tools

The Texas-Mexican has ordered a 79-in. driving wheel lathe from the Niles-Bement-Pond Company.

The New York Central has ordered a 60-in. horizontal boring machine from the Niles-Bement-Pond Company.

The Long Island has ordered from the Niles-Bement-Pond Company one 10-ton, 3-motor electric traveling crane.

The Missouri Pacific has ordered one 2,500-lb. single frame steam hammer from the Niles-Bement-Pond Company.

The Chesapeake & Ohio has ordered a 42-in. boring mill and a 1,100-lb. steam hammer, from the Niles-Bement-Pond Company.

The Los Angeles Railway Corporation has ordered a No. 1 car wheel lathe from the Niles-Bement-Pond Company.

The Union Pacific has placed an order with the Industrial Works, Bay City, Mich., for a 15-ton locomotive crane with 45 ft. boom.

The Atchison, Topeka & Santa Fe has placed an order with the Milwaukee Electric Crane & Manufacturing Company, Milwaukee, Wis., for a 15-ton crane.

Shops and Terminals

The Illinois Central has awarded contracts for the construction of water treating plants at Matteson, Galena, Amboy, Ill.; Fort Dodge and Council Bluffs, Ia., to Joseph E. Nelson & Sons, Chicago. Contracts have also been awarded to the Railroad Water & Coal Handling Company, Chicago, for the construction of water treating plants at Wall Lake, Logan, Rockwell City and Denison, Ia.

The Union Pacific.—Contracts have been awarded to the Graver Corporation of Chicago for one 30,000-gallon per hour Graver Type "K" ground operated water softener for Granger, Wyo. This treating plant will be equipped with two standard Graver Corporation of Chicago for one 30,000-gallon per tract also covers the reconstruction of five present treating plants to the improved Graver Type "K" design.

PERSONAL MENTION

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

W. R. Meeder has been appointed master mechanic of the Missouri & North Arkansas with headquarters at Harrison, Ark., succeeding C. W. Bugbee, who has resigned.

F. W. Boardman, fuel supervisor of the Texas & Pacific with headquarters at Dallas, Tex., has been appointed general master mechanic with the same headquarters. He is succeeded by L. E. Dix.

PURCHASING AND STORES

George Kefer, chief clerk in the purchasing department of the Long Island, has been appointed purchasing agent, succeeding H. B. Hodges, retired.

CAR DEPARTMENT

G. W. Easling, car inspector of the New York Central lines at Corning, N. Y., has been retired after serving with the company for more than 30 years.

C. E. Copp, master painter for the Boston & Maine until his retirement on a pension two years ago, returned to Billerica shops in the early days of the shopmen's strike to assist in supervising the new men taken on to paint equipment. The emergency being over, Mr. Copp has now returned to his summer home at Alton Bay, N. H.

H. Englebright, master car repairer of the Southern Pacific at West Oakland, Cal., has recently retired from active service after 52 years of continuous service with the same road. Born in New Bedford, Mass., June 10, 1852, Mr. Englebright was taken by his parents to California at the age of five, when the gold mines were still the dominant industry in that state. He entered the service of the old California Pacific as a blacksmith apprentice in 1869, and worked at this trade at various points until 1892, when he was appointed roundhouse and car foreman at Fresno, Cal. He was appointed general car foreman at San Francisco in 1898, and master car repairer at Oakland, Cal., in 1900, which position he held continuously until his retirement, after an interesting experience which has seen the linking of the west to the east by the first transcontinental line, the development of motive power from 35-ton to 225-ton locomotives and the introduction and subsequent universal use of the automatic air brake, of which device he has made a particular study.

H. Englebright

GENERAL

W. D. Robb has been appointed ranking vice-president of the Grand Trunk with the title of vice-president and general manager and will take up the duties of Howard G. Kelley, whose resignation as president is announced. He is the first chief executive of the Grand Trunk to have risen step by step, with unbroken service, from an apprenticeship in the company. Mr. Robb was born at Longueuil, Quebec, in 1857, his father having come to Canada from Scotland to join the Grand Trunk in its construction stage. He received his early education at Sherbrooke Academy and at St. Francis College, Richmond, Que. He began his career with the Grand Trunk in 1871 as an apprentice machinist. He was appointed night foreman at the Montreal shops in 1883, and was promoted to the position of foreman at Belleville in charge of the motive power and car department in the same year. In 1897, he was appointed master mechanic of the middle division with headquarters at London, Ont., and in 1901 was made acting superintendent of motive power at Montreal. Mr. Robb was promoted to the office of superintendent of motive power in 1902, a position which he occupied until his appointment in 1917 as vice-president in charge of motive power, car department and machinery. His jurisdiction was extended in 1918 to take in the operating, maintenance and construction departments of the system.

W. D. Robb

OBITUARY

William Andrew Thompson, Jr., one of the vice-presidents of the Texas Company, New York City, died at his home in Brooklyn on July 24.

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Machine Tool Prices Advance

Machine tool prices reached rock-bottom several months ago and from all indications, the present increase in prices may be expected to continue. Low prices in the early months of this year were caused essentially by the absence of buyers and the liquidation of large stocks of new machines in the hands of both manufacturers and the government. In their anxiety to sell, manufacturers were willing to make concessions in price which cannot be obtained at the present time. Reliable second-hand tools have also been largely disposed of and today few machines are in stock. With a scarcity of machines available, there are also unmistakable signs that both the railroads and general industry will be in the market for machine tools in the near future. This may be expected to accentuate the rising price tendency, the same result being brought about by an increasing cost of raw materials, such as pig iron and brass, together with increasing labor costs. In some localities it is difficult even now to get the skilled labor needed in making machine tools. In the early months of this year, certain railroads refused to order machines because they felt that prices were going still lower, but the error of this assumption is now apparent. Those who purchased machine tools six months ago not only secured them at a low price, but found them of great value in facilitating shop work during the strike. It is obvious that for the sake of early deliveries and in order to obtain as many machines as possible with limited appropriations, orders for machine tools should not be delayed.

The Greater Need for Foremen

About the busiest and most hard working man around any railroad shop or terminal is the foreman. The demands upon his time and ability were never more pressing. The position demands in the first place a knowledge of what work should be done, how it best can be performed under the existing conditions, and when it has been sufficiently and satisfactorily completed to meet requirements. What is even of more importance, he must know how to get along with and how to handle men and also must maintain a certain dignity without conveying the impression that he is without feeling and sympathy for the men working under his direction. He is the one who comes in direct and constant personal touch with the great body of workmen and, therefore, represents the management. The day in which a man's value as a foreman was measured by his ability to force men to perform a greater amount of work in a day than they otherwise would do has passed. The need is not for drivers, but for leaders. The successful conduct of the mechanical departments of American railways for a long time to come will depend upon the rebuilding of the shop organizations at this critical time. The foreman must be a good educator. Under present conditions it will not be possible for a foreman to handle as many men and secure satisfactory results as was the case even a short time ago. Instead of overworking an already busy foreman, far more can be accomplished by reducing the size of a department or gang or by selecting more sub-foremen. The foremen who have shown their loyalty and ability in the past should be supported and given a greater opportunity for time to think and plan their work.

Standard Practice Cards

Only a comparatively few railroads have reduced their maintenance of equipment standards to written form, either on cards or mimeographed sheets. Standard practice cards are valuable for many reasons, one of the most unexpected following directly as a result of the strike. New men, unfamiliar with car and locomotive repair work, but able to read drawings, can take the standard practice cards and follow instructions, performing the work satisfactorily with little or no supervision. In the majority of cases, however, these cards are not available and even capable machinists or mechanics, if unfamiliar with the work, need practically continuous supervision for a certain period. Some of the new men have shown a strong desire to acquaint themselves thoroughly with the various parts of cars and locomotives and learn the best methods of repairing these parts. Standard practice cards are invaluable for this purpose. Most roads, however, depend upon foremen and experienced workmen transmitting what is considered the best local practice to new men as they are employed. Another advantage of the cards is the assurance that good practices developed at one point on a system will be known and practiced throughout the system. Railroad men are notoriously backward in advertising themselves or giving publicity to new methods and devices which they have developed. If they are compelled to report these practices to the mechanical department for incorporation on standard practice cards, all the shops on the system will benefit by the latest and best methods. In view of the many advantages, it would appear that as fast as possible railroads should reduce to writing, arranged for convenient use, detailed information regarding the best recommended methods of overhauling, machining, or repairing all the essential parts of cars and locomotives.

Inspectors for Outside Repairs

The next few months undoubtedly will see a tremendous demand for locomotives and cars to handle the vast amount of traffic offered to the railroads. A realization of this prospect has led many roads to send a considerable number of locomotives and cars to outside concerns for overhauling. When the concerns selected are old established builders, the work can in most instances be performed properly with a comparatively limited amount of supervision and inspection. In other cases, however, contracts have been let to concerns that have had comparatively little experience in doing such work and have but a limited amount of suitable equipment or experienced workmen or foremen. In such cases the results obtained will depend to a large extent upon the men who are selected by the railroad and sent to overlook the work while it is being done. The matters that will be referred to such an inspector and the points for which he will have to be on the lookout, demand a man with a broad practical experience, good judgment, firmness, and also the necessary tact and ability to secure what he wants without antagonizing those with whom he comes in contact. These are qualifications which are possessed by many foremen as they are essential to his success. At the present time, unfortunately, these men can poorly be spared from their regular jobs. The majority of regular material inspectors do not have the required practical experience. It will be necessary in many cases to select men who previously have not been used for such work. As the positions offer excellent opportunities for broadening a man's experience and would be of value to a man who has the qualifications needed for a foreman, those chosen should be men who afterward can be used in a supervisory capacity. As an assistance to these men and to find how they are developing, a general traveling inspector periodically should visit the various outside shops where repair work is being done.

Don't Kick the Same Brick Twice

This is a day of specialization, and fortunately so, because by this means articles are produced in great quantities at low prices, enabling modern workingmen to take as a matter of course luxuries unknown to kings a century ago. In spite of the benefits of specialization, however, men should not focus their attention so exclusively on one subject as to be blind to everything else that goes on around them. Such an attitude is not conducive to broadmindedness and it is doubtful if any man succeeds as well as he might even in his own specialty unless able to stand off occasionally and view it in relation to the work of others.

The various departments of railroad shops are highly specialized, and boilermakers, for example, cannot usually do machinists' work, or blacksmiths do boiler work. Yet the foreman who confines himself exclusively to the work of his own department and refuses to recognize or consider the work and problems of other departments, will never be in line for promotion. Successful higher mechanical officers have, almost without exception, been specialists in one branch of shop or roundhouse work, but have also acquired a broad gage, general knowledge of the work of all the other departments. There is altogether too much tendency for both foremen and men in one department to be disinterested in the work of another department, to the extent that they notice wastes of material, or costly methods of doing the work without saying anything about them. For example, if a boilermaker sees a 3-in. king bolt nut in a pit, it would require little effort on his part to pick it up and give it to the truck gang, or at least notify the foreman so that it could be saved and used over again. That may not be his main business, but it would benefit the road. If the cab foreman sees that the stripping gang is damaging cabs in taking them off, it is his duty to notify the erecting shop foreman, *and he usually does because it means extra work for his men.* He should be just as solicitous about mistakes which he observes while walking through the blacksmith shop.

Many times little jobs could be done by any one of several departments, but "what is everybody's business is nobody's business," as shown by the following story quoted from Factory: "A man stumbled over a brick in one of the walks between two shops the other day. He hurt his toes and cussed the brick. Five minutes later he returned the same way—kicked and cussed it again. Further watching showed that the same man kicked and cussed the brick four times in seven trips through the walk, and of the other men passing that way, two did the same thing within a space of 45 minutes. In all probability the brick is in the same place, being kicked because it is nobody's business to move it three feet to one side where it cannot possibly get in anybody's way." It is obviously foolish for any one to "kick the same brick twice." If all would get together to eliminate waste of time and waste of material in whatever department, the result would be immediately reflected in reduced cost of shop operation.

Roller or Ball Bearing Trucks

The use of roller and ball bearings has become quite general in many classes of machinery and has resulted in a considerable saving in the amount of power consumed. As their use has been so successful in some other fields, they naturally have been considered for passenger and freight car journal bearings. Early experience with anti-friction bearings on cars in this country was not successful and it is therefore of interest to note that a new type of roller bearing, which is expected to do away with the defects of formed designs, has recently been introduced on the Great Eastern Railway of England.

The savings that can be effected by ball or roller bearings have sometimes been greatly exaggerated. In figuring the increased train loads that might be hauled, if cars are equipped with anti-friction bearings, many people overlook the fact that grade resistance is the biggest factor in determining the train loads on most divisions and this is not affected in the slightest degree by a reduction of journal friction. Ball or roller bearings effect the greatest reduction in resistance at starting, which would be most advantageous in passenger service since it would eliminate the necessity for taking slack in many cases. At higher speeds a considerable reduction in resistance is also effected, although it is not in proportion to the decrease in the co-efficient of friction because the rolling resistance of the wheel on the rail and air friction are also important factors in train resistance. The maximum saving would probably be in the neighborhood of 20 per cent at 40 miles an hour, which would again decrease at greater speeds. A considerable amount of energy is expended in overcoming grade resistance and accelerating trains so the fuel saving for the entire run would probably be nearer to 10 or 12 per cent on an average division. The advantages of the anti-friction bearing would, of course, be greater on level track than on heavy grades.

Probably the additional expense of applying anti-friction bearings would not be justified unless there was an appreciable saving in fuel, although the maintenance—aside from renewals, which are still an indeterminate factor—might be considerably cheaper than with plain bearings. The present standard design is extremely simple, but it has the objection that its reliability depends upon frequent and expert attention. The bills for oil and waste in addition to those for inspection, constitute quite a large item in the expense of train operation. The results of tests of ball and roller bearings in regard to durability, reliability and savings in fuel and maintenance, will be watched with interest as this type of equipment affords attractive possibilities for reduction in the cost of transportation.

Copper Boiler Tubes and Fireboxes

The use of copper for locomotive firebox plates and boiler tubes was abandoned in this country many years ago. It is therefore interesting to note that this material will probably be tested again in actual service to determine whether it is more economical than steel under present conditions. The price of copper is now lower than it was before the World War, while the price of steel is more than 50 per cent higher. Furthermore, the cost of coal and wage rates are much higher than formerly so that the conclusions which were reached under the circumstances existing 20 years or so ago may not hold good today.

One of the factors that caused the railroads to abandon the use of copper was the high cost of this metal. This is not such a serious objection, however, because the scrap value is very little less than the first cost and judging by experience in other countries, the life of the parts should be at least equal to those made of steel. An interesting discussion of the relative merits of copper and steel for locomotive boiler tubes occurred at a recent meeting of the Institution of Mechanical Engineers in Great Britain. One of the speakers at this meeting stated that copper tubes gave a mileage two or three times as great as steel and had only one-thirtieth as many failures. Except in very unusual cases, copper tubes do not corrode or pit and they are, therefore, suitable for use in bad water districts. There is a question, however, whether copper tubes would not set up a galvanic action that would cause corrosion if used with steel firebox plates. In Great Britain the firebox plates as well as the tubes are of copper. The statement is often made that copper tubes save a considerable amount of fuel although little evidence is presented that might be considered conclusive. As has been pointed out before, the limiting factor in heat transmission through boiler tubes is probably the rate at which the heat is transferred from the gas to the tube and, therefore, copper may not give any better results than steel even though it has a heat conductivity eight times as great and does not accumulate as much scale as does steel.

P. C. Dewhurst of the Jamaica Government Railways, who has had experience with both materials, states that he does not see sufficient justification for the use of copper tubes unless it is because of better conductivity. Owing to the high coefficient of expansion of copper, the tube sheets are distorted more between the cold and working temperatures than when steel tubes are used and furthermore, Mr. Dewhurst states, steel tubes do not suffer from eroding at the firebox end, just inside the tube sheet. It is evident that each material has certain important advantages and it will be interesting to note the results of comparative tests which should end the futile theoretical discussion.

Effect of Power Plant Practices on Locomotive Design

A COMPARISON between the modern steam locomotive and the modern stationary or marine power plant shows a striking difference in fuel consumption per unit of power delivered. Noting this difference, many casual observers have jumped at the conclusion that the days of the steam locomotive were numbered and that electrification with economical central power plants and motor-driven trains should be practically universally adopted. But the greater economy of the central power plant is offset by the losses in transmission and by the higher cost of the equipment and, therefore, electric locomotives do not realize the full advantage of the stationary plant.

If the comparison is carried further and other factors besides fuel economy are considered, additional striking differences become apparent. On the one hand is the steam locomotive with its high-capacity boiler and its simple reciprocating non-condensing engine, a remarkably compact unit of relatively low weight per horsepower, easy to operate, low in initial cost and so simple that it can be repaired and maintained readily by types of mechanics of whom a large number are available. However, it can be operated only a few hours continuously and consequently makes only a limited mileage in the course of a year. Considerable non-productive time is spent at terminals or in the shops due to the necessity of cleaning fires, inspections and care of boiler or machinery. In this respect it must be acknowledged that the electric is superior to the steam locomotive.

On the other hand, the stationary power plant occupies a large space and an expensive building. The total weight of machinery per horsepower and the financial investment is large. In addition to boilers, turbines and generators, there is a considerable amount of auxiliary machinery. The condenser alone is bulky and requires a large amount of circulating water to condense the steam. The operation must be under the control of a well-trained engineer. Such a plant can be operated, however, for long periods of time without shutdowns for inspection or for repairs.

Hitherto locomotive development has been mainly in the direction of greater capacity with certain additions, such as superheaters and feedwater heaters, which increased the boiler efficiency, but the engine has still remained a simple, non-condensing one. Compounding has been used to a certain extent, but is now rarely employed except for locomotives of the Mallet type. Condensing has not been resorted to on account of the size and complications of a condenser and because of the lack of space for the larger cylinders that would be required.

Steadily increasing fuel costs are bound to bring about marked increases in the overall efficiency of the steam locomotive. In seeking ways in which this can be attained, advantage should be taken of the engineering practices for the best stationary power plants. Turbines and reduction gears have reached a high degree of efficiency and at the same time are reliable and remarkably compact. Engineers in a number of countries are giving serious thought to their adoption as a substitute for the present reciprocating locomotive engine. Some of the most valuable work which has thus far been done in this direction has been carried out by the Ljungstrom brothers in Sweden. After a vast amount of pioneer investigation, they have constructed a locomotive which shows a remarkable increase in efficiency when compared with that obtained with any reciprocating-engine locomotive ever built.

From a description of this locomotive, which is given in this issue, it will be noted that many stationary power plant practices which have helped to increase economy have been included in the design. The feedwater is raised to about 300 deg. F. by a three-stage heater fed by exhaust steam from the various auxiliaries. A turbine-driven exhaust fan is used to create the necessary draft. Instead of lengthening the boiler tubes in an attempt to transfer a little more heat from the gases of combustion to the water in the boiler, the tubes have been shortened and the surplus heat employed to raise the temperature of the air before it is admitted to a closed ash pan. The steam from the main turbine is condensed and a high vacuum secured. The feedwater is used over and over, thus reducing to a minimum the formation of boiler scale. The condenser being of the air-cooled type, it is not necessary to carry a large quantity of cooling water. A tube blower has been installed to keep all tubes free from soot. The steam pressure and degree of superheat also are notably high.

The Ljungstrom turbine locomotive is worthy of careful study because of the radical departure from all established standards of locomotive practice. The designers have unquestionably succeeded in their endeavor to increase the thermal efficiency. It remains to be seen whether such locomotives can be readily maintained with ordinary facilities and whether they can be built to give the high power output required to meet operating conditions in this country. Nevertheless, this will stand as an epoch-making locomotive. It seems certain that future progress will be along the lines of adapting to the locomotive the principles which have been instrumental in bringing the stationary power plant to its present high state of efficiency and reliability.

What Our Readers Think

Poor Box Car Door Fasteners

Roselle Park, N. J.

To the Editor:

While walking through any large freight car yard, one still observes many defective box car doors and fixtures. Some of these give the appearance of extending an invitation to burglars.

Considering the severe duty that a box car door is subjected to, it is surprising to find many of them equipped with door fixtures that are too frail, causing them to break or to become otherwise defective. Common defects are: Door hasp bent or broken; wooden door stops split, loose or broken; door track loose; door guides and lower door angle too short; door hanger sheave pins worn out or door hangers bent; door lock sealing plates too weak. Some of the bottom hung doors can only be operated with the aid of a crow-bar and the combined strength of several men.

Regarding wooden or reinforced wooden doors as applied to the older classes of cars, it is altogether too easy in many cases to force an entrance into such loaded cars without breaking the seal, thus permitting pilfering of freight to a much larger extent than would be the case were good substantial door fixtures applied according to A.R.A. standard box car door sheet, Drawing 30A. Car Inspector.

Mutual Confidence Would Settle Railroad Troubles

Green Cove Springs, Fla.

To the Editor:

The development and history of our railroads has been one continuous struggle, first, to produce a machine that would replace the horse, then to construct a road that the prime mover could haul loads over, then to secure the money with which to purchase equipment and extend lines, then to develop the country served to a point where it would support the investment represented by the road.

The building of our great railroad systems, from the ground up, was a huge work and required the full powers of such men as Hill, Vanderbilt and Harriman—exceptional engineers of American progress. The only way in which they could possibly make a success of their undertakings was to benefit, through service, the country through which the railroads ran. Mr. Hill went to Europe and purchased a carload of black bulls and distributed them along his road, that the farmers might have a better grade of beef stock and make more money. This is a simple instance of how alert these men were to help the people that their roads served, and it goes without saying these same people were as much interested in the roads as it was possible for them to be. When a prosperous year came and they had money to spare, they loaned it to the roads. The relationship was mutual, harmonious and good.

Passing from this early and altogether fine condition, comes a period of financial exploitation of our roads. During this same time the confidence of the people in the railroads was shaken, the sources of supply for railroad capital were destroyed, and they found it almost impossible to secure the money needed to keep the systems in working order. To meet this, rates were increased and more water added, then another increase in rates until the Interstate Commerce Commission was created and the roads were subjected to a period of drastic regulation.

Along with this sweating process that the roads have passed through has come the loss of confidence between employer and employee, or more properly between employees, since all are employees of the road. This breech among workmen is perhaps one of the very hardest to remedy or remove. The loss of good will among any group of workmen cuts deep into the profits of their employers. When workers are loyal to their tasks and to their leaders, they are properly poised, in the correct frame of mind to enjoy their work, and there will be a maximum production of good work. Without this same good will, no amount of pay will create the incentive that will get results. Therefore, the first thing for the roads to do is to have all the employees and all departments get together. It is especially important that the railroad officers should work to win the confidence of the men under them. There is as much departmental and official mistrust as exists among the ranks of the workers. Everybody must take it upon himself to instill confidence in all with whom he has dealings. In this way and only through the restoration of mutual confidence will permanent good come or the day of strikes be past. A strike is only the advertisement to the outside world that a group of workers have lost faith in the management. A strike reflects discredit upon the entire enterprise. A negative state of mind antagonizes profitable production. In every walk of life—political, industrial, religious, or military—a leader only leads as long as he is able to retain the confidence of his followers. We need to stop, look back and fashion our relationships after the examples of some of the early railroad makers.

The time has come when strikes in any one of our public service industries should be abolished. Any labor dispute in the fields of transportation, communication, food, fuel or clothing (perhaps also protection) should be settled by a commission, and its decision should be final in all cases without resort to strike. After all, this is only saying in so many words that the public will be served, that the public will pay for the service it gets and that it will not be charged excessive rates; that all employees in the industries mentioned will get a square deal, a fair wage rate, and otherwise be treated on a par with the same class of workmen in other lines; that those in executive stations will have the assurance of constant full production. The first result that will come out of this new order of management will be increased loyalty, large production and increased savings accounts for the workers and better returns for the companies involved.

I do not think the effects of a strike can be measured; the spirit of rebellion kills our national life, our patriotism is lowered, our standards of citizenship suffer; it is a blight that seriously affects the nation. Therefore, if we are to continue as a great nation, we must remove the conditions that cause workmen to mistrust each other and advance from this age of strike to one of a better understanding; we must advance to the newer day with the confidence and loyalty of the early days in railroading. The future leaders must have thorough training in human nature and relationships. A broader view of human frailty and faith in the old, old rule that "We help ourselves most when we are serving the other fellow for the sake of service and its invisible rewards" was never more essential than at the present time and cannot be overlooked in the future.

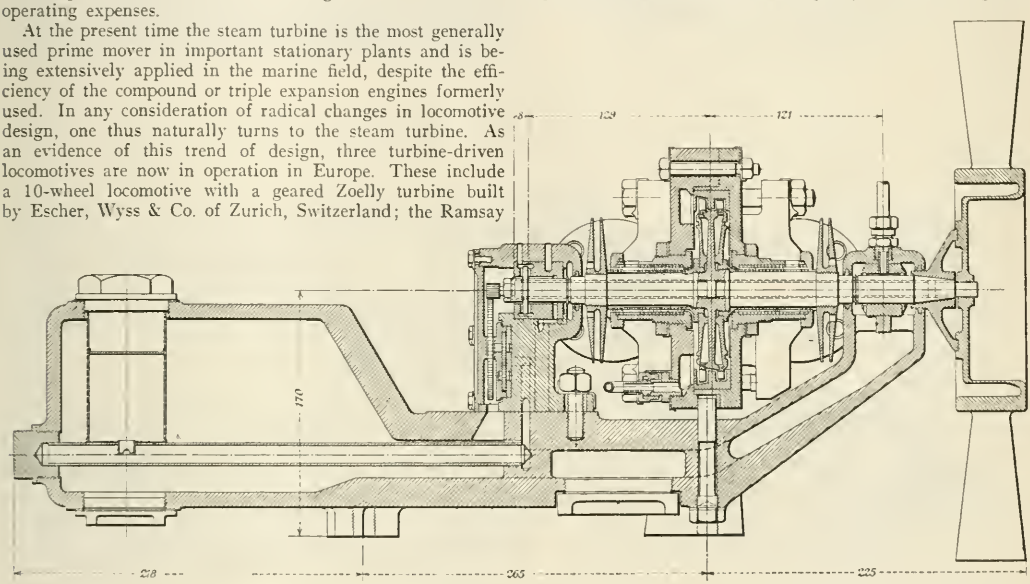
I have worked in railroad shops and have first-hand understanding of the workers' lot. I have worked with some of the leaders in minor positions and been in contact with men who have had considerable authority and also know that their pathway is not especially strewn with roses. I have a very profound sympathy for them all and because the work they are to do is so necessary, it seems a pity that this distorted relationship should have crept in and upset everything leading to progress. Frank Roberts.

The Ljungstrom Turbine-Driven Locomotive

Remarkable Efficiency Shown in Swedish State Railway Tests by Locomotive with Many Striking Features

When it is recalled that the superheated-steam locomotive converts only about six to eight per cent of the heat value of the coal consumed into useful work, whereas from 15 per cent to 19 per cent is converted in modern power plants, it is apparent that there is room for large improvements in locomotive efficiency. The importance of the matter stands out prominently at the present time on account of the world-wide increasing cost of fuel. While this increase has not been as pronounced in this country as in Europe, fuel is still one of the largest items of railroad operating expenses.

At the present time the steam turbine is the most generally used prime mover in important stationary plants and is being extensively applied in the marine field, despite the efficiency of the compound or triple expansion engines formerly used. In any consideration of radical changes in locomotive design, one thus naturally turns to the steam turbine. As an evidence of this trend of design, three turbine-driven locomotives are now in operation in Europe. These include a 10-wheel locomotive with a geared Zoelly turbine built by Escher, Wyss & Co. of Zurich, Switzerland; the Ramsay turbo-electric locomotive of the 2-6-6-2 type and 22,000 lb. tractive force on the London & North Western, England, built by Armstrong, Whitworth & Co.; and the Ljungstrom geared-turbine locomotive of 30,000 lb. tractive force on the Swedish State Railways. A very complete description of the Swedish design has been given in recent issues of Engineering (London) to which the *Railway Mechanical Engineer* is indebted for most of the information and illustrations used for this article.



Turbine Driven Induced Draft Fan

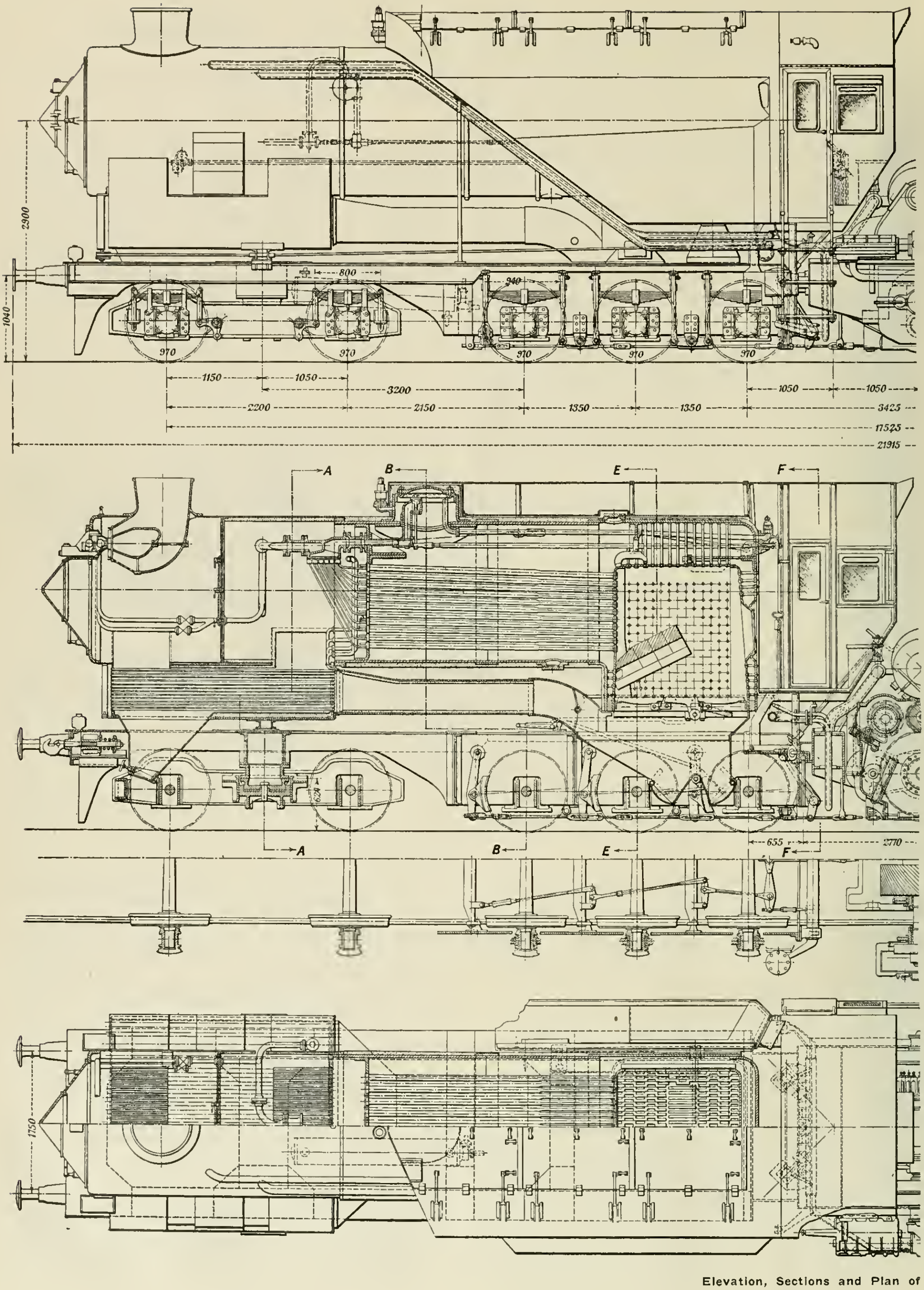
Object and General Description of Design

The design is largely the work of Fredrik Ljungstrom, assisted by his older brother, Birger Ljungstrom, general manager of Aktiebolaget Ljungstroms Angturbin, at whose factory near Stockholm the work of construction was carried out. In regard to running gear, boiler design, locomotive practice and requirements, the engineers of the Swedish State Railways collaborated with the builders. By combining the knowledge of an old established manufacturer of turbines and power plant equipment with that of practical railroad engineers, an epoch marking locomotive has been brought out after a vast amount of investigation and preliminary experimental work. In working out the details the object aimed at was to adapt the most advanced power station practices to the space and weight limitations of an ordinary locomotive and still retain the relatively high efficiency, reliability and possibility of long continued operation without inspection or withdrawal from service for repairs to boiler or machinery. Bearings and running parts have been enclosed as far as possible. The feed water is used over and over, thus reducing the amount of scale and necessary boiler work to a minimum. Tests in regular service have shown a fuel consumption of less than half that of standard type locomotives of a similar capacity when hauling the same trains. The small size of the boiler and the little coal required are striking proofs of increased efficiency.

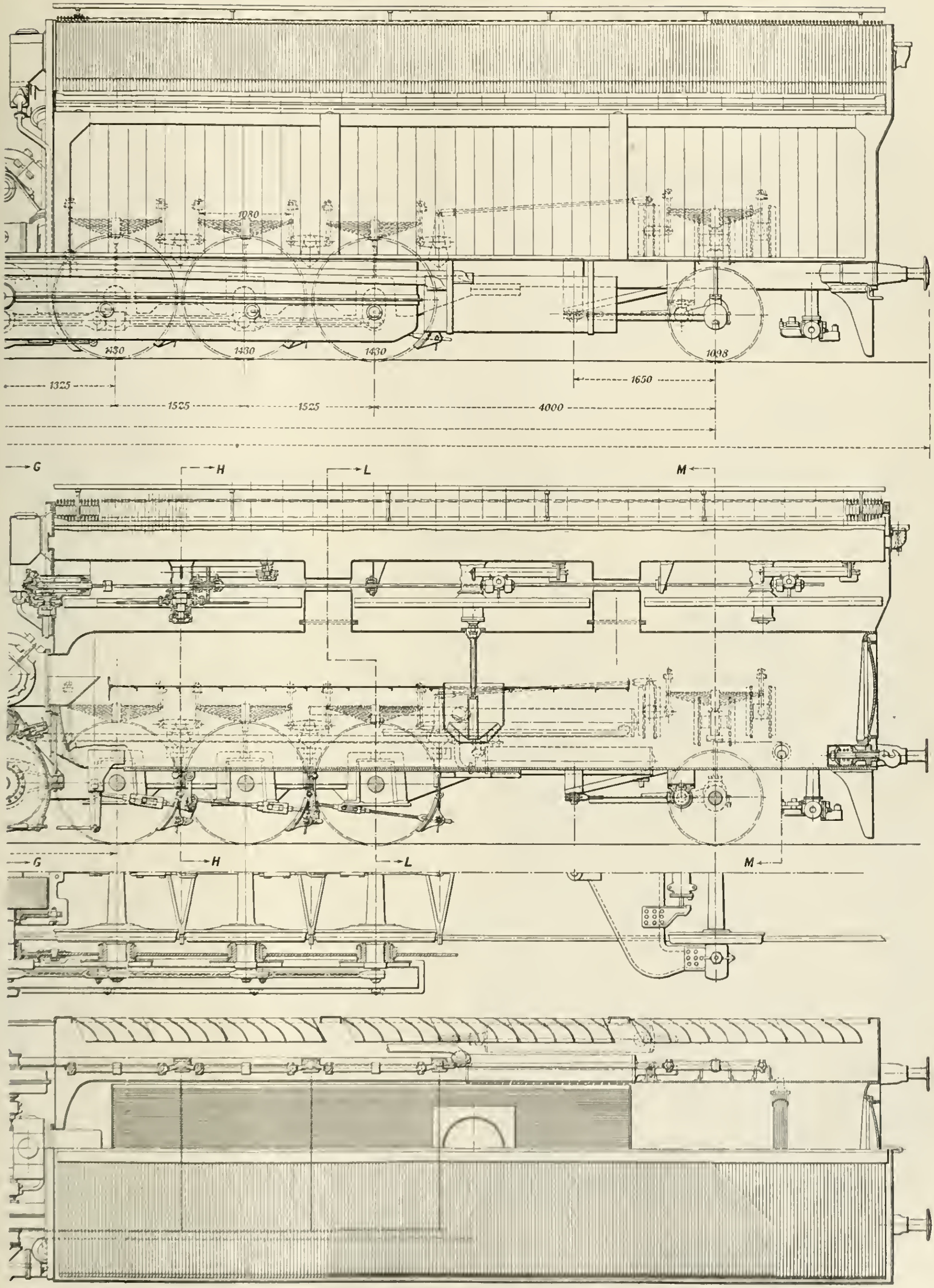
It will be noted from the drawings that the locomotive consists of two parts, a boiler unit and a condenser unit. The forward half, containing the boiler and coal bunker, weighs 138,800 lb. and is carried on a four-wheel leading truck and three pairs of wheels with boxes and pedestals of ordinary European design. All ten wheels are of 38¼ in. diameter and are used simply for carrying the weight. The rear unit, in addition to the condenser, carries the turbine, reduction gear and part of the auxiliary machinery. It weighs 143,360 lb. and is carried on three pairs of coupled driving wheels, 56¼ in. diameter, and a two-wheel trailing truck with 43¼ in. wheels. The weight on the driving wheels is 107,520 lb. and on the trailing truck, 35,840 lb.

Boiler and Air Heater

The boiler carries 285 lb. steam pressure and is of the straight top type, 66 in. outside diameter, with a firebox 63 in. long by 63 in. wide which gives a grate area of 28 sq. ft. There are 160 tubes, 3 in. outside diameter and 9 ft. 10⅛ in. long between the tube sheets. The evaporative heating surface includes 108 sq. ft. in the firebox and 1,130 sq. ft. in the tubes, a total of 1,238 sq. ft.



Elevation, Sections and Plan of



Ljungstrom Turbine-Driven Locomotive

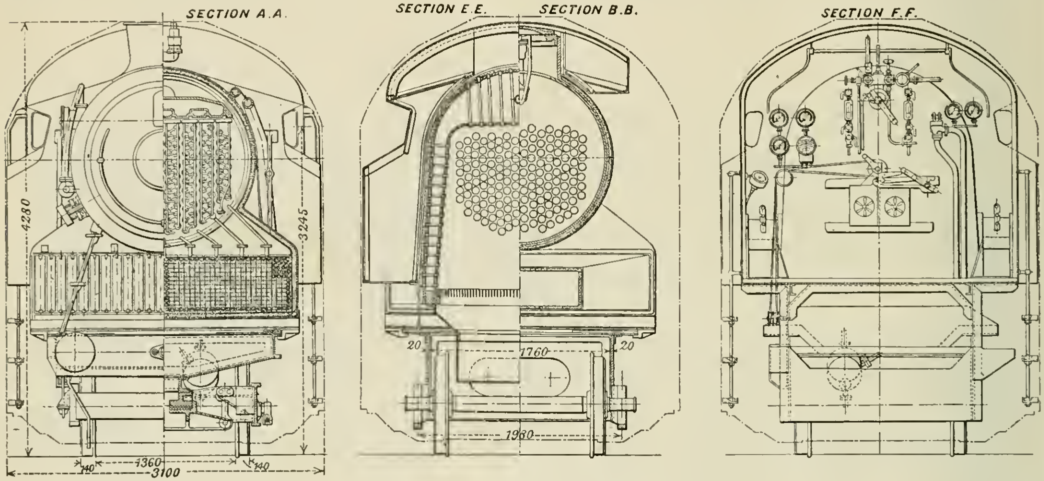
The length of the tubes is only about two-thirds that of ordinary locomotive boilers. This was decided upon because it was thought that greater economy could be secured by utilizing the surplus heat contained in the gases for preheating the air required for combustion. This is believed to be the first instance in which an air preheater has been used on a locomotive.

The smokebox is divided into two portions by a transverse diaphragm which causes the gases to pass down and through the air heater before going to the stack. This heater which is located beneath the smokebox contains 650 longitudinal brass tubes, 1.3 in. outside diameter, 8 ft. 11¼ in. long and with a heating surface of 1,787 sq. ft. The gases leave the boiler tubes at about 610 deg. F. and are cooled to about 300 deg. F. in passing through the air heater while the air for combustion is raised to about 300 deg. F.

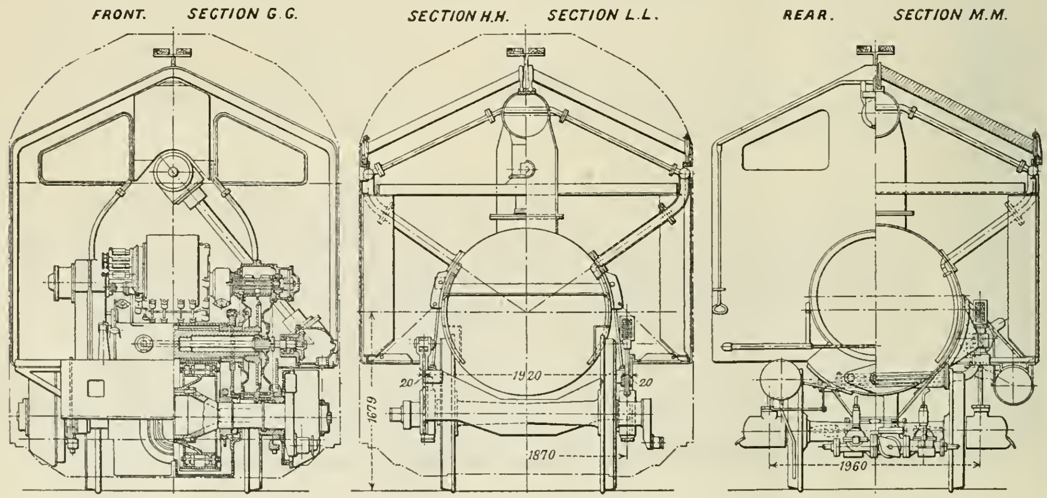
The front portion of the air heater casing is extended downward to form a hopper in which soot and dust can collect and from which they can be discharged at will. A large duct connects the rear end of the air heater to the closed ash pan. The supply of air to the ash pan is controlled by a series of vertical shutters or dampers which cover the front end of the heater and can be opened and closed from the cab. The handle by which they are operated is interlocked with the firedoor in such a way that they are closed automatically when the firedoor is opened, thus avoiding the danger of flame or gases being blown back into the cab when the door is opened, while the locomotive is running. There is also an additional damper in the duct to the ash pan for further regulation. The coal is carried in a saddle bunker of seven tons capacity, mounted on top of the boiler and extending from the front of the dome to the cab. Its tapered form serves to bring the coal to doors opening to the foot plate on each side of the firebox where it is most convenient for the fireman.

Induced Draft Fan

As the exhaust steam is all condensed, it becomes necessary to use a fan to create the required draft. As will be noted from the drawings, the stack has an extension reach-



End Views and Sections of Boiler Unit



End Views and Sections of Condenser Unit ing down into the front compartment of the smokebox, and carried forward where it terminates in an annular opening with a horizontal axis. A turbine-driven fan is mounted on the front of the locomotive with the fan blades close to the annular opening to the stack and serves to draw the gases from the smokebox and force them through the stack. The cooling of the gases to 300 deg. F. while passing through the air heater also reduces their volume, both of which simplify the fan problem. The maximum speed of the fan is 10,000 r.p.m., at which speed the turbine develops 40 hp. The front end projects from the smokebox and contains an oil reservoir and pump.

The turbine consists of a single impulse wheel with two rows of rotary blades. The blades are welded up into a complete ring and clamped to the center disc by two plates The turbine shaft is hollow and carries a central spindle to which the fan is attached. The turbine works at full boiler pressure and exhausts against a back pressure of 75 lb. to the high pressure feedwater heater or to the main turbine.

The fan impeller is machined from a solid steel disc and the hub is counterbored from both sides to give a flexible connection and permit the rim and blades to rotate about their own center of gravity and run without vibration.

Superheater and Tube Blower

All tubes contain superheater elements. Each element is heated by the gases passing through two tubes, the superheater pipes making four passes through the first tube and then four through the second tube before returning to the header. The length of each pass is shorter as the steam becomes superheated. The superheating surface is 861 sq ft.

Provision has been made for blowing the soot out of the tubes, the mechanism being operated from the cab. A horizontal steam pipe extends across the front tube sheet above the top row of tubes, and to this pipe is connected a series of smaller vertical pipes between each alternate row of tubes. These small pipes have drilled holes opposite each tube opening. When the engineman desires to remove the soot from the tubes he can admit steam to each one of the vertical pipes in succession. As extensions of the pipes pass down into the air heater, boiler tubes, superheater elements and air heater tubes are all cleaned at the same time. The tubes being blown in small sections, there is no appreciable interference with the draft, such as would result if all tubes were blown at the same time.

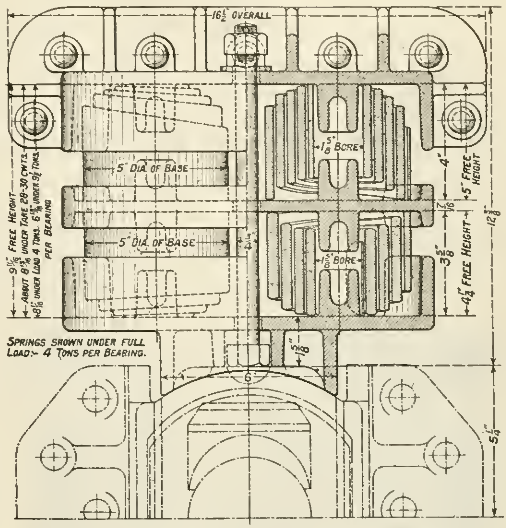
(Description will be continued in the next issue)

Volute Journal Box Springs

COMPARATIVELY few volute springs are used on American rolling stock although they are by no means unusual in European practice. The accompanying illustrations show an application of volute springs to the journal boxes of a six-wheel tender on the Bombay, Baroda & Central India railway. This differential bearing spring gear, which is known by the trade name "Herculo," was designed by A. H. Sheffield and manufactured by F. R. Rand & Co., London. Springs of the general type are suitable for use with journal boxes on any pedestal type truck and are used on passenger and freight service cars as well as on locomotives and tenders.

In this particular installation the springs are arranged in a group of four for each box, each group consisting of two upper and two lower springs in series. The upper springs are of a lighter section and will, therefore, deflect under a load a greater amount than the lower group of springs, thus insuring easy riding conditions whether the tender is empty or loaded. The total stroke is divided between the upper and lower springs and as the springs are wound in reverse directions, they have different periods and oscillation is damped out.

Referring to the drawing which is reproduced from a description in the Railway Gazette, London, the upper steel casting is bolted to the tender frame while the lower casting rests on top of the journal box. The through bolt is



Construction of Differential Spring Gear

provided to hold the lower casting, the springs and the intermediate collar together when the tender frame is lifted from the wheels and axles.

These springs are also reported to have given good satis-

Differential Spring Gear Applied to Tender

faction on locomotive trailing trucks and where they have been used the flange wear has been slight.

Dynamometer Tests of the Locomotive Booster

Severe Trials Demonstrate Reliability at Heavy Loads and High Speeds—Maximum Drawbar Pull 11,000 lb.

SINCE the advent of the locomotive booster, which was first applied early in 1919, numerous tests have been made in road service but up to this time little information has been available regarding the mechanical efficiency of the device or the power which it develops. While the results of actual operation can be studied best on the locomotive, it is necessary to test the booster independently if its performance as a machine is to be determined. With this in mind, the Franklin Railway Supply Company, New York, recently conducted a thorough dynamometer test of the latest type of booster. The purpose of the test, which was made under the direction of Dr. Harvey N. Davis, of

Fig. 1—The Test Plant, Showing Boiler (at left), Booster and Condenser

the Engineering School of Harvard University, was to determine accurately the ability of the booster to stand up satisfactorily under continuous heavy loading and operation at high speed, the power which the booster will deliver under varying conditions of speed and boiler pressure on a locomotive, the steam consumption per brake horsepower hour or drawbar pull under such conditions and the mechanical efficiency.

Description of the Booster Engine

The Type C-1 booster which was tested is a 10 in. by 12 in. double-acting two-cylinder engine with cranks set at 90 deg. Some of the important mechanical features of the design are as follows: The gear ratio between the booster engine shaft and the trailer axle is 14 to 36. The engine frame is designed to withstand the stresses imposed upon it with the minimum strain and the gear cover has been made an integral part of the casting. The bearings in the trailer axle boxes have been made larger and an oil tight case has been provided for the trailing axle gears, affording splash lubrication of these parts. The rocker design has been changed to relieve the bottom journals of all stress and stops have been so placed that the pitch circles of the gears are held in the proper relative position at all times. The engine case has been fitted with an oil tight cover which is easily removed and replaced. A new design of manifold for the live and exhaust steam has been applied at the rear of the cylinder with large cross section in the passages to reduce the steam velocity. A manifold has also been attached to the crank case to receive all air connections. The appearance of the booster is well illustrated in Fig. 1 which shows the machine connected to the dynamometer shaft with the cover of the crank case removed and the rear end elevated.

The Test Plant

The test equipment was designed especially for this test and for the routine test under load to which all boosters are subjected after assembling at the factory of the Poole Engineering & Machine Company, Baltimore, Md. The steam plant consists of a 250 hp. Heine boiler with a low temperature superheater and a feed water heater connected in parallel with and draining into the main condenser. The test bed carries a shaft and 18 in. gear, similar to a standard trailer axle gear, direct connected at one end to a prony brake. The steam pipe from the boiler to the test bed is fitted with a gage to show the inlet pressure and a thermometer to indicate the superheat, which ranged between 30 and 35 deg. F. in most of the tests. A second pressure gage is located about 30 ft. back from the inlet gage, the piping between duplicating that on a locomotive. Pressures read on this gage are called throttle pressures in the report and correspond to the boiler pressure on a locomotive.

The booster was operating on the test plant during four

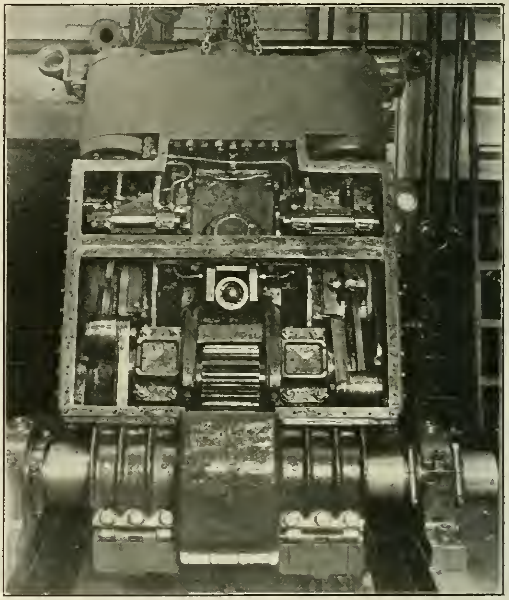


Fig. 2—Top View of the Booster, with Cover Removed

days under a wide variety of conditions ranging from stalling tests to high speed runs at 22 m.p.h. Some of the trials were made with the exhaust piped to the condenser to measure the steam consumption and others with the steam discharging to the atmosphere through 40 ft. of 4 in. pipe to duplicate roughly conditions on the locomotive. The tests represented an equivalent run of about 92 miles as of a 45 in. trailer wheel, most of which was made under heavy load.

During each of the tests the speed and boiler pressure were held as nearly constant as possible. Indicator cards were taken and records made of the speed, the brake load, steam pressure and temperature and steam consumption.

From the data thus obtained the details of the performance of the booster were determined as set forth in the following paragraphs.

Mechanical Efficiency

The mechanical efficiency of the booster, or the ratio of the power delivered at the rim of the trailer wheel to the power developed in the cylinders, is plotted in one of the curves on Fig. 3. It will be noted that it varies from 90 per cent at 6 m.p.h. to a maximum of 95 per cent at 14.5 m.p.h. dropping slightly at higher speeds. The mechanical efficiency of the booster does not change with the steam pressure over the limited range met with in practice.

These mechanical efficiencies seem very high but the explanation of the excellent results is to be found in the high efficiency of the gear arrangement, the effective lubrication and the unusually high mean effective pressure. A typical curve of the brake horsepower, which corresponds with the

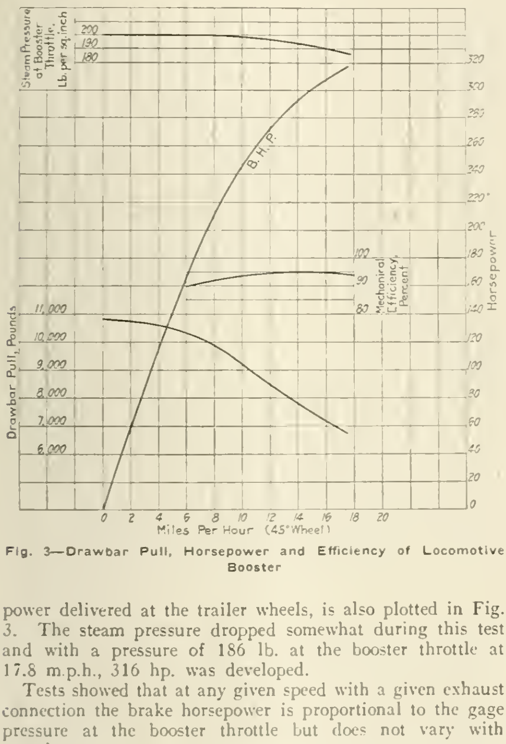


Fig. 3—Drawbar Pull, Horsepower and Efficiency of Locomotive Booster

power delivered at the trailer wheels, is also plotted in Fig. 3. The steam pressure dropped somewhat during this test and with a pressure of 186 lb. at the booster throttle at 17.8 m.p.h., 316 hp. was developed.

Tests showed that at any given speed with a given exhaust connection the brake horsepower is proportional to the gage pressure at the booster throttle but does not vary with superheat.

Drawbar Pull

A typical curve of the drawbar pull as obtained during the tests is shown in Fig. 3. For convenience in predicting the drawbar pull curve of the booster on any particular locomotive the chart of Fig. 4 has been plotted for speeds from 0 to 25 m.p.h. and boiler pressures from 140 lb. to 200 lb. gage.

In using this chart the pressure that can be maintained at various speeds by the boiler supplying the booster is estimated and the corresponding points are plotted on the chart, using the pressure lines as guides. A constant pressure equal to the boiler pressure of the locomotive can be realized over the entire speed range if the cut-off in the main locomotive cylinders is shortened enough at each speed to keep the steam consumption of the main cylinders and the booster cylinders within the limit of the capacity of the locomotive boiler. It will be noted that with 200 lb. pressure the type C-1 booster delivers a pull of 11,000 lb. at starting and at 20 miles an hour is still giving nearly 7,000 lb. at the drawbar.

Steam Consumption and Water Rate

To show the steam consumption of the booster under conditions identical with those plotted in Fig. 4. Fig. 5 has been

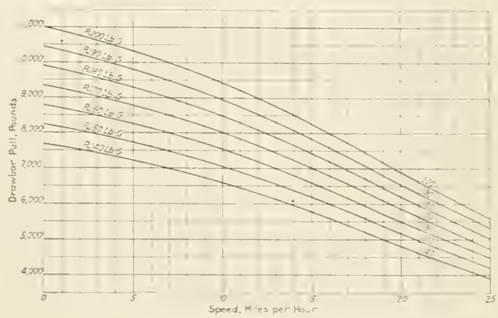


Fig. 4—Drawbar Pull Curves at Various Steam Pressures

drawn. The values given by this chart are based on superheat of 30 deg. F., the average value during the tests. The steam consumption is assumed to decrease about one per cent for each 6 deg. F. increase in throttle superheat. If saturated steam were used the consumption would be approximately five per cent greater than shown and if highly superheated steam were used, the values would be materially less.

The water rates as determined from the tests varied from 40.8 lb. to 43.4 lb. per brake horsepower hour. These rates

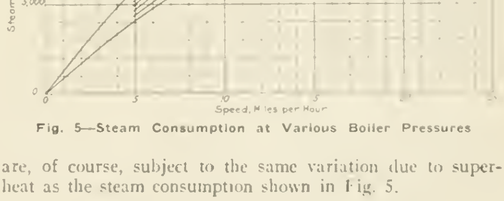


Fig. 5—Steam Consumption at Various Boiler Pressures

are, of course, subject to the same variation due to superheat as the steam consumption shown in Fig. 5.

Application to Operating Conditions

The manner in which the data obtained in the test can be used to determine the performance of the booster in actual service is illustrated in Fig. 6. This shows the increased hauling power and increased acceleration that can be obtained when the booster is applied to a Pacific type freight locomotive. In the chart the drawbar pull exerted by the locomotive or required to pull the train is plotted ver tically and the speed in miles per hour is plotted horizontally. The drawbar pull required for a 2,500 ton freight train, averaging 40 tons per car, on level and on grades up to 0.8 per cent is shown in the series of dotted lines. The lower solid line shows the drawbar pull of the locomotive without the booster and the upper line the drawbar pull with the

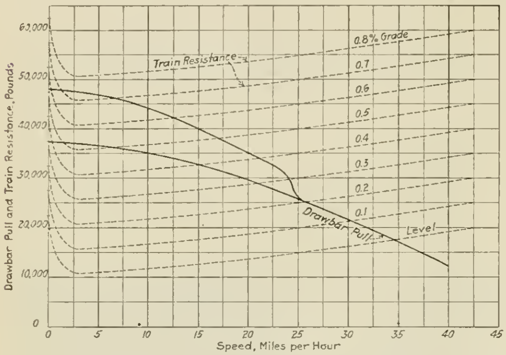


Fig. 6—Performance of Pacific Type Locomotive Hauling 2,500 Tons With and Without Booster

booster in operation, on the assumption that the booster is cut out at about 23 m.p.h.

Assuming the train is starting on level track it is evident that the locomotive without the booster can exert drawbar pull considerably greater than the train resistance. The difference between the drawbar pull of the locomotive and

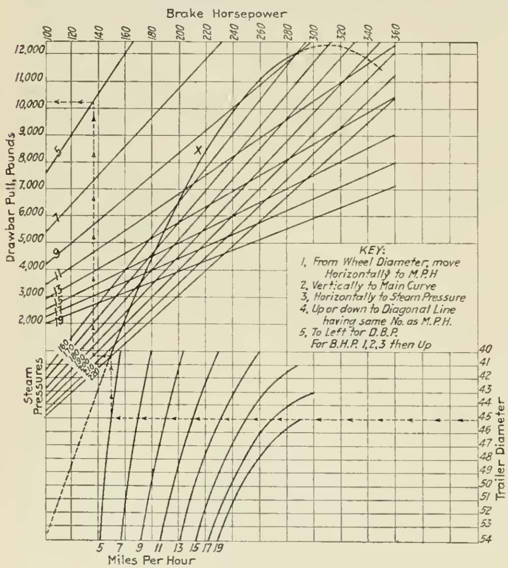


Fig. 7—Chart for Drawbar Pull of Booster

the resistance of the train is available for acceleration. With the booster still more power can be obtained for acceleration and the speed of the train will be increased more rapidly. As the speed increases the train resistance increases and the drawbar pull drops off until finally the drawbar pull just equals the train resistance. Under this condition no more acceleration will take place and the train will run at a constant speed of about 34 miles per hour on level track, as shown by the intersection of the drawbar pull and train resistance curves.

The pull required to start this tonnage on various grades is also plotted on this chart which shows the locomotive can only just start a train of this weight on a 0.3 per cent grade. With the booster the locomotive is able to start it on a 0.5 per cent grade and attain a speed of 17 m.p.h. If the booster is thrown out the speed of the train on this grade will drop back to 6 m.p.h. and if it stops the locomotive would be unable to start again without the aid of the booster.

The great advantage of the booster as shown by this chart is to enable the locomotive to make a grade of 0.7 per cent, while without the booster a train of this weight would stall the locomotive on a grade slightly more than 0.5 per cent. Even with a grade of 0.5 per cent, however, the booster offers the advantage of enabling the train to make a speed of 17

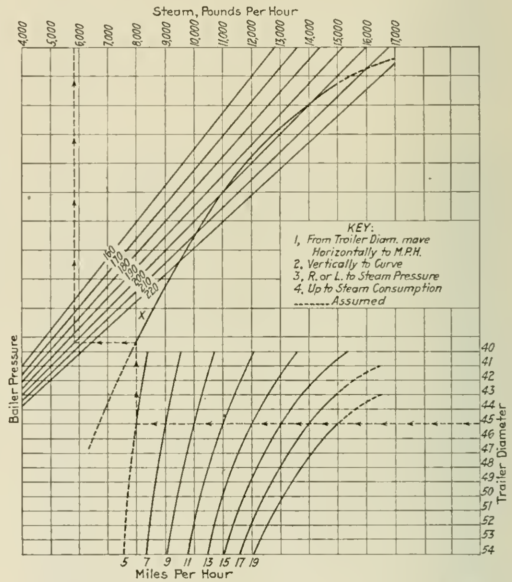


Fig. 8—Chart for Determining Steam Consumption of Booster

m.p.h. instead of only 6 m.p.h., thus saving over 64 per cent of the running time on the grade. With a grade of any appreciable length this saving in running time would be an important item, particularly near congested stations.

In order to enable engineers to predict the results that will be obtained under any given conditions, the curves shown on Fig. 7 have been developed. From these curves the tractive effort for any size wheel and any steam pressures can be determined, as it will be readily understood that these are the only two variables in the formula.

As an example of the use of the chart, assume that the tractive effort for a 45-in. wheel at 200 lb. boiler pressure is desired at speeds at from 5 to 13 miles an hour. The trailer wheel diameter is located at the right of the curves and the 45-in. point is used as the origin. The horizontal line is followed to the left until it crosses the speed curve that is desired, in this case five miles an hour. From the intersection of the horizontal line with this curve a vertical line is followed to the main brake horsepower curve, marked X. From this point a horizontal line is followed again either to the left or right until it crosses the steam pressure curve desired, in this case 200 lb. Then a vertical line is followed, up or down, as the case may be, to the diagonal line in the upper set for the same speed, in this instance to the line marked 5, and moving horizontally from this point to the left, the drawbar pull at the given speed and boiler pressure can be read from the scale at the side. Similarly any desired figure can be obtained and the drawbar pull curve set up for any conditions.

Another factor of interest to engineers is the steam consumption for the booster. To enable this to be readily determined at various speeds, the chart shown in Fig. 8 has been developed. Having determined the wheel diameter and knowing the boiler pressure, the chart is used as follows:

From the point on the lower right hand margin corresponding to the trailer wheel diameter, a horizontal line is followed to the miles-per-hour curve, and thence moving vertically to the curve marked X. From this curve a horizontal line is followed to the steam pressure curves, and then moving vertically to the top of the chart the steam consumption in pounds per hour can be read from the scale. It will be seen from the examples given that a complete prediction of the performance of the booster can be made from these curves.

Effect of Tonnage and Speed on Fuel Consumption*

Ton Miles Per Hour Affects Fuel Rate; Economical Tonnage For Various Speeds. Effect of Grade and Car Weight

By J. E. Davenport
Engineer, Dynamometer Tests, New York Central

This discussion touches the subject of the economic train load or train speed purely from the standpoint of fuel. Admitting that many times other operating conditions, or costs, or returns, finally settle the question of train load, it is altogether fitting that this association approach the discussion with entire attention directed toward the fuel consumption. The tonnages referred to herein are gross tons of 2,000 lb., not adjusted tons.

A train hauled by a locomotive is a unit made up of two components. The first component, the locomotive, is a machine capable of exerting a maximum drawbar pull at low speeds, and capable of producing a maximum dynamometer horsepower output at some higher speed dependent upon its dimensions (in the case of the modern Mikado this speed is around 30 miles an hour), but in terms of useful work per unit of fuel consumed the maximum efficiency is neither at the maximum dynamometer pull nor the maximum dynamometer horsepower. A modern Mikado type locomotive capable of exerting a dynamometer pull of some 60,000 lb. at speeds below eight or ten miles an hour, and a dynamometer horsepower of some 2,500 at speeds in the neighborhood of 30 miles per hour, shows its maximum efficiency from the fuel standpoint while producing a dynamometer horsepower output in the neighborhood of 1,400, and this output may be produced at any operating speed above approximately 10 miles per hour. The second component, the train, is a machine capable of being hauled most efficiently, as expressed in terms of resistance to hauling, at the lowest possible speeds and in car units of the highest possible weights which can be placed on four-wheel trucks. This statement may need modification when more knowledge is at hand concerning resistance of cars equipped with other than four-wheel trucks. The great number of variables entering into the makeup of the train unit indicates the reason that the question of economic train load is one so difficult of ready solution in all its phases, including the fuel rate. The most efficient fuel performance occurs somewhere between the most efficient locomotive performance and the most efficient train haulage performance.

The foregoing roughly expressed generalities are shown

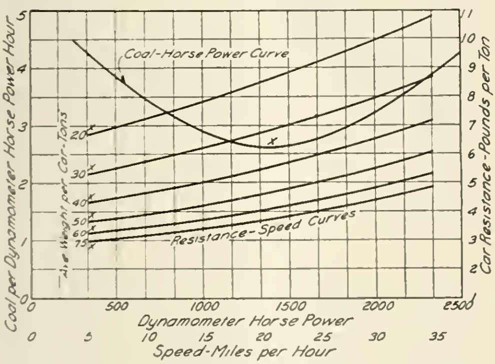


Fig. 1—Relation of Locomotive Fuel Consumption and Train Resistance to Train Speeds

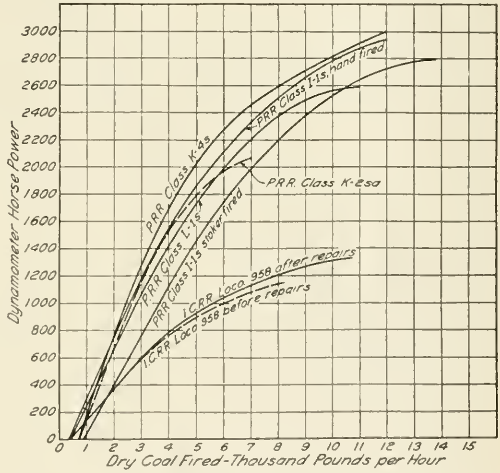


Fig. 2—Showing the Increasing Rate of Fuel Consumption in the High Ranges of Horsepower Output

*Abstract of a paper presented before the International Railway Fuel Association, Chicago, May [illegible] 1922.

graphically in Fig. 1. That portion of each curve marked with an X indicates the most efficient point of operation as related to that component of the train unit.

There are, possibly, many methods of arriving at the relation of load and speed to fuel consumption of which the following is suggested for your consideration. Two commonly accepted principles form the foundation of this method: First, the locomotive component of the train unit develops useful power related definitely to the fuel consumed. Second, the train resists haulage in terms related definitely to the grade, including curvature, speed and weight of the individual cars.

The production of useful power and its relation to fuel consumption is shown in Fig. 2, wherein the dynamometer horsepower developed is plotted against the coal consumed per hour. The curves are plotted from figures developed at the Pennsylvania and University of Illinois locomotive testing plants and represent the most reliable information obtainable on locomotive performance. It will be noted that at the point of maximum horsepower output the coal con-

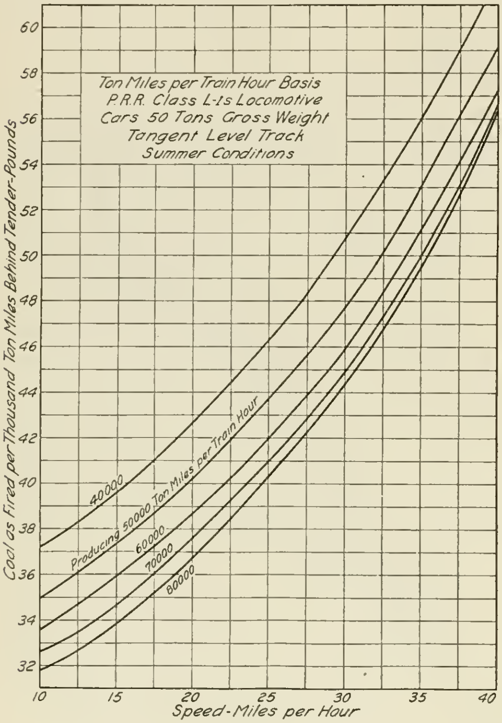


Fig. 3—Relation of Speed to the Ton-Mile Fuel Rate for Various Rates of Ton-Mile Output

sumption increases most rapidly with each unit of power produced. The resistance to haulage is shown in Fig. 1. These curves are reproduced from the University of Illinois studies on Freight Train Resistance. The values shown therein were substantially checked by the writer several years ago, and it is felt under average conditions these curves are entirely acceptable as a measure of car resistance.

Using the Pennsylvania Class L1s Mikado test reported in Bulletin No. 28, Figs. 4, 5, 6, 7 and 8 are submitted, showing in each case the consumption rates while the locomotive is working steam. Fig. 3 shows the relation between speed and coal as fired per thousand ton miles behind the tender with cars of 50 tons gross weight on tangent level track under the development of 40, 50, 60, 70 and 80 thousand ton miles per train hour, indicating a reduced fuel consumption at a set speed with increased ton mile production and a rapidly increasing consumption at a set ton mile production with an increase of speed.

Fig. 4 shows the relation between speed and coal as fired per thousand ton miles behind the tender with cars of 50 ton gross weight for trains of varying weight on tangent level track. These curves indicate that for each weight of train

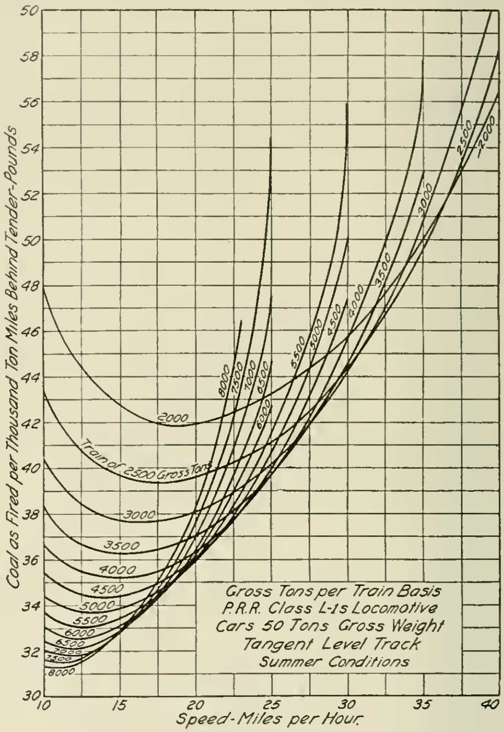


Fig. 4—Speed-Fuel Rate Characteristics of Trains of Various Weights

there is a speed of minimum fuel consumption; the lighter the train the higher this speed. Also they indicate the rapid increase of consumption with increase of speed beyond the point of minimum consumption; the heavier the train the more rapid the increase in consumption. It is interesting to note that the 2,000-ton train and the 8,000-ton train consume the same amount of fuel at 22 miles per hour, but by operating the 8,000-ton train at 11 miles per hour its coal consumption may be reduced to 75 per cent of the minimum possible with the 2,000-ton train.

Fig. 5 shows the relation between train load and coal as fired per thousand ton miles behind the tender with cars of 50 tons gross weight, operating at various speeds on tangent level track. These curves locate 20 miles per hour as the most economical speed for a train of from 2,000 tons to 2,500 tons, 15 miles per hour for trains from 2,500 to 6,000 tons and 10 miles per hour for trains from 6,000 to 8,000 tons, these economic speeds of course would be altered slightly had other individual speed lines been shown. These curves indicate that for 10 miles per hour operation the train tonnage should be over 8,000 tons for minimum consumption; for 15 miles per hour operation, between 7,000 and 8,000 tons; for

20 miles per hour operation, 4,500 to 5,500 tons; for 25 miles per hour operation, around 4,000 tons; for 30 miles per hour operation, slightly under 3,000 tons; for 35 miles per hour operation, slightly under 2,500 tons; and for 40 miles per hour operation, something less than 2,000 tons.

Fig. 6 shows the relation between speed and coal as fired per thousand ton miles behind the tender with 40 cars of 50 tons gross weight (2,000 ton train) on tangent level track and tangent grades of .1 per cent, .2 per cent, .3 per cent, .5 per cent, .8 per cent and 1 per cent. These curves emphasize the effect of speed and grade on fuel consumption and

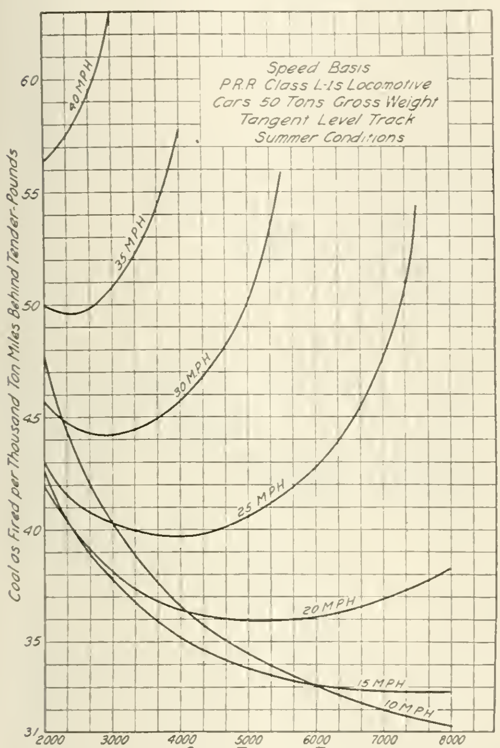


Fig. 5—Curves Showing the Economical Tonnages for Various Operating Speeds

indicate that the heavier the grade, the less the speed at which minimum fuel consumption may be expected. For example, the minimum rate on a 1 per cent grade is 199 lb. per thousand ton miles at 8 miles per hour, and on level track 42 lb. at 18 miles per hour. Also it requires 10 per cent more fuel at 14 miles per hour on a 1 per cent grade than at 8 miles per hour.

The foregoing charts having dealt with cars of 50 tons gross weight, a figure close to the average for eastbound loads on trunk line roads, Fig. 7 is produced to indicate the relation between speed and coal as fired per thousand ton miles behind the tender for the empty car return movement, cars of 20 tons gross weight, on tangent level track. These curves indicate the same relation as with the loaded cars: a minimum consumption for each train weight at some definite speed, the lighter the train the higher the speed. They also indicate that for operating speeds between 10 and 20 miles per hour a train of 150 cars shows the most economical performance; between 20 and 24 miles per hour, trains of 125 cars; between 24 and 30 miles, trains of 100 cars; between 30 and 36 miles, trains of 75 cars, and between 36 and 40 miles per hour, trains of 50 cars. Comparing the minimum consumption of 2,000 ton trains in Figs. 5 and 8, it is noted that the empty car train requires 60 per cent more fuel than the loaded train. This indicates the importance of the empty car movement in any fuel economy program.

Practical Application

Using recent dynamometer car tests with a 4-8-2 type locomotive, computing the train resistance established for level tangent track and relating this figure to the actual average dynamometer pull recorded, there is located what might be termed the equivalent grade for this territory. In Fig. 8 there is plotted the relation between the coal as fired per thousand ton miles behind the tender and speed for trains of cars of 35 tons weight, and trains of cars of 55 tons weight, both sets of curves making use of the equivalent grade figure of .06 per cent. The trains shown in the upper group, i. e., of 35 ton car weight, represent trains falling in the fast

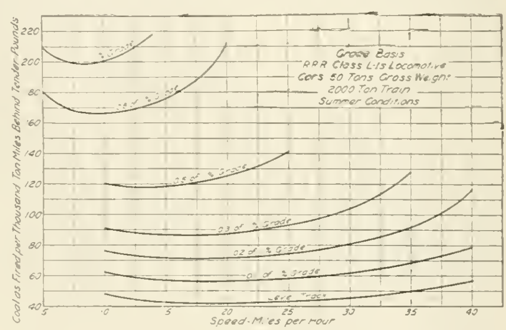


Fig. 6—How Grade Affects the Relation Between Speed and Unit Fuel Consumption

freight service and trains in the lower group, i. e., of 55 ton car weight, represent trains falling in the slow freight service.

Analyzing the operation from the curves shown in Fig. 8 for the period of 1921, covering the five summer months, in the fast freight service an average load of 2,675 tons was handled at an average operating speed of 19½ miles per hour, and in the slow freight service an average load of 5,750 tons was handled at an operating speed of 15 miles per hour. This fast freight service from the foregoing analysis shows the coal consumption of 76.6 lb. per thousand ton miles and the slow freight service a coal consumption of 54 lb. per thousand ton miles, showing an increase of 41 per cent in fuel for the fast freight service over the slow freight. A similar check of a different class of power in another territory, indicating an equivalent grade of .085 per cent, shows a coal consumption of 84 lb. per thousand ton miles in fast freight service and 63 lb. in slow freight, or an increase of 33 per cent in fuel in the handling of fast freights, which increase results from the combination of a higher speed, lighter train load and lighter individual car weight.

Many errors are made by the yard forces in computing the size of the individual train in both fast and slow freight trains. These errors in numerous cases on the slow freight side amount to as high as 20 per cent in the tonnage ordered and on the fast freight side running at times to 15 per cent. When errors of this nature produce a train heavier than is ordered the resultant will produce a more economical coal consumption since the operating speed in this service is from 14 to 20 miles per hour. However, when the error results in an underload of from 10 to 15 per cent the increase in the operating speed of this particular unit will result in an increased coal consumption as high as 10 per cent or 12 per cent.

Conclusions

The method outlined herein for ascertaining the relation between train load, speed and fuel consumption is suggested as possible for practical application for use during that portion of freight train movement while the locomotive is using steam. The fuel consumption during that portion of the run while the locomotive is drifting and during the delay periods must be computed in a different manner, and from the locomotive test plant results will amount to from 300 to 900 lb. per hour, depending upon the class of locomotive and method of firing. It is evident that local operating conditions will in each case govern the ratio of the portions of the run during which the locomotive is using steam and hauling the train and during which the locomotive will be

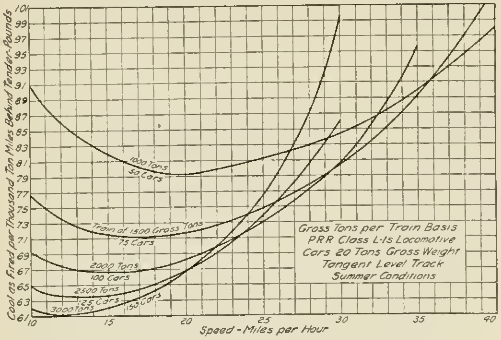


Fig. 7—Speed-Fuel Rate Characteristics of Trains of Light Weight Cars

consuming coal at this lesser figure, or in other words the relation between train load, speed and fuel consumption varies in each territory and each direction and can best be solved by local studies. Assuming the foregoing proposed method as containing a fair amount of merit, the conclusion is reached that for each weight train in each direction there will be a definite speed at which the minimum coal consumption will result, and with speeds either higher or lower than this definite speed there will be an increase in coal consumption. Generally speaking the handling of heavier cars and heavier trains and operation at moderate speeds will greatly assist in reducing the fuel bills.

Discussion

The following is an abstract of a written discussion presented by E. E. Ramey (B. & O.):

As the subject indicates, the effect of train load and running speed on unit fuel consumption alone has been considered in the paper, and the conclusions are given in pounds of coal per 1,000 gross ton-miles. It is also fairly general practice to measure the wage performance in freight service on the basis of some such unit as gross ton-miles per hour of crew time or wage cost of train and engine crews per 1,000 gross ton-miles, and it is not inappropriate to attempt a combination of the fuel and wage costs, which are the controlling factors in the cost of producing ton mileage, and to use the combined fuel and wage cost as an indicator of

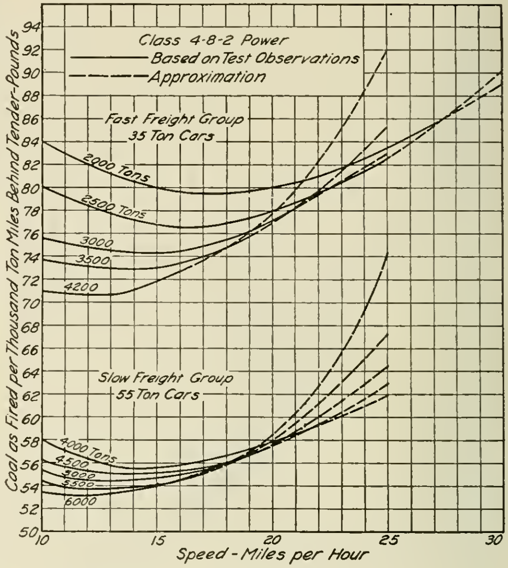


Fig. 8—Application to a Typical Operation on .06 Per Cent Equivalent Grade

the trend of the actual unit cost of the movement of traffic.

In practice this may be done currently by the compilation of a running daily and cumulative record of the performance of similar trains and groups of trains arranged as the particular operating conditions may render desirable. Comparison of the performance day by day of specific engine runs or operating divisions with good previous performances and with properly established standard performances will indicate the trend of the unit expense of moving the traffic.

To illustrate the position here taken, Table I has been

TABLE I—COMBINED COST OF FUEL AND WAGES PER 1,000

Gross Ton-Miles for Trains of 2,000 tons to 6,000 Tons

Crew time, hours	Running		2,000-ton train			3,000-ton train			4,000-ton train			5,000-ton train			6,000-ton train		
	Time, hours	Speed, m. p. h.	Coal	Wages	Total	Coal	Wages	Total	Coal	Wages	Total	Coal	Wages	Total	Coal	Wages	Total
13.0	10.0	10	14.8	26.4	41.2	12.0	17.6	29.6	10.8	13.2	24.0	9.7	10.6	20.3	9.3	8.8	18.1
12.1	9.1	11	14.4	24.2	38.6	11.7	16.1	27.8	10.4	12.1	22.5	9.6	9.7	19.3	9.2	8.1	17.3
11.3	8.3	12	14.0	22.1	36.1	11.6	14.7	26.3	10.3	11.1	21.4	9.6	8.9	18.5	9.1	7.4	16.5
10.7	7.7	13	13.8	20.6	34.4	11.4	13.7	25.1	10.2	10.3	20.5	9.5	8.3	17.8	9.2	6.9	16.1
10.2	7.2	14	13.6	19.3	32.9	11.4	12.9	24.3	10.2	9.7	19.9	9.5	7.7	17.2	9.2	6.4	15.6
9.7	6.7	15	13.5	18.0	31.5	11.3	12.0	23.3	10.2	9.0	19.2	9.6	7.2	16.8	9.3	6.0	15.5
9.3	6.3	16	13.4	16.9	30.3	11.3	11.0	22.3	10.2	8.5	18.7	9.6	6.8	16.4	9.4	5.7	15.1
8.9	5.9	17	13.4	16.0	29.4	11.3	10.7	22.0	10.3	8.0	18.3	9.7	6.4	16.1	9.5	5.3	14.8
8.6	5.6	18	13.3	15.2	28.5	11.3	10.1	21.4	10.3	7.6	17.9	9.8	6.1	15.9	9.6	5.1	14.7
8.3	5.3	19	13.3	14.4	27.7	11.4	9.6	21.0	10.4	7.2	17.6	9.9	5.8	15.7	9.8	4.8	14.6
8.0	5.0	20	13.3	13.7	27.0	11.4	9.1	20.5	10.5	6.8	17.3	10.1	5.5	15.6	10.0	4.6	14.6
7.8	4.8	21	13.4	13.7	27.1	11.5	9.1	20.6	10.6	6.8	17.4	10.3	5.5	15.6	10.3	4.6	14.9
7.6	4.6	22	13.4	13.7	27.1	11.6	9.1	20.7	10.7	6.8	17.5	10.5	5.5	16.0	10.6	4.6	15.2
7.4	4.4	23	13.5	13.7	27.2	11.7	9.1	20.8	10.9	6.8	17.7	10.7	5.5	16.2	10.9	4.6	15.5
7.2	4.2	24	13.5	13.7	27.2	11.8	9.1	20.9	11.1	6.8	17.9	11.0	5.5	16.5	11.2	4.6	15.8
7.0	4.0	25	13.6	13.7	27.3	12.0	9.1	21.1	11.3	6.8	18.1	11.3	5.5	16.8	11.7	4.6	16.3
6.6	3.6	28	13.9	13.7	27.6	12.5	9.1	21.6	12.1	6.8	18.9	12.4	5.5	17.9	13.5	4.6	18.1
6.4	3.4	30	14.3	13.7	28.0	12.9	9.1	22.0	12.8	6.8	19.6	13.6	5.5	19.1	....	....	....
5.9	2.9	35	15.3	13.7	29.0	14.7	9.1	23.8	....	....	....	....	....	....	....	....	....
5.5	2.5	40	16.9	13.7	30.6	....	....	....	....	....	....	....	....	....	....	....	....

prepared on the basis of Fig. 4 of Mr. Davenport's paper. In addition to these specified conditions, the following assumptions have been made to incorporate the wage factor:

(a) Locomotive run of 100 miles for Mikado locomotive.
(b) Terminal and road delays amounting to a total of three hours per trip.
(c) Train and engine crew wages of $27.32 for eight hours or 100 miles with overtime at the rates generally in effect.
(d) Cost of coal on tenders, $5.00 per ton of 2,000 lb.
(e) Consumption of coal during the three hours of delay at the rate of 750 lb. per hour.
(f) Crew time used in estimating the wage and fuel expense.

The general indication of the table for the conditions assumed, is that the wage factor predominates to the extent that the running speed for the lowest unit cost of wages and fuel combined is practically identical with the running speed for the lowest unit cost of wages alone, i.e. 20 miles per hour.

The running speeds for the lowest unit cost of fuel under the specified conditions vary from 19 to 20 miles an hour for a train of 2,000 tons to 12 miles an hour for a train of 6,000 tons. This would indicate a material variation for the heavier trains between the running speed of lowest unit fuel cost and that of lowest unit cost of wages and fuel.

In a general way it would appear that for the trains of 3,000 gross tons or more, reduction of delays will cause the running speed of lowest unit wage cost to approach the running speed of lowest unit fuel cost, resulting in a cumulative lowering of the combined unit cost. It appears that for the trains of less than 3,000 the running speed for the lowest possible combined unit cost is around 20 miles per hour. These conclusions are based upon the condition of tangent level track.

Alloy Steel Reduces Weight of Locomotive Parts

Rods, Axles and Crank Pins Made Lighter and Dynamic Augment Reduced on Union Pacific No. 7000 by Using Carbon Vanadium Steel

By R. J. Finch
American Locomotive Company, Schenectady, N. Y.

In the 4-8-2 type experimental locomotive No. 7000 recently built by the American Locomotive Company at its Schenectady plant for the Union Pacific, carbon-vanadium steel was used in a number of the principal working parts, these parts being as follows: main and side rods, driving axles, trailing axles, crank pins and piston rods.

In using this high-grade steel in this locomotive, it was thought best both by the railroad company and the locomotive builders to take advantage of the better qualities of this steel partly to secure lighter parts by allowing higher stresses and partly to give an additional factor of safety. Therefore, in designing these parts the stresses were kept within a max-

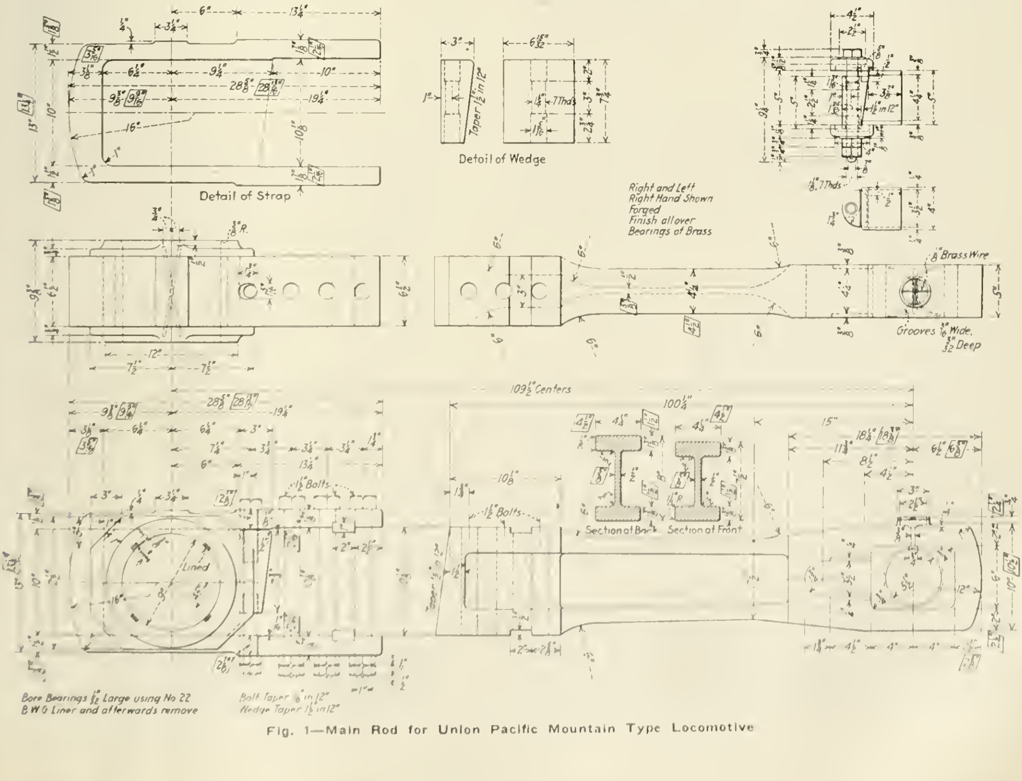


Fig. 1—Main Rod for Union Pacific Mountain Type Locomotive

imum of 15 per cent above the limit of stresses ordinarily used when the same parts are made of carbon steel, whereas the elastic limit of the carbon-vanadium steel used exceeded the elastic limit of carbon steel by more than 50 per cent.

It should be borne in mind that an increase in stress of 15 per cent for the carbon-vanadium steel over the carbon steel does not mean a saving in weight of 15 per cent, inasmuch as it is necessary to maintain ample bearing areas for the several crank pins and knuckle joints, which bearing areas are independent of the material used.

The purpose of this article is to show not only what was done in saving weight, but also just what was done in lessening the blow of the different wheels upon the rails (commonly known as dynamic augment). This saving in weight and decrease in the blow delivered to the rail enables the locomotive to haul more tonnage, which in turn means saving in coal and water, or a saving in money.

This saving is again extended to the upkeep of track and roadbed as well as upkeep in the machine itself by the lessening of the pounds. While the amount of saving in weight may seem trivial, yet if the saving in dollars and cents be considered for all these items, it would be found to be surprisingly high.

Fig. 1 shows a detail of the main rods and Fig. 2 of the side rods, the enclosed dimensions being about what would have been required had the parts been made of carbon steel. Fig. 3 shows the piston rod, which was made 4¾ in. hollow bored instead of 5 in. solid, to maintain areas for keys and crosshead and piston fits. The saving in weight in the crank pins and axles has been accomplished entirely by hollow

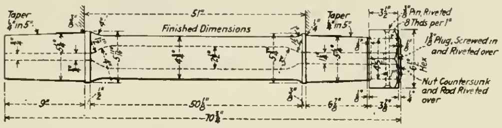


Fig. 3—Details of Hollow Piston Rod

boring, it being necessary to maintain ample bearing area for the journals. No saving was made in the weight of the front crank pin. The main crank pin was hollow bored 3½ in. in diameter, the hole being swedged down to 1¼ in. for a distance of 6 in. from the outer end. The intermediate and back crank pins were drilled out with a hole 2 in. in diameter extending from the inside face to within 1½ in. of the shoulder for the crank-pin collar. The driving and trailing axles were hollow bored 3 in. in diameter.

Table I shows the weight of the different parts; one column shows the actual weight of the carbon-vanadium parts, another column shows what the same parts would have weighed if made of carbon steel, while still another column shows the weight saved for each part, and the last column, the total saved per locomotive. It will be noted that the aggregate saving in these parts was 1,490 lb.

Of the 94 lb. saved in one main rod, 42 lb. was in the reciprocating part of the rod. This, added to the 99 lb. saved in one piston rod, gives a saving in reciprocating weight for each side of 141 lb. The driving wheels of this locomotive were balanced in accordance with the Master Mechanic's formula of balancing 50 per cent of the reciprocating weight. Fifty per cent of this 141 lb. divided among four wheels gives a saving in reciprocating weight of 18 lb. per wheel.

Table II shows the reciprocating weight of 18 lb. per wheel, to which is added the saving in the revolving weight for each wheel due to the lighter main and side rods and crank pins. It will be noted from this table that there was a saving in balance at the crank pin of 29 lb. for each front wheel, 66 lb. for each intermediate, 171 lb. for each main and 38 lb. for each back wheel. The centers of gravity of

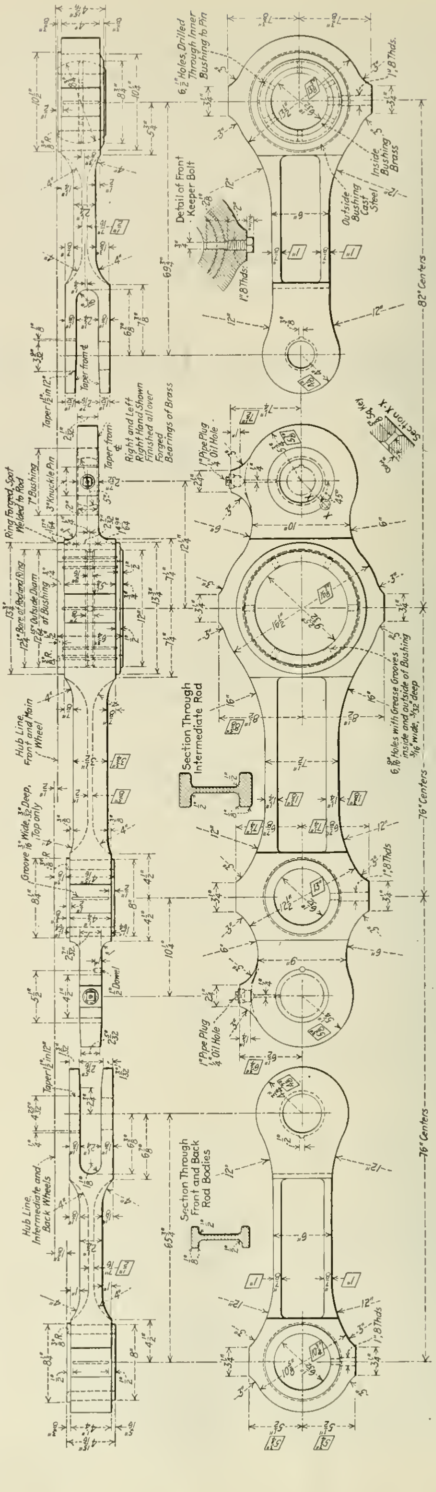


Fig. 2—Back, Intermediate and Front Side Rods

the balances, however, were farther out than crank pin radius, and the actual savings in weight were 15.6 for front, 34 for intermediate, 101.8 for main and 19.6 lb. for the back wheels. Twice the sum of these four savings, or 342 lb., is what was saved in the wheels themselves. This, added to the 1,490 lb. given in Table I, or 1,832 lb., is what was saved in the weight of the locomotive by the use of this carbon-vanadium steel.

TABLE I.—WEIGHT OF PARTS.

Name of part	Actual weight of carbon-vanadium parts, lb.	Estimated weight of carbon steel parts, lb.	Saving in weight per piece, lb.	Saving in weight per engine, lb.
Front Crank Pin	102	102	...	...
Main Crank Pin	472	532	60	120
Inter Crank Pin	120	130	10	20
Back Crank Pin	120	130	10	20
Piston Rod	332	431	99	198
Main Rod	1206	1300	94	188
Side Rods, Front	328	353	25	50
Side Rods, Inter	728	783	55	110
Side Rods, Back	270	290	20	40
Front Driving Axle	1383	1520	137	137
Main Driving Axle	2081	2220	139	139
Inter Driving Axle	1406	1545	139	139
Back Driving Axle	1406	1545	139	139
Trailing Truck Axle	1635	1825	190	190
			Total	1490

The bottom line of Table II shows just what was saved in each wheel in the blow, or dynamic augment. The amount added to the counterbalance to neutralize a portion of the longitudinal inertia forces due to the reciprocating parts is unbalanced in a vertical direction, and these figures are the additional blow which would have been caused by each wheel if this 18 lb. of additional weight had been balanced in each wheel. This figure for the dynamic augment, or vertical blow on the rail, is based on a speed of 73 miles per hour, or a speed in miles per hour equal to the diameter of the drivers in inches. The blow varies directly as the square of the speed, and if blows are wanted for less or greater speeds, they can readily be calculated. The total additional blow per side would be four times 806 lb., or 3,224 lb. The dynamic augment of the locomotive as built is 45,230 lb. per side at 73 miles an hour.

TABLE II. SAVING IN COUNTERBALANCE WEIGHT.

Saving in Balance at Pin, lb.	Back	Inter.	Main	Front
Reciprocating	18	18	18	18
Revolving weight of Main Rod	..	..	52	..
Revolving weight of Side Rods	10	38	41	11
Revolving weight of Crank Pins	10	10	60	0
Total at Pin	38	66	171	29
Total at Counterbalance	19.60	34	101.80	15.60
Dynamic Augment at Dia. Speed, lb.	806	806	806	806

The balances on the one side being at 90 deg. to the balances on the opposite side, the maximum combined effect of the blow on the track, or on a bridge, would be when both balances were down, the one balance being at a 45 deg. angle forward of the perpendicular, and the other 45 deg. back of the perpendicular. This combined blow at diameter speed would be 2 × 3,224 × .707 = 4,560 lb., .707 being the cosine of the 45 deg. angle. It is then seen that not only a saving in weight in the engine of 1,832 lb. was accomplished, but greater still, a continuous blow or pound of 3,224 lb. per side (4,560 lb. total) was saved.

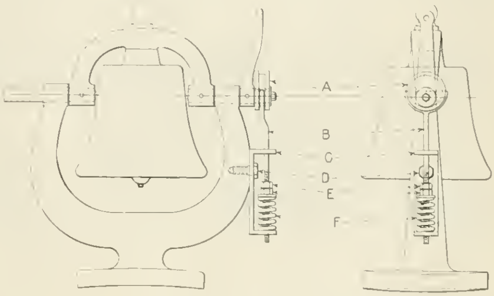
The Pennsylvania Railroad reports that its surprise checking conducted during the month of July, in the Eastern Region, shows that efficiency in train operation has not been impaired, in the slightest degree, by the shopmen's strike. The records show a perfect performance in more than 99.9 per cent of the cases. A total of 33,807 tests were made, and but 38 failures were recorded. Eight divisions had absolutely perfect scores. They were the Philadelphia, Cumberland Valley, Cresson, Trenton, Baltimore, Norfolk, Elmira and Schuylkill Divisions.

Friction Stop for Locomotive Bells

By Warren Ichler

EVERY mechanical engineer is familiar with the complaints of enginemen because of the turning over of locomotive bells by the various mechanical ringers now in general use. In an effort to prevent this nuisance various mechanical officers have resorted to pieces of hose attached to the top of the bell yoke; to ropes wrapped around the hand crank and bell yoke and various other makeshift appliances which have served to correct the turning over of the bell but are very unsightly and at best mere temporary expedients.

The effort has been to make a positive stop for the bell yoke, and while it is admittedly desirable to have a positive stop for extreme cases, a more desirable device would be one which would bring the bell to a gradual stop without throwing undue torsional stresses on the trunnion pins and shearing stresses on the rivets through these pins. Another troublesome feature of any positive stop is the fact that the downward swing of the bell is accelerated in greater or less degree depending on the character of the device used, and consequently the strain on the supporting pins and rivets becomes greater and greater as the acceleration increases.

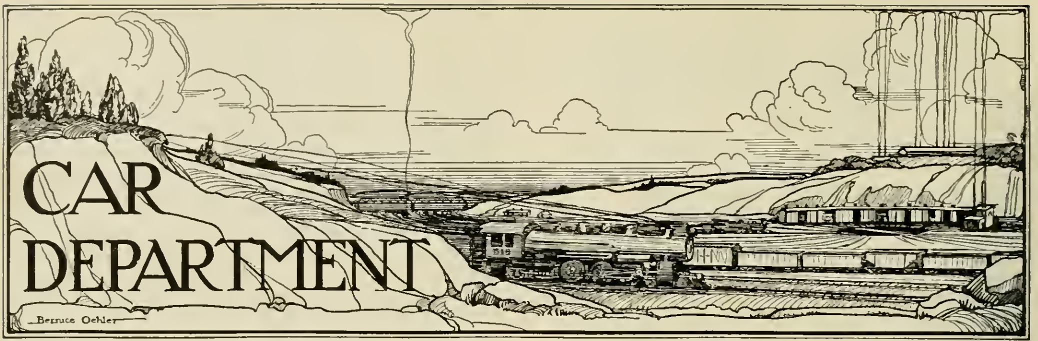


Method of Applying the Stop

In an effort to solve this problem, the writer made the device shown in the drawing and the results were so much better than had been expected that this simple mechanism is here offered for the benefit of other mechanical officers.

As will be seen from the sketch, the device consists essentially of an eccentric *A*, a push-rod *B*, yoke *C*, cap-screw *D*, coil-spring *F* and adjusting nuts *E*. The eccentric is mounted on the trunnion pin of the bell on the left or hand-crank side, the pin being made long enough for this purpose. The mounting may be secured by a key or by a hub and set-screw, and the eccentric is placed with the radius of eccentricity opposite the clapper when the bell is at rest or at its extreme low point. Any movement of the bell from this position causes the eccentric to depress the forked push-rod against the resistance of the string; this causes the push-rod to act as a friction brake on the eccentric. Of course, the frictional resistance of the push-rod increases directly with the upward stroke of the bell and decreases directly with the downward stroke.

In practice this device has worked splendidly and with practically no attention except an occasional adjustment to suit individual preferences regarding the arc of the bell stroke. The eccentric is usually made with a ¾-in. radius of eccentricity, the push-rod of ⅝-in. round, the yoke of ⅜-in. by 2-in. bar and the spring of ⅛-in. brass wire wound on a ¾-in. mandrel. The only part requiring machining is the eccentric and it is believed that a cast eccentric could be successfully used



Interesting Examples of Passenger Car Development

Progress in Design from 1836 to Date as Exemplified by One of the Oldest Car Shops

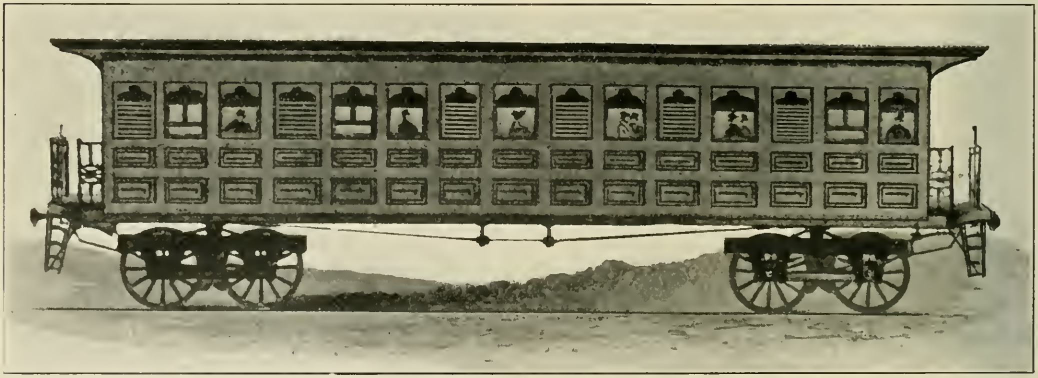
THOSE who are familiar with modern railroad equipment oftentimes fail to realize the remarkable progress that has taken place in the short period of 90 years since the first locomotive was introduced in this country. The history of railroad development is a fascinating subject, and it may be of interest to readers of the *Railway Mechanical Engineer* to review briefly the evolution of the modern passenger coach as exemplified in the work of a car building plant established when railroads were in their infancy.

One of the oldest and best known of the car shops in the east is the long-established Harlan and Hollingsworth Corporation at Wilmington, Del., now owned and operated by the Bethlehem Shipbuilding Corporation, Ltd., as its Harlan plant. This plant had its beginning in 1836 when the firm of Betts & Pusey was organized for the purpose of building railway cars. Its history has been closely interwoven with the development of car building since that early date, and the plant takes considerable pride in this intimate association with the industry practically from its beginning. It is interesting to note that a number of the present employees date their connection with the Harlan plant back to more than fifty years ago.

The first car shop occupied by Betts & Pusey consisted of a three-story, plain brick building 65 ft. long and 45 ft. deep. In the basement of this building, the blacksmith fires were located and the iron was forged for the trucks and other parts. On the upper three floors the business of car building was conducted in all its branches.

A few woodworking tools in vogue in that day together with the work benches, etc., were distributed about the second floor; while the upholstery room, the cabinet shop, the trimming room and other divisions of the business occupied the remaining space not required by the erection of the car bodies. The cars, when completed, were lowered bodily through large traps in the floor, and landed on the first story, where, after receiving their running gear, they were painted and varnished in readiness for delivery.

Due to the lack of connections in the early days between the existing railroads, the matter of making deliveries of finished cars, especially to lines any considerable distance from the car shop, presented an important and difficult prob-



Type of Passenger Car Built in 1836

lem. It was at times necessary to draw the new cars to their destination over improvised shifting wooden tracks. In the case of cars built for southern roads, these were shipped completely assembled on vessels to the seaport town nearest their point of destination. Sometimes cars were made in sections for shipment like present day knocked-down furniture, and were assembled on arriving at the road for which they had been built.

These physical limitations of the early car builders in making deliveries naturally limited the scope of territory over which it was advisable to take orders, and Betts & Pusey, therefore, confined their activities principally to roads whose proximity to Wilmington permitted easy conveyance of the cars from the shop to the tracks.

Morris Run No. 1 Built in 1840 for the Tioga Railroad

Interior of the Tioga Car

A review of the various types of cars built at the Harlan plant from its beginning to the present time takes in practically every forward step in the development of the modern steel passenger car, and shows most strikingly the transition from one period of design to the next. An interesting fact is that the first form of car, which resembled the old stage coach in design, was used for only a very short time, being quickly superseded by larger and stronger cars very much of the same general type as used today. This advance in design was followed in turn by the lavishly finished car, profusely decorated, polished and ornamented inside and out, which has recently given way to the simple, dignified, safe and comfortable all-steel coach.

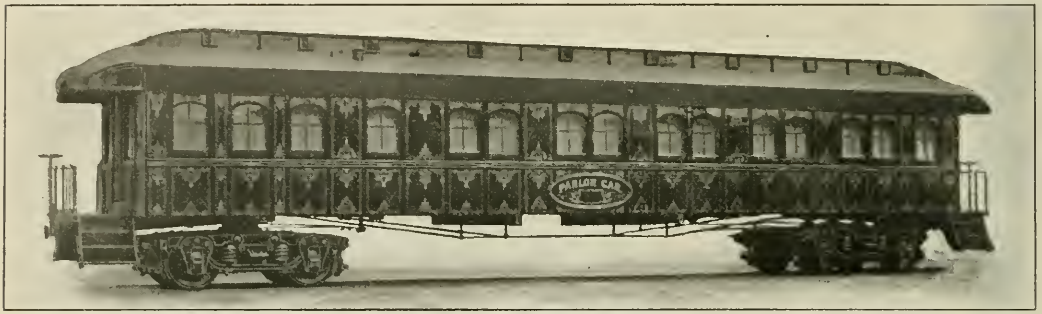
The first cars were built largely of wood; truck frames and underframes were wood, with a very restricted use of iron. As car sizes increased, the use of iron became more general in all parts, and gradually increased until the advent of the all-steel coach where wood is used only in window frames, trimmings, etc.

The first railroad cars built at the Harlan plant were contemporary with the beginning of the railroad industry of the United States. In 1830 there were only 23 miles of railroad in operation in the United States, and it was on August 9, 1831, that there was run what deserves to be called the first passenger train in America. This was the train hauled from Albany to Schenectady on the Mohawk and Hudson railroad, by the famous De Witt Clinton locomotive, and was made up of cars of the old stage-coach construction.

In the design of cars built at the Harlan plant in 1836, five years after the operation of the first railroad train, as can be seen from the accompanying illustrations, the stage-coach type had been abandoned and the end platform is seen to have been adopted, thus setting a style that has become standard in American car building.

Within four years from the date of its establishment, or in 1840, the firm, which was then known as Betts, Pusey and Harlan, built what was considered the best type of coach designed up to that time and which was in reality the first of the modern type of passenger car. This car was built for the Tioga Railroad, which is now operated by the Erie Railroad and extends from the Pennsylvania-New York state line to Morris Run, Pa. This car, known among railroad men as the "Tioga Car" and named the "Morris Run No. 1," obtained considerable prominence through being chosen by the Harlan and Hollingsworth Corporation to be placed in exhibition at the Chicago Exposition of Railway Appliances, held in 1883, as an illustration of the durability of passenger coaches when constructed of the best materials, as well as to furnish a comparison between the earliest and later types of cars. This car was put in service in September, 1840, and ran regularly until August, 1883. Its cost was $2,040.

The dimensions and details of the Tioga car, in comparison with the modern passenger car, show to what an extent the art of car building has progressed. In length this car was 32 ft. over frame, its width was 8 ft. 6 in. over frame, while its height from floor to ceiling was 6 ft. 4 in., with no raised roof. It was built with continuous framing, solid bracing, double uprights, stationary sash and Venetian blinds. The order for this car specified "One first-class passenger car" to be finished in every respect in a "highly modern" manner, with all the latest improvements. It was styled in the contract "An Eight-wheeled Passenger and Ladies' Accommodation Car," and was intended to excel anything of the kind then running in the country. Although at this late date we can scarcely realize the actual state of affairs as then existed in railroading owing to the great improvements that have since taken place, it is fair to assume that the Morris Run No. 1 when it left the shop equaled, and perhaps excelled, in beauty of finish, in comforts and arrangements, any other car then in operation. There is no doubt, however, as to the thoroughness of the construction and the quality of the materials used in this early car, as is attested by its operating life of nearly half a century.



Centennial Parlor Car Built at Harlan Plant in 1876

This car was a total departure from what had previously been used in this country and abroad, and more nearly approaches present day practice than any car built up to that time. Among other features it contained a "hood" consisting of an extension of the roofing, which extended beyond the body for protection to passengers when alighting. The roof, however, was not raised, the upper boarding being laid on flat from end to end.

The windows of this car had the peculiarity of being glazed in solid without any sash, and the wooden panels forming the sides of the car were made to open by sliding the lower half up inside the upper half. These panel openings were very narrow and were intended for ventilation rather than for sight. This arrangement gave the car a very odd appearance on the outside.

The building of a car like the Morris Run No. 1 was quite an achievement, when it is considered how crude the available tools were for working the iron and wood. The equipment of the original Harlan Plant shop, about the year 1836, consisted of a circular saw, a Daniels planer (which could plane but half a car stringer at a time, the piece being then taken out and the other end put in), a very limited assortment of other primitive appliances of a like degree of adaptability, and a few work benches for the carpenters.

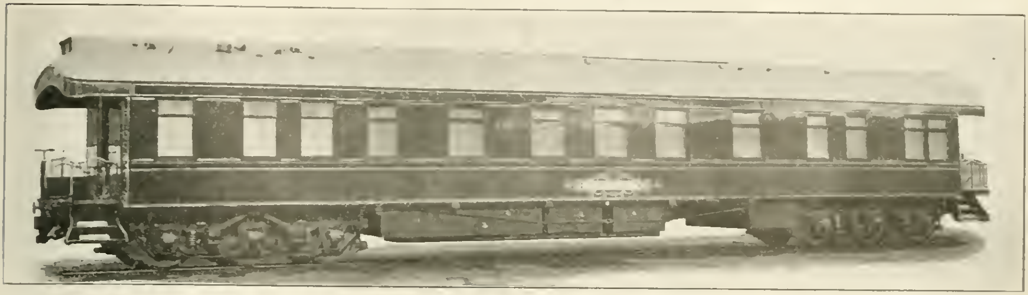
Improvements in details of car design and construction followed rapidly after the style of passenger cars with doors and platforms at the ends of the car had been accepted as standard design. As a side light on the attitude of the minds of the people of this country in those early days, it is quite natural to find that the ideals of American democracy should have found an expression in the building of cars in which all passengers were on equal footing, paid equal fares; where there were no distinctions as to classes of passengers, and all occupied a common traveling space. In Europe, however, car building took a different trend, and cars were developed with the class compartments that are in use today.

An example that embodied the most up-to-date ideas of the period when it was considered necessary to decorate and finish passenger cars elaborately in order to add to their attractiveness, is the Centennial parlor car built at the Harlan Plant in 1876 for exhibition at the Philadelphia Centennial. This car was 50 ft. long over frame, had a smoking room in one end with 6 chairs, a drawing room in the other end with 20 pivoted chairs, and a wash room and water closet in between. The interior finish of this car was very elaborate, following the style of that period, with mahogany, cherry, butternut and maple woods used in the panelling and trim.

Interior of the Centennial Parlor Car

As mentioned before, the interior decorations of the cars of this period were exceedingly ornate. Panels in different kinds of highly polished wood, inlay and marquetry work in elaborate designs, and intricate carved pieces were much used. The interior of a parlor car of this period shown herewith gives a good idea of the character of the interior finish.

In exterior appearance, the Centennial parlor car is also a fine example of the tendency of the time and will no doubt recall to many of the older readers of this the time when cars thus decorated were the rule. The abundance of gold leaf, colors and decorative work with which the cars were embellished certainly gave them an attractive and inviting appearance.



Private Car for Mrs. Lily Langtry Built in 1888

In the matter of luxuriousness and expensiveness in cars, probably the high water mark was reached in the private car built at the Harlan Plant in 1888 for Mrs. Lily Langtry. This car was the ne plus ultra in car building at the time, and it is doubtful if it has been exceeded in luxurious appointments by any car built since. The details of the finish can be imagined when it is known that the price was more than $65,000.00, and this at a time when the cost of labor and material was far less than at the present time.

Interior of Delaware & Bound Brook Car Built in 1876

The elaborateness of the finish of the cars just mentioned is in striking contrast with the simplicity of the design of the cars of the present time. There has been a decided change in the ideas of car designers and decorators since the cars of the Centennial period. A comparison of the interior of the passenger car of today, as for example the Norfolk and Western car illustrated, with the interior of a car of 1876, like the Delaware and Bound Brook, is very interesting. Not only is there a remarkable gain in simplicity and beauty in present day cars, but there also is a considerable economic saving in eliminating the expensive decorative effects of former days.

Improvements in methods and machinery used at the Harlan Plant naturally kept pace with the increasing demand for better and more elaborate passenger equipment. Numerous extensions and additions have been made to the plant and the present time finds it fully equipped with modern and up-to-date machine, forge, plate, carpenter and joinery, and upholstery shops, and with extensive car building tracks. The Harlan Plant now specializes in steel passenger car production and is experiencing one of the busiest periods in its long history.

Interior of Latest All-Steel Coach for the Norfolk & Western

Exports of Locomotives and Cars.—In June, 1922, forty-six locomotives, valued at $783,000, were exported from the United States. Of these 25 went to Argentina.

Four hundred and ninety-seven freight cars, valued at almost $1,000,000, were exported. Of these 200 went to Argentina and 100 to Chile.

Mechanical Refrigeration of Railroad Cars*

Early Attempts Show Difficulty of Developing Suitable Equipment; Dense-Air System Proposed

By W. M. BAXTER

THE subject of mechanical refrigeration as applied to railroad equipment is fraught with tremendous difficulties. First, the physical achievement of a successful mechanical process which will meet the multifarious demands of modern railroad transportation has not yet become a fact. Second, the economics of the problem are such as to lead the author to believe that it will be some time before a practical refrigerating machine can be applied to individual refrigerator cars. Third, from a railroad operating viewpoint any mechanically refrigerated railroad equipment must be held in specified traffic. This is a serious drawback because of the lack of universality of its use, and especially in its acceptance in interchange.

Again, being mechanical, such equipment must have the attention of attendants who must be specifically and practically trained in its maintenance and operation, and even with the most practical achievements along these lines it would be a long time before such a piece of railroad equipment would be heralded by the American railroads.

European Attempts at the Mechanical Refrigeration of Railroad Cars

The year 1912 marks approximately the beginning of serious attempts at mechanical refrigeration of railroad cars. The first effort that achieved any degree of success was that attempted by the chief of motive power and rolling stock of the Moscow-Kazan Railroad of Russia. Here a semi-absorption process was employed, consisting of refrigerating or expander coils located in the roof of the car and a connection on the outside leading from a drum of anhydrous ammonia, with a suitable expansion valve interposed. The other end of the refrigerating coil was conducted to a crude absorber located underneath the car. This absorber was in reality nothing more than a water tank having an aspirator tube placed therein. To start the process in operation it was only necessary to open the expansion valve and expand the gas in the refrigerating coil; the affinity of the water for the gas in the absorber maintained the back pressure and created the low-pressure side of the machine. It was the intention of the railroad to take the aqua ammonia thus formed in the absorber to a stationary regenerating plant and there distill off and reliquefy the anhydrous ammonia and charge it into suitable receptacles or drums which would be kept on hand and reapplied to equipment passing these points, which latter would virtually perform the same function as re-icing stations. This process failed because it was considerably cheaper to use natural ice for cooling purposes.

While attached to the American Army of Occupation as a major of engineers, the author was on one occasion sent to Poland where he saw in Warsaw an interesting car built in 1912 at Cologne, Germany, for the Russian Government Railways from the designs of M. Humboldt. In the central compartment of this car was a 10 h.p. oil engine which drove an ammonia compressor of 4 tons refrigerating capacity The condensing coils were placed under a sunshade roof on top of the car. No water was used for condensation, the day temperature of the atmosphere being depended upon to wipe off the heat of compression and thus liquefy the ammonia. The liquefied ammonia was passed to various expansion valves, one being located in each of the four refrigerating rooms into which the car was divided—two at each end of the engine compartment. By manually controlling these expansion valves different temperatures could be maintained in each of the various rooms if desired. According to a German railroad official in Warsaw, the cost of operating this car was about 80 per cent more than it would have been had natural ice been employed.

At Mayence on the Rhine, the headquarters of the French Army of Occupation, the author observed a rather new departure in car refrigeration, consisting of three insulated cars placed ahead of a central car provided with a refrigerating plant which was followed by two insulated cars. These cars were built and tried out in 1913. The traffic handled was butter and the service was from Kurgan on the Siberian border to Riga on the Baltic, a distance of about 1,500 miles. The temperature maintained in the cars was about 35 deg. F. Brine was pumped through piping and coils from the central plant which consisted of a complete refrigerating unit designed by the Linde Company, of Wiesbaden, Germany, one end of the car being partitioned off to serve as a sleeping room for two attendants. The machinery consisted of two double-acting ammonia compressors direct-connected to Diesel engines, ammonia condensers, a brine cooler, and two pumps for brine and for cooling-water circulation, respectively. A fan ventilator in connection with the condenser was set in operation when the train was standing, as otherwise the air passing through the louvres in the upper side walls of the war was not sufficient. A reservoir of cooling water was located beneath the car, as also were water-cooling radiators for the motors.

Absorption System of Mechanical Car Refrigeration

In 1913, when connected with the Canadian Pacific Railroad at Montreal as assistant to the general manager, the author began the study of mechanical refrigeration for railroad cars and built an absorption-system car, which was followed by two more cars constructed by him in the United States. The condenser and absorber were located underneath the car and the source of energy was a slow-burning charcoal fire.†

While this car from a construction point of view was a success in that it stood rough usage, met all the requirements of the Master Car Builders' Association, was cheap to build and economical in operation, nevertheless it was difficult to keep the pipe joints tight and leakproof. The real cause of failure, however, was due to boil-overs or foaming as soon as the car was switched or put in motion. The author devoted much time to this feature but was never able to prevent it. Of course, as soon as this occurred the car became inoperative, as liquor passed to the condenser and no anhydrous ammonia remained to expand in the refrigerating coils.

The Dense-Air System of Car Refrigeration

In 1917 the author abandoned all ammonia processes and attempted to achieve the result by means of the dense-air

*Abstract of paper presented at a joint meeting of the Metropolitan Section of the American Society of Mechanical Engineers, and the American Society of Refrigerating Engineers, New York, May 16, 1922. The author is president of the Baxter-Stewart Refrigerator Transport Company and vice-president of the Ideal Truck Equipment Company, Chicago.

†An illustrated description of the absorption-system refrigerator car designed by Mr. Baxter was published in the *Railway Mechanical Engineer* for December, 1916, page 662.

process. In this he has been quite successful. This system is now in use on large refrigerated motor trucks which are equipped with a one-ton dense-air refrigerating machine and have a capacity of 30,000 lb. of dressed beef at a load. The temperature maintained is 36 deg. on a 90 deg. day. A fleet of these trucks have been in continuous service for four years in the stockyards district of Chicago, handling traffic in a radius of 24 miles.

Fig. 1 shows diagrammatically the process as used on two of these trucks. The plant has a refrigerating capacity of 1000 lb. Its source of energy is a gasoline engine and the refriegerating medium is the air. With this combination the only operating supplies necessary are gasoline and oil. The refrigerating mechanism is located in a space occupying 2 ft. of the length of the body on the front end, leaving a receiving chamber for perishable goods 23 ft. 6 in. long, 7 ft. 4 in. wide, and 6 ft. 2 in. high. The refrigerating coils are located in the roof of the car and are fastened to the steel-plate and angle-iron carlines, which makes it possible to swing carcasses from the coils by meat hooks. The refrigerating machine is adjusted thermostatically to maintain the temperature of 36 deg. F. It can also be adjusted to reasonably lower room temperatures if desired, it being possible to carry the expanded air temperature of the refrigerating medium to 30 deg. below zero.

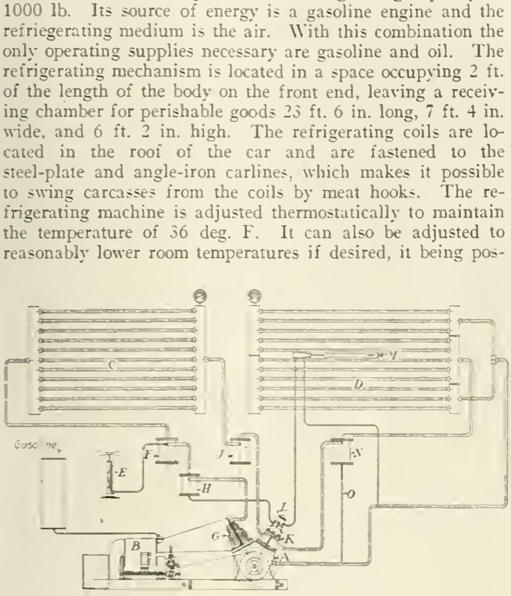


Fig. 1—Diagram of Dense Air Process of Refrigeration

The Refrigerating Machine. The dense-air process is based upon the fact that a perfect gas under pressure, expanding adiabatically and performing external work will suffer a drop in temperature proportional to the mechanical energy produced. Its fundamental advantages lie in these characteristics: There is an unlimited supply of the agent everywhere, as air is the medium; it is readily dried by the use of deliquescent salts, it is innoxious, non-poisonous, and its explosive force lies only in its expansibility under pressure; a leak may be readily sealed and the air, once dried, becomes a perfect medium of refrigeration at temperatures much lower than is possible with any agent except CO_2.

The refrigerating unit consists of a compressor employing two cylinders (5 in. bore by 5 in. stroke), and an integral expander consisting of two cylinders ($4\frac{3}{8}$ in. bore by 5 in. stroke), both sets of cylinders operating from the same crankshaft. The unique feature of this design lies in the valve mechanism and means for controlling the expander unit. The exhaust valve is a rotary valve functioning both cylinders. The inlet valves are controlled and timed by a compound rotary cam whose length is adjustable by thermostatic control, thus making it possible to alter and control by thermostat the ratio of expansion, and therefore the resultant temperature. Castor oil is used as a lubricant in both the compressor and expander sides and the oiling system is in itself a closed cycle. The expander mechanism is oiled from the oil separator in the exhaust from the compressor and fed under pressure of the high side to the cams, valve mechanism and pistons of the expander. The compressor pistons are lubricated by splash from the crankcase and an oil separator in the low side returns the oil to the crankcase.

In operation the machine requires 1¾ h.p. which is furnished by an air-cooled engine of the Henderson motorcycle type. The engine also drives an exhaust fan of approximately 4,000 cu. ft. capacity which produces a rapid flow of air across the compressed-air cooler, the compressor cylinders and gasoline engine cylinders. Proper ducts are provided to connect the various members to be cooled.

The Thermodynamic Cycle. In order to illustrate the system and to set forth the simplicity of the refrigerating process and the incidental mechanism, attention is again called to Fig. 1 in which *A* is the refrigerating unit, *B* the gasoline engine which supplies the power, *C* the compressed-air cooler and *D* the refrigerating coils.

The device is primed by the use of the hand pump *E* connected with the drier *F*, operation of the hand pump being continued until the gage indicates the density required, as the capacity of the machine depends upon the densities of the two sides, regardless of the ration of expansion. Priming, therefore, is necessary to increase the relative capacity of the device.

In operation the compressor cylinders *G* take air through their pistons from the crankcase and discharge into the cooler *C* first through the oil separator *H*, thence through the drier *F* which removes the entrained moisture, converting the hydrous content into a fixed brine and allowing the anhydrous air to pass on to the cooler *C* where the thermal coefficient of the mechanical energy performed and the specific heat due to change in volume are removed, the cooler serving to bring the temperature of the compressed air down to a point approximately 27 deg. higher than the weather temperature of the day.

The compressed air which has been cooled now passes through the secondary drier *J* to the expander, the secondary drier serving as a precautionary device to remove any moisture which may have passed the drier *F* because of high temperature at that point. In the expander *K* the air is expanded adiabatically at the ratio of expansion determined by the position of the control piston in the cylinder *L*, which is in turn controlled by the thermostat *M*. The expanded air, of extremely low temperature, is carried to the oil separator *N* in which any oil is removed before it may enter the refrigerating coils *D*, as oil in the coils produces a decided loss in efficiency. The oil extracted in the separator *N* is returned to the return pipe from the refrigerating coils *D* by a crossover *O*, both oil and air being finally returned to the crankcase from which the compressor cylinders take their supply.

The thermostatic control of the ratio of expansion is accomplished by means of a piston whose position determines the length of the cam face, which in turn determines the proportionate time of opening and closing the inlet valves, and therefore the ratio of expansion. The position of the control piston is determined thermostatically by a leak-off connected with the thermostat, by which high-pressure air is allowed to escape to the low-pressure side and move the piston proportionately to its rate of escape.

The Ethyl Chloride System

In addition to the systems described there is another, of the compression type, using ethyl chloride as the medium. Ethyl chloride boils at 54.5 deg. F. and liquefies at the low pressure of 15 lb., with condenser water at 65 deg. F. Its critical temperature is 365 deg. F., which is sufficiently high to preclude the danger of generating permanent gases. Being a neutral gas, it is possible to use thin seamless drawn copper tubes, and the joints may be soldered if desired.

As the boiling point of ethyl chloride is so low, a partial vacuum is necessary on the low side of the machine to produce the required temperature in the car. The medium is handled by a valveless rotary compressor.

The machinery is located in the end of the car and the method of operation is as follows: The medium is evaporated in the refrigerator pipes in the refrigerating compartment. The gas is then drawn to the compressor and forced into the condenser where it is liquefied. The condenser consists of a series of copper tubes placed vertically in the compartment with the compressor. The heat of compression is removed by means of a small spray of water fed to the top of the condenser, and this water is cooled by a fan so arranged that the current of air is distributed equally over the entire surface of the condenser. The power to drive this mechanism is taken from the axle of the car by means of a belt and countershaft below the compressor. Between the countershaft and the truck axle are interposed two idler pulleys upon a common guide, these pulleys being held together by springs and placed upon a guide in order that they may operate in either direction. The arrangement is such that in whichever direction the car is running the machine automatically takes up its refrigerating work. The water for cooling the condenser is carried in a tank underneath the car, from which it is pumped by a small rotary pump attached to the main shaft of the compressor. An oil engine is provided for the purpose of continuing the operation of refrigeration when the car is standing still, thus making it possible to set the car out of the train when necessary. The water for cooling the cylinder of the engine is carried in a small tank on the roof of the car.

Conclusion

As stated at the beginning of the paper and for the reasons there mentioned, it will be some time before mechanical refrigeration will be adopted on American railway cars. However, the author believes that it can be accomplished by equipping refrigerator cars with a thermosiphon system and providing a tank in the roof of the car with two compartments, one for receiving ice from regular icing stations and the other for holding a weak brine solution into which is submerged a refrigerating coil; the source of energy for cooling this brine to come from a central refrigerating-plant car carried in the train and having a capacity sufficient to refrigerate ten cars. The brine cooled in this central car would be pumped under a pressure of two or three pounds to the refrigerating coils in the various refrigerator cars, and even remove the latent heat of the brine in the tanks, if necessary, thus freezing it, thereby storing refrigerating work to be used if the car should be set out; or if the car is to be used in traffic where it is not operated from the central-plant car, then, as previously mentioned, it may be iced in the usual way, and by means of the thermosiphon system a rapid automatic circulation of the secondary refrigerating coils will take place whether the car is standing or in motion. It should be possible to store enough latent-heat energy to operate one of these cars at least 72 hours without re-icing or reconnection to the central-plant car.

This central-plant car should have installed within it a dense-air refrigerating machine of 30 tons refrigerating capacity for a ten-car unit. This machine may be driven by any standard form of gas or oil engine, preferably of the Diesel type, and the entire operation can be so designed that no water is needed to carry away the heat of compression.

Properties of Chilled-Iron Car Wheels

THE Engineering Experiment Station of the University of Illinois in co-operation with the Association of Manufacturers of Chilled Car Wheels has, for some-time past, been engaged in an investigation as to the physical properties of chilled car wheels. The scope of the investigation embraced tests to determine (1) the strains caused by mounting the wheel on its axle; (2) the strains caused by the static or wheel loads; (3) the ultimate breaking strength of flanges and strains caused by flange pressure; (4) the strains due to temperature gradients in the wheel caused by brake application; (5) incidental problems relating to the above.

The results of the investigations covering the strains caused by mounting the wheel and by static or wheel loads has been embodied in Bulletin No. 129 by J. M. Snodgrass and F. H. Guldner, the engineers in charge of the work. The strains in the wheel caused by forcing it on the axle were first determined for two 33-in. 725-lb. M.C.B. wheels. The same pair of mounted wheels was then subjected to static loads ranging from 20,000 lb. to 200,000 lb. per wheel and the resulting strains noted. The loading effect was produced by applying the load to the axle by means of a testing machine and allowing the wheels to transmit it to a pair of rails, the conditions being similar to those found in service. A similar set of tests was carried out with a pair of 33-in. 740-lb. arch plate type wheels.

A car wheel in service is subjected to stresses caused by (1) manufacturing processes, which may cause initial stresses; (2) forcing the wheel on the axle, or mounting; (3) the proportion of the car loading supported by one wheel; (4) the lateral pressure on the wheel flanges produced by rounding curves, by wind, or by the unevenness of the track; (5) non-uniform temperatures in the wheel caused by brake application; (6) centrifugal force when the speed is high.

Important initial stresses, if existent, can be traced to improper manufacture. Annealing is universally practiced and if properly performed, either removes or reduces to a small amount the inevitable initial stresses.

Forcing the wheel on the axle produces compression in a radial direction and tension in a tangential direction throughout the entire wheel. The intensity is greatest at the bore and decreases toward the tread, being negligible at the rim. On being placed in service, the wheel encounters conditions that produce an exceedingly complex stress distribution within it. Only those due to static load are considered in the present report.

Chemical analyses were made of several wheels and specimens were taken out for tensile and compressive tests. Hardness tests, both by the Brinell method and with the scleroscope were also made in an attempt to associate the quality of hardness with other physical properties.

During the investigation, a Berry strain gage was used to determine distortion. By this instrument unit strains could be read directly to 0.0001 in. and by estimation, to one tenth of this figure. A 600,000 lb. Riehle testing machine with an autographic attachment was used for determining the mounting pressure and later for the application of static or wheel loads.

The results of the investigation may be summarized as follows:

(1) The tensile strength of the metal taken from different parts of the plates of three wheels ranged from 23,300 lb. to 32,800 lb. per sq. in. and the modulus of elasticity ranged from 14,000,000 lb. to 28,000,000 lb. per sq. in. It is probable that these variations may be explained by variations in chemical composition of the several specimens and variations in the treatment of the wheels after casting. Whatever be the reason, however, they suggest that a study of the metallurgy of wheel irons offers possibilities of improvement by which the higher values obtained in these tests might be consistently maintained or possibly exceeded in the future.

(2) No distinct relation was apparent between the ultimate strength of wheel iron and either the Brinell or the scleroscope hardness, nor could a constant relation be determined between the Brinell and scleroscope results. Brinell hardness in the body of the wheel varied from 110 to 150 and scleroscope hardness from 30 to 40.

(3) In forcing the 625-lb. and 725-lb. M.C.B. or Washburn type of wheel on an axle the maximum tensile strain or stress is a tangential or "hoop" strain or stress occurring at the bore, and it may be on either the inner or the outer face of the wheel.

On the outer face of this type of wheel in a radial direction the strains or stresses are compressive. They are a maximum at the bore and, in traversing the section of the wheel from the bore toward the tread, they decrease up to a point where the radius equals the mean radius of the core, beyond which an increase occurs up to a point at or near the intersection of the inner and outer plates, after which a decrease again occurs.

On the inner face in a radial direction the strains or stresses are likewise compressive and a maximum at the bore. If a similar traverse be made across the section, these strains or stresses decrease up to a point where the radius equals the mean radius of the core; they are then of approximately uniform intensity up to a point whose radius is equal to the outer radius of the core; beyond this point they again decrease.

Tensile and compression stresses as high as 17,000 lb. were observed.

(4) In pressing the 740-lb. arch plate wheels on the axle the maximum tensile strain or stress was a tangential strain or stress on the inner face and at the bore. In general, the tensile stresses on either face of the wheel were a maximum next to the bore and steadily decreased toward the tread.

With respect to the strains or stresses in a radial direction on the outer face, no measurements were taken in close proximity to the bore, and accordingly nothing definite can be stated concerning their intensity in this region. However, the strain in a radial direction taken nearest to the bore was relatively small and was tension in one wheel and compression in the other. This fact may be due to bending action in conjunction with the thrust of mounting. As the tread was approached, the strains and hence the stresses became compressive and of increasing intensity, reaching a maximum at a point whose radius was equal to the mean radius of the core, beyond which they again decreased.

On the inner face over the region investigated, the strains or stresses in the radial direction were compressive, reaching the maximum nearest the bore and decreasing to a minimum at a point whose radius was equal to the mean radius of the core, after which they again increased.

Stresses observed were as high as 16,800 lb. for tension and 13,700 lb. for compression.

(5) In the regions of the chaplets and core holes, pressing the wheel on the axle causes tensile strains in a tangential direction which are of lesser intensity than, but approach in magnitude to, those at the bore.

(6) The stresses and strains in the brackets which are produced in a radial direction by mounting are relatively insignificant.

(7) The strains caused by mounting the wheels on the axles, when mounting alone is considered, are greatest in the hub near the axles. These strains, although apparently high in the case of the greatest values recorded, are steady and not repeated as is the case with the majority of strains produced in service. Moreover, these highest strains extend through a comparatively thin layer of metal near the axle and this strained layer is backed by other layers of less strained metal.

(8) In general the static load is transmitted from hub to rail mainly through the outer plate, while the smaller portion of the load goes through the inner plate. This effect is more pronounced in the 740-lb. arch plate than in the 725-lb. M.C.B. type of wheel. This division of the load seems desirable in that the inner plate may be considered as affording a reserve capacity for the purpose of absorbing the effect of the side thrust exerted on the flange when rounding curves.

(9) Pressing the wheel on the axle is much more effective in producing stress or strain within the wheel than the normal static load, and it therefore follows that the addition of the normal static load does not greatly add to or otherwise modify the more important of the existent strains caused by mounting.

(10) Abnormally heavy loads, in the absence of impact, side thrust, etc., may be sustained by wheels without increasing the normal strains, already existent, to such an extent as to seriously stress the wheel.

(11) The maximum strains reported, caused by the combined effects of mounting and static load, appear large when expressed in terms of the stress that would exist if the material were subjected to simple tension or simple compression. As previously stated, these strains are produced in the main by the mounting load and the more important strains are those of tension, which in general are greatest near the bore of the wheel. The character of the strains and the backing of the material most strained by less strained material, probably makes possible without injury to the material greater strains or deformations than would be allowable in the case of material not so supported and subjected to simple tensile stress. As previously stated, the problem is one of compound stress, and the method used in computing the stresses reported is thought to give the highest values for these that could be expected under such conditions. Any error in estimating, from the stress values determined in this way, when elastic failure might take place, would be upon the side of safety. In this connection it should also be remembered that the stresses reported are those produced by two forms of wheel loading only, and that the strains and stresses resulting from these two forms of loading (mounting and static) may be materially modified by additional stress-producing factors to which a wheel may be subjected in service.

The First French Railway Instruction Car

By Raymond Legonne

THE Paris Orleans Railway of France has always been a leader in the instruction of apprentices and the training of young men for supervisory positions. The road has had special training courses for some time and is now supplementing the work with a well equipped instruction car, recently built. This car is used to give practical and theoretical training to men selected by examination from the enginemen, gang foremen, and assistant foremen of the company. The men are examined four times a year in the car where apparatus, charts and schedules used in their work are provided and full information is given by the superintendent appointed as instructor.

The instruction car and auxiliary car, which are operated together, are 36 ft. 6 in. and 35 ft. long respectively and are of the most modern construction. The apparatus in the car includes complete Westinghouse air brake equipment with an air pump which has been cross sectioned and fitted with small electric lamps which, as they are illuminated or darkened show the working of the different valves. Other equipment in the car includes steam heating apparatus, electric and air communication apparatus, injectors, lubricators and other locomotive accessories.

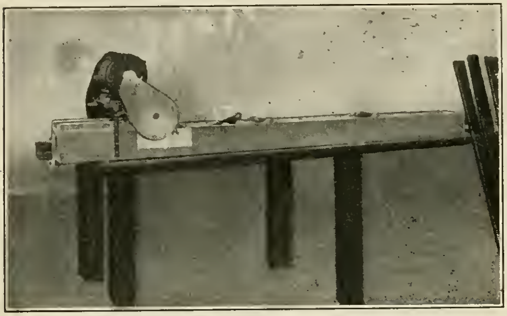
On a platform suspended with counterweights from the ceiling of the car is a complete small sized model of track, sidings and signal apparatus electrically operated with semaphores, bells, crossing signals and other apparatus in use on the system. The car can be darkened when required for the use of moving pictures in connection with the instruction work.

Three Unique Car Shop Devices

At one of the car shops of a railroad in the east many appliances have been developed for facilitating car repair work. Among the most interesting are those described below.

Machine for Painting Car Siding

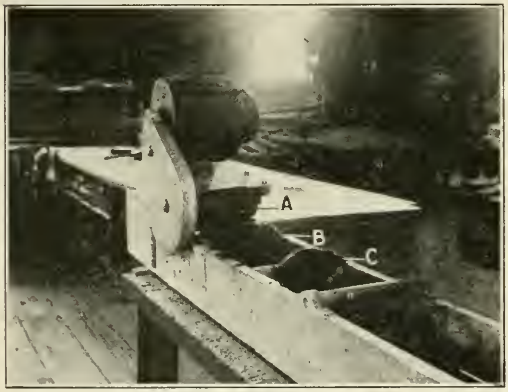
When siding on box cars is renewed it is usually necessary to apply two coats of paint. The first coat must dry for a day before the second is applied, which causes delay in getting cars off the repair track. In the case of foreign equipment, the per diem for the extra day often makes a net loss if only minor repairs are made. In order to avoid holding cars for painting, this shop applies one coat of paint to



General View of Machine for Painting Siding

the siding before it is put on the car. The painting machine is useful for speeding up this work.

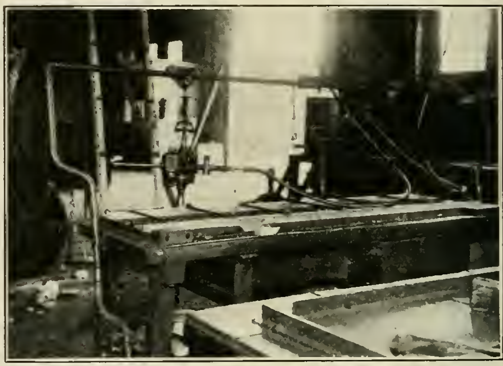
The device takes up comparatively little space, being about 10 ft. long and 10 in. wide. The operating parts are shown in the first illustration. The motor is geared down and drives the 3½ in. by 7 in. wooden roller *A*. The frame carrying the motor and upper roller is pivoted so that the roller can be raised when a piece of siding is fed under it.



Details of Painting Machine

Roller *A* rests on another 3½ in. roller which is in contact with a 6 in. roller *B* and drives it by friction. The large roller is covered with lamb's wool and the under side dips into paint in a tank in the base.

The siding is fed in between the wooden rollers and passes over the lamb's wool roller which moves in the opposite direction. The pressure between the roller and the siding forces the paint out of the lamb's wool and the under side of the board is practically flooded with paint. About a foot beyond this roller is a brush *C* which removes any excess of paint and smooths the surface. The board then passes over two small wooden rollers and as it comes out is placed on a



Device for Assembling Car Ladders

rack to dry. The siding passes through at about 50 ft. per min. but even at this speed no paint slops off the rollers, every drop being returned to the tank.

Assembling Car Ladders

Large numbers of cars on this road are equipped with ladders having wooden stiles and straight iron rungs. Assembling these ladders is a tedious operation if done without special equipment but the work is readily handled with the frame shown in the photograph. This consists of a bench

Motor-Driven Saw for Trimming Edges of Roofs

with an iron top on which all the required equipment is mounted. In assembling the ladders the ⅝ in. carriage bolts are first inserted through the stiles which are then placed on the frame, being held in the proper position by angle irons. The rungs are put in place and the nuts started on. The operators then place the air motor socket over each nut in turn and tighten them. The supporting frame of pipe is pivoted and can be swung over either stile. When all the nuts have been tightened the air hammer is used to rivet over the ends of the bolts.

Saw for Cutting Roofs

A good use for a discarded motor is shown in the illustration herewith. This motor, of ½ hp. and operating at

1,750 r.p.m., is mounted on four small wheels and drives a 14 in. saw. The bottom of the guard is slightly above the level of the wheels and the saw projects down 1¼ in. below the guard. A substantial handle is provided and the wires from the motor run through a switch on the handle. This makes a convenient device for sawing the edges of freight car roofs.

Recent Decisions of the Arbitration Committee

(The Arbitration Committee of the A.R.A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Proof of Derailment Under Rule 32

Wabash car No. 66272 was extensively damaged while being handled in a Chesapeake & Ohio train at Huntington, W. Va., August 24, 1920, and disposition was requested under Rule 120. The Chesapeake & Ohio was authorized to repair the car, charging for the work under Rule 120, and the car was returned to service April 13, 1921. Shortly after that, however, a representative of the Wabash, while at the Huntington shops, secured a copy of a report by the foreman who picked up the damaged car, in which he stated that the car was derailed, the cause being the bursting of an air hose on another car in the train. In the meantime the writer of the report had been killed, but the Chesapeake & Ohio presented affidavits from other employees showing that there was no derailment.

The Arbitration Committee accepted the original report of the accident, showing derailment, thus making the handling line responsible for the cost of repairs.—*Case No. 1221, Chesapeake & Ohio vs. Wabash.*

Damage Caused by Break in Two Due to Broken Carrier Iron Bolts

Pere Marquette car No. 52591 was extensively damaged in a Big Four train on February 21, 1921, when the train broke in two due to the failure of the carrier iron bolts on another car. There was no derailment. The damaged car was several cars removed from the break in two and the cars adjoining it were neither of them damaged. The car owner claimed that the coupler on the car which caused the break in two was out of position and defective, bringing the case under paragraph (e), Rule 32. The Big Four claimed that the damage was caused under conditions covered by interpretation No. 5, Rule 32.

The Arbitration Committee upheld the contention of the handling line, ruling that the damage to the car is at owner's responsibility.—*Case No. 1225, Cleveland, Cincinnati, Chicago & St. Louis vs. Pere Marquette.*

Handling Line Protection for Wrong Repairs Under Rule 70

On January 6, 1921, Chesapeake & Ohio car No. 37394 was delivered by the St. Louis-San Francisco to the Atchison, Topeka & Santa Fe at Kansas City, Mo. At the time the car was received no exceptions were taken to the wheels but on the following day at another point on the latter line the inspection disclosed one pair of cast iron wheels in place of Davis cast steel wheels. The car was moved to Chicago where the wrong wheels were removed and replaced with cast steel wheels. The Atchison, Topeka & Santa Fe made request from the St. Louis-San Francisco for protection to cover the wrong wheels, inspection having disclosed that the cast iron wheels were applied prior to the delivery of the car to its line. The St. Louis-San Francisco refused to issue a defect card, stating that the car had been through several interchanges, including that to the St. Louis-San Francisco, with no exceptions noted and that the wheels were not changed while in its possession.

The Arbitration Committee decided that, assuming the car was stenciled for cast steel wheels at the time of its receipt from the St. Louis-San Francisco, the Santa Fe is responsible under Rule 70.—*Case No. 1226, Atchison, Topeka & Santa Fe vs. St. Louis-San Francisco.*

Accident Damages Must Be Reported With Owner's Defects Under Rule 120

Atlantic Coast Line box car No. 27455 was made bad order on arrival at the Texarkana yard of the Texas & Pacific under load, October 31, 1920, on account of a broken transom and loose and decayed siding. Later, while a switch engine was moving the car in the yard, a rail broke, causing it to turn over against a bank, when the entire roof slid off and the brake beam connections were bent. In picking up the car the brake cylinder was broken and the truss rods bent. When the car arrived at the shop inspection disclosed that none of the sills or siding were broken but that all the siding was rotted away from the sills and that the sills and cross ties were badly decayed. These conditions were reported to the owner under Rule 120 without advising the owner that the car had been in an accident. Subsequently a repair card marked "No Bill" was forwarded to the Atlantic Coast Line, covering the wreck damage, on receipt of which the Atlantic Coast Line declined responsibility for any portion of the repairs because of the fact that the car had been damaged in an accident. The Texas & Pacific cited Rule 41 and Arbitration Cases Nos. 697, 1012 and 1120, to support its view that the car owner should accept charges for the renewal of all parts not broken in the accident. The Atlantic Coast Line cited Arbitration Cases Nos. 709, 846 and 1,070 to support its view that sufficient damage had been done to the car to contribute to or be the cause of damage to other parts of the car, renewal of which would otherwise be at owner's responsibility.

The Arbitration Committee, stating that if all defects had been reported in the inspection statement required by Rule 120, a mutual understanding could have been reached before repairs were made, decided that the bill against the car owner should be withdrawn.—*Case No. 1223, Texas & Pacific vs. Atlantic Coast Line.*

Time Limit for Rendering Car Repair Bills

A car owned by the Pacific Coast Railroad was repaired by the Lehigh Valley on July 28, 1920. The bill for repairs was rendered in the July, 1921, account, but was not mailed from Philadelphia until August 11, and was received by the Pacific Coast Railroad on August 15, 1921. The owner contended that the bill was outlawed since it was not mailed until one year and fourteen days after the car had been repaired. The Lehigh Valley maintained that rendering the bill in its July account brought it within the year's time allowed by Rule 91.

The Arbitration Committee sustained the contention of the Lehigh Valley, deciding that the bill should be paid.—*Case No. 1228, Lehigh Valley vs. Pacific Coast Railroad.*

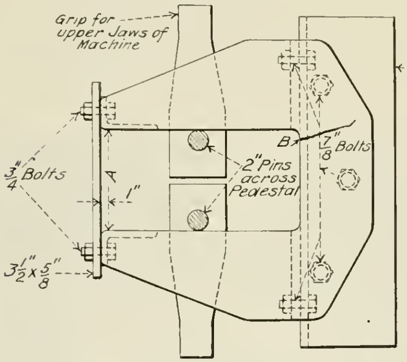
The Best Metal for Pedestal Wearing Faces

Pullman Tests Lead to Adoption of High Manganese Electric Cast Steel in Built-Up Pedestals

THE trucks under all new Pullman equipment built since the close of Railroad Administration control in 1920, have been fitted with pedestals built up of open hearth steel plates and wearing surfaces of special steel angles riveted to the front and back plates.* These pedestals were adopted because of the occasional failure of the reinforced cast iron pedestals formerly applied under abnormal conditions such as those brought about by a derailment. The built-up pedestals have twice the strength of the former reinforced type to resist failure at the corner, as has been demonstrated by tests in a tensile machine, conducted as shown in the sketch. The reinforced cast iron pedestals broke under a load of 26,000 lb. while the steel pedestals, after shearing a tie strap bolt, failed under a load of 52,000 lb.

At the outset, however, it was recognized that the conditions of wear between the pedestal guiding faces and the journal boxes would not be as good as obtained with gray iron pedestals and gray iron boxes, and a series of wear tests were undertaken to develop the best possible metal which would be mechanically practicable for use in the pedestal guide angles, from the standpoint of cutting, or being cut by any of the metals that might be used in passenger car journal boxes.

The wear tests were performed on a shaper. Tests pieces of journal box material approximately 4 in. long by 1 in. wide were set into an iron block weighing 400 lb. The pieces

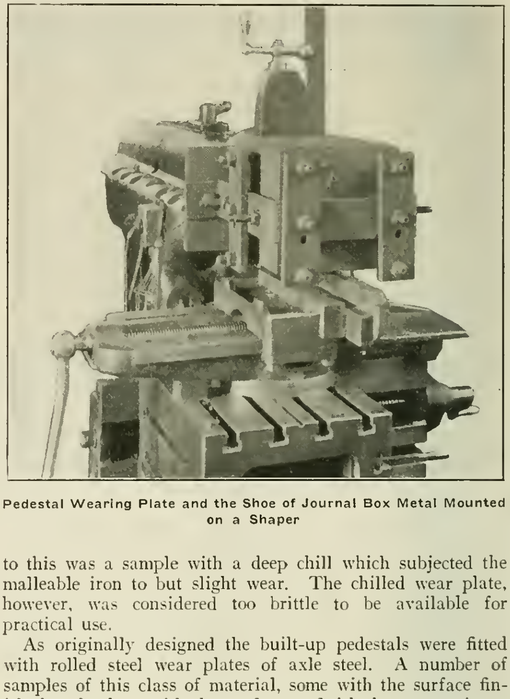


Method of Comparing Strength of Truck Pedestals

of pedestal guide metal were clamped to the shaper table and the journal box metal, designated as the shoe in the accompanying summary of the tests, weighed by the iron block, was moved back and forth on the wear plate by the shaper ram. Thus, 4 sq. in. of shoe surface, under a load of approximately 100 lb. per sq. in., was subjected to a 4-in. travel from 30 to 35 times a minute.

The pedestal wear plate materials tested included cast iron, a semi-steel-gray iron mixture, heat treated malleable iron, open hearth steel samples of varying carbon contents, chrome-vanadium steel, spring steel and high manganese electric cast steel. The medium soft cast iron wear plates were tested with shoes (representing the journal box) of cast iron, low carbon open hearth steel and malleable iron. The cast iron on cast iron wore appreciably, but did not cut. The cast iron on malleable iron, heat treated, showed very little wear and no cutting, but the material is not practicable for journal box construction. With open hearth steel and the treated malleable iron shoes, the cast iron developed considerable cutting of wearing surfaces.

The semi-steel samples, ranging in Scleroscope hardness from 38 to 70, depending on the carbon, some heat treated and others case-hardened, were all tested with malleable iron shoes. Most of these samples were subjected to heavy cutting on both surfaces or to excessive wear. The only exception



Pedestal Wearing Plate and the Shoe of Journal Box Metal Mounted on a Shaper

to this was a sample with a deep chill which subjected the malleable iron to but slight wear. The chilled wear plate, however, was considered too brittle to be available for practical use.

As originally designed the built-up pedestals were fitted with rolled steel wear plates of axle steel. A number of samples of this class of material, some with the surface finished and others with the surface unfinished, representing a considerable range of heat treatment and case-hardening, were tested with shoes of the various materials which might possibly be used in journal boxes. The shoes and wear plates were badly cut in all of these tests.

Good results were obtained with a comparatively low carbon open hearth steel, case-hardened, with a heat treated chrome-vanadium steel, a tempered spring steel and heat treated electric cast steel. With the exception of the latter, however, none of these metals are practicable for use as pedestal wear plates, either because of the cost of manufacture or brittleness of the metal. The high manganese electric cast steel, heat treated to produce a Brinell hardness of between 450 and 500, produced excellent results with both malleable iron and steel shoes, the wear being very slight and the surfaces showing no evidence of cutting. Furthermore,

*For description of this pedestal see an article in the *Railway Mechanical Engineer* for September, 1920, page 589.

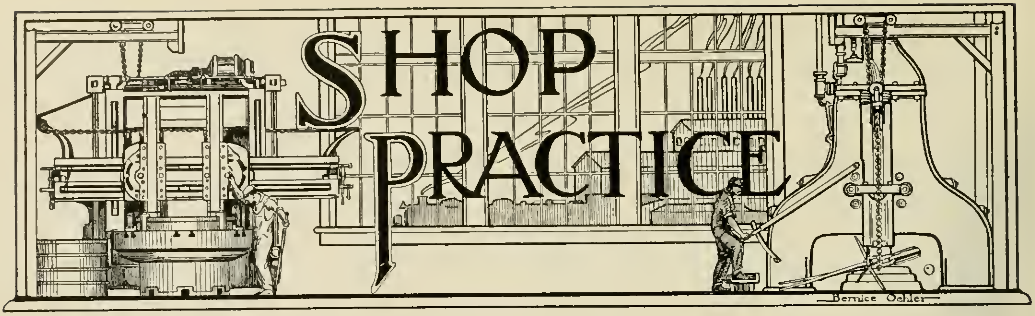
this metal possesses the required mechanical properties and has been adopted for the wear plates in place of the rolled section of axle steel originally used.

A summary of the results is presented in the accompanying table, in which all set pieces not specified to the contrary, have both wearing surfaces machined smooth.

SUMMARY OF TEST RESULTS

Test No.	Pedestal wear plate: Material	Pedestal wear plate: Scleroscope hardness	Shoe	No. of ft. Travel	Observed Wear On: Wear Plate	Observed Wear On: Shoe	Approximate equivalent shoe wear per 1,000 ft. travel	Remarks
1	C. I. Medium soft..	40	Cast iron	7,000	.016	.318	.045428	Started wear immediately; surfaces smooth
2	C. I. Medium soft..	..	O.H.S., 19 C	1,633.33	.078	.0205	.012551	Cutting at start of test
3	C. I. Medium soft..	..	Mall. iron	6,000	Could not be accurately measured due to cut surface	.005	.000833	Surfaces cut considerably
4	C. I. Medium soft..	..	Mall. iron, heat treated.	6,000	No measurable wear	.002	.000333	No cutting of either surface; too brittle for practical use
5	Semi-steel—gray iron mixture.	38	Mall. iron	466.66	Could not be accurately measured due to cut surface	Could not be accurately measured due to cut surface	......	Both badly cut
6	Semi-steel—gray iron mixture, special treatment	44	Mall. iron	600	Could not be accurately measured due to cut surface	Could not be accurately measured due to cut surface	......	Both badly cut
7	Semi-steel—gray iron mixture, special treatment.	42	Mall. iron	700	Could not be accurately measured due to cut surface	Could not be accurately measured due to cut surface	......	Both badly cut, wear plate had slight chill that was penetrated in grinding surface preparatory for test
8	Semi-steel—gray iron mixture, medium chill.	70	Mall. iron	1,166.66	None	.0945	.08046	Heavy wear on mall. iron, wear plate had slight cavities that picked up shoe metal
9	Semi-steel—gray iron mixture, high sulphur added.	42	Mall. iron	7,000	.023	.0365	.005214	Both cut
10	Semi-steel—gray iron mixture, deep chill.	69	Mall. iron	7,000	None	.0205	.002929	Good combination, but wear plate is brittle and will not stand riveting
11	Mall. iron, heat treated	..	Mall. iron, heat treated.	1,600	.....	.12	.0750	Cutting after fifty minutes
12	O. H. S. .10 C, as rolled, not machined.	20	Mall. iron	315	Could not be accurately measured due to rough surface and cutting	Could not be accurately measured due to cut surface	.....	Both badly cut
13	O. H. S. .46 C.....	..	Mall. iron, heat treated.	1,600	.003	.076	.04750	Both badly cut
14	O. H. S. .46 C. as rolled, not machined.	..	Mall. iron	1,800	.003	.077	.042777	Both badly cut
15	O. H. S. 46 C......	..	Cast iron	3,996	.009	.108	.027027	Both badly cut
16	Axle steel	..	O.H.S., 19 C	5,133.33	.046	.05	.009740	Cutting at start of test
17	H. T. axle steel. .49 C	..	Mall. iron, heat treated.	1,200	Could not be accurately measured due to cut surface	.12	.10	Cutting after twenty minutes, both badly cut
18	H. T. axle steel, .49 C. not machined.	..	Mall. iron, heat treated	1,400	Only slightly worn, not measured	.116	.082857	Shoe badly cut
19	H. T. axle steel, .49 C. not finished	..	Cast iron	1,600	Could not be accurately measured due to cut surface	.12	.0750	Cutting in twenty-five minutes; wear plate slightly worn
20	Axle steel, .49 C. case-hardened, not finished	..	Cast iron	2,700	Could not be accurately measured due to cut surface	.073	.027037	Shoe badly cut, wear plate slightly
21	Axle steel, .40 C. heat treated, drawn at 1000° F.	40	Mall. iron	583.33	Could not be accurately measured due to cut surface	Could not be accurately measured due to cut surface	......	Both cut and worn badly
22	Axle steel, .40 C, heat treated, drawn at 500° F	40	Mall. iron	1,050	Could not be accurately measured due to cut surface	Could not be accurately measured due to cut surface	......	Both cut and worn badly
23	Axle steel, 40 C, quenched, not drawn	40	Mall. iron	1,050	Could not be accurately measured due to cut surface	Could not be accurately measured due to cut surface	......	Both cut and worn badly
24	Axle steel, .49 C, cyanide hardened, not machined	..	O.H.S., 19 C	800	Could not be accurately measured due to rough surface and cutting	.047	.058759	Both cut immediately
25	Axle steel, .49 C, cyanide hardened...	..	O.H.S., 19 C	1,600	Could not be accurately measured due to cut surface	.102	.063750	Cutting after twenty minutes
26	O.H.S., .25 C, case-hardened with 1.10 carbon case, not finished	86	Mall. iron	4,200	None	.043	.010238	Rough surface cuts shoe
27	O.H.S., 25 C, case-hardened with 1.10 carbon case........	..	Mall. iron	4,200	None	.034	.008095	Good combination, but cost of manufacture too expensive
28	Tire steel, 67 C, heat treated, drawn at 800° F..	50	Mall. iron	933.33	Could not be accurately measured due to cut surface	Could not be accurately measured due to cut surface	....	Both badly cut
29	Chrome vanadium steel, normalized...	40–45	O.H.S., 19 C	5,950	.017	.0745	.012521	Both cut
30	Chrome vanadium steel, heat treated, quenched at 1550° F	88–92	O.H.S., 19 C	7,000	.001	.0005	.000071	Good combination, but too brittle for practical use
31	Spring steel, annealed	39–43	O.H.S., 19 C	4,550	.015	.0715	.015714	Both cut
32	Spring steel, tempered	60–65	O.H.S., 19 C	7,000	.001	.0105	.00150	Good combination, but impractical for use on standard pedestal
33	Electric cast steel, heat treated	475*	O.H.S., 19 C	7,700	.002	.0085	.001104	Good combination; friction surfaces glazed
34	Electric cast steel, heat treated........	475*	1.00 C annealed spring steel.	7,000	.0035	.000[illegible]	.000071	Good combination; friction surfaces glazed
35	Electric cast steel, heat treated	475*	Mall. iron	7,000	.0005	.0095	.001357	Good combination, friction surfaces glazed
36	Electric cast steel heat treated	475*	Mall. iron	6,000	None	No measurable wear	....	Excellent friction surfaces glazed

*Brinell



Eliminate Costly Hand Fitting and Filing

Many Operations, More Profitably Done on Modern Milling or Grinding Machines than by Filing, Are Outlined

By M. H. Williams

THE continued extensive use of files in some railroad shops is largely due to precedent, and the sooner machines are installed to eliminate hand fitting and filing the better. A file is cheap. Unfortunately the man behind a file is expensive when compared with the same man operating a modern milling or grinding machine which does the same work far better and in less time. It is considered a good investment to replace an old style lathe by a modern one, where a saving of 10 to 20 per cent can be effected. It is a better investment to install enough modern machines so that filing or other hand fitting operations will be unnecessary.

It would take too much space to consider in detail all railroad shop operations which can be done more profitably by machines than by hand filing but several of the more important of these operations are mentioned below.

Taper Frame Bolts. Taper cylinder and frame bolts are used to hold two members together and, in addition, to prevent the two members from shifting on each other. They, therefore, are in reality enlarged taper pins which, in order to function properly, must be a perfect fit in the taper reamed holes. The closeness of the fit should be similar to the fit of a twist drill in a drill socket, or a lathe center in a lathe. Taper bolts are generally turned, being finally finished with a file. In some shops they are made on bolt skimming machines. Owing to the accuracy essential they should all be ground the same as drill manufacturers grind twist drill shanks. Bolt grinding has been practiced to a limited extent and it no doubt will be extended as grinding becomes more general.

A type of machine suitable for grinding bolts is the 10 by 36-in. plain cylindrical grinder, shown grinding a wrist pin in Fig. 1. After the installation of grinding machines, taper bolts are rough turned in quantities to step sizes, varying by about 1/16 in. diameter, and placed in stock. When required for use they are ground to the required taper and diameter. This is a quicker method than finish turning and then filing. In addition, the surfaces are smoother, more uniform and not full of the humps which are unavoidable with file finishing. As a result, the bolts are practically perfect fits in the taper holes. Some doubt may be expressed as to the advisability or economy of bolt grinding. The best way of testing the method is to arrange with some grinding machine manufacturer to grind a number of rough-turned bolts, the short time required being recorded and the finish of the surfaces noted. This will generally convince the most skeptical that grinding is the proper method to follow.

Piston and Valve Rods. When repairing piston and valve rods, these rods are commonly ground on gap piston rod grinding machines and many roads have convincing data comparing the grade, finish and cost of turning and filing vs. grinding. What shop is there which, once having used a piston rod grinding machine, would willingly go back to turning and filing?

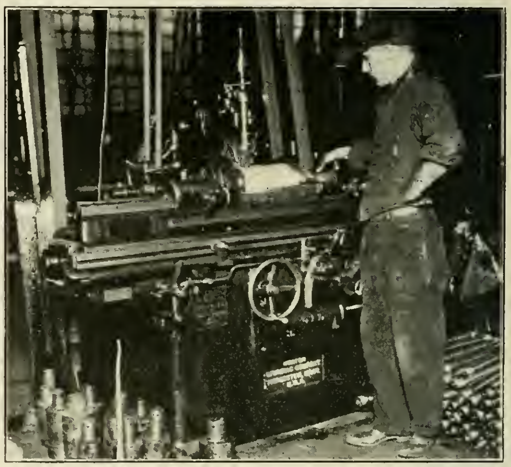


Fig. 1—10-In. by 36-In. Plain Cylindrical Grinder Finishing Wrist Pin

Piston and valve rod grinding should be carried one step further and made to include all new rods. For this purpose a grinder having about 20-in. swing by 80 to 120 in. long should be selected, the length of the machine depending on the length of piston rods common to the road. In order to grind the taper ends this machine must be provided with a swiveling table similar to the ordinary plain grinding machines. (This is a feature not common to gap grinders.) Where these machines have been introduced it is the custom to rough turn the rods about 1/32 in. large and grind both the straight and taper surfaces to the required sizes. Superior fits in the crosshead and piston head are thus secured as well as round, smooth and straight rods which tend to eliminate packing troubles. Grinding machines of this size are also used for grinding axles, crank-pins, crosshead and other pins, therefore being kept fully employed.

Crank-Pins. These pins are generally turned on center lathes, although the large turret lathe is now finding favor for this purpose. The most approved method is to rough

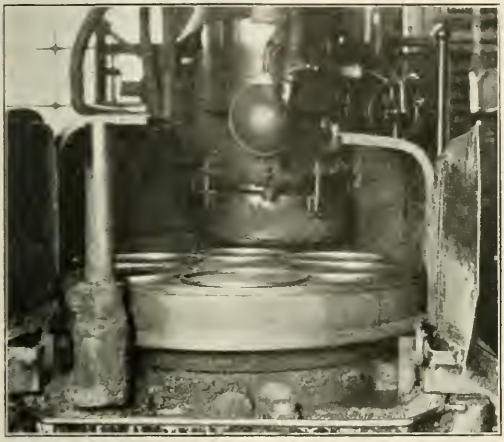


Fig. 2—Rotary Surface Grinder Equipped with Magnetic Chuck Grinding Packing Rings

machine the surfaces fitting the rod brass about 1/32 in. large and afterwards transfer to grinding machines for final finishing. This results in a superior bearing surface and requires less time than rough turning, finish turning, filing and smoothing with emery paper, or turning and rolling.

Locomotive Axles. To a limited extent locomotive axles have been rough turned on center lathes and afterwards finished on grinding machines. While this was never a filing job it is mentioned to call attention to the uses that can be made of a large grinding machine.

Packing Rings. There is not much filing on packing rings. However, in the line with modern machine shop methods, packing rings in some shops are blanked out to step thicknesses and placed in stock. When necessary to fit them to piston grooves, the sides are ground on rotary surface grinders of the type shown in Fig. 2. This results in the rings fitting the grooves better than when simply turned on their sides. Owing to the small amount of time required when setting rings on a magnetic chuck, grinding is quicker than turning for finishing the sides. This is especially true where each ring is individually fitted to varying widths of piston grooves. The rotary surface grinder can also be used for other purposes as explained later on.

Crosshead Pins. In a number of shops crosshead pins are blanked out in quantities on turret lathes and placed in stock. When finishing to fit the crosshead, the taper ends and bearing surfaces are ground on 10 by 36 in. grinding machines. This results in economical blanking out and finishing, and well fitting parts. Files should not be used on these parts.

Piston Valves. There is not much filing on piston valves. In making new or repairing old valves considerable time is saved by providing proper gages so that the parts shall be interchangeable. Each part should be made to limit gages or micrometer measurements so that, when assembling, the parts will go together without hand fitting or filing. This can readily be accomplished by devoting a little time to the question of tolerances for the various parts going to make up the valve. The sides of piston valve packing rings are economically ground on rotary surface grinders. In some shops the outside surfaces are ground after the rings have been cut at the lap joint, the rings being held in a compressed state on an arbor. This makes it possible to finish the rings to the same diameter as the bushing and insure a steam-tight joint all the way around the ring when in the bushing. This is doing just what the makers of good automobiles do, the large cylindrical grinder mentioned being suitable for this purpose.

Main Rods. It may appear that files must be used on main rods, but what does experience show? For worn rods the following repairs may be necessary: Jaws worn or out of square, sides rough, brasses requiring renewals, wedges worn, or new ones necessary, etc. Starting with the rod jaw, these when worn are readily milled on heavy vertical milling machines, or the larger vertical plain knee type machine, as shown in Fig. 3. About the only extra appliances required are small helical milling cutters, lower supports for the cutters, suitable clamping devices for holding rods on the table and a truss or overhead crane to support the overhanging end of the rod. With these devices at hand it is easy to clamp a rod to the machine table and true up the jaws. Owing to the small amount of metal to be

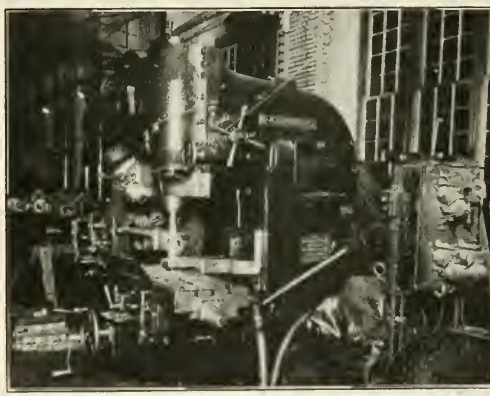


Fig. 3—Powerful Knee-Type Milling Machine Truing Main Rod Jaw

removed (only enough to true up the jaw and remove the high spots), the milling feeds average from 2 to 4 in. per min. As the jaws generally do not have a total length of surface requiring truing exceeding 20 in., the time for milling is a small item. Surfaces finished in this manner are smoother, more regular and more nearly square than when done by an expert filer. One great advantage of milling rod jaws is the greater accuracy of the surface, making it possible to machine the rod brasses to the correct size to fit the jaws, thus eliminating filing.

The sides of main rod front ends when worn are readily finished on large 22 in. by 7 ft. surface grinders of the type shown in Fig. 4, the customary plan being to hold the rod on a magnetic chuck. In the event of new wedges, blocks or front brasses being added to a rod, these parts are put in place in the rod at the same time and ground with the rod.

As a result all the members are flush with the sides of the rod. With all this work done by machinery there is not much left for the file. The same grinding machine is also used for finishing guide bars, this work helping to keep it busy.

Rod Brasses. When rod jaws are milled or even filed true, the brasses are readily machined on an ordinary planer, crank planer, shaper or milling machine to fit the rods, without filing. To do this properly it is necessary to carefully measure the rod and brasses which is best done with micrometer calipers. This may take additional time both in measuring and machining. However, it is much easier and quicker to make these to correct size during the machining operation than to half do the machine work and finish with a lot of laborious filing. When the parts are machined accurately to size, an improvement in the quality of fitting follows. A file is used only to remove the burrs.

Rod Keys. By modern methods rod keys are either milled complete from the rough forging on plain knee type milling machines, or partly milled and finish ground on surface grinders. This is much quicker than planing and afterwards finishing with a file.

Side Rods. The file is not used to any extent on side rods. However, should the ends require refinishing they are readily ground on the rectangular surface grinders, or where battered, they can be ground on swing grinders.

Knuckle Pins. Like crosshead pins, knuckle pins are economically manufactured in quantities for stock on large turret lathes or automatic machines. When fitting to varying sized rods, the taper ends and straight surfaces are ground on a 10 by 36 in. grinding machine. Case-hardened pins are finished as readily as soft pins, grinding having

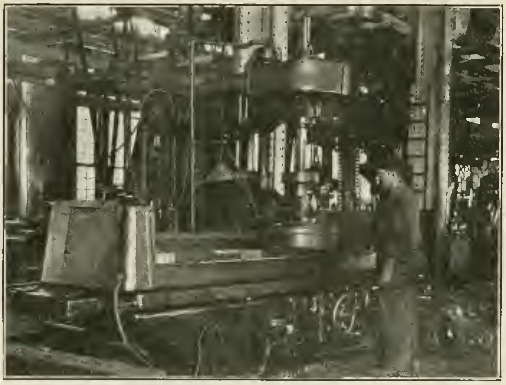


Fig. 4—Surface Grinder Equipped with Magnetic Chuck; Can Be Used for Finishing Links, Main Rods and Many Other Parts

the advantage of the desired smooth bearing surfaces. There is no filing here.

Knuckle Pin Bushings. Bushings for knuckle pins should have true and smooth bearing surfaces, best obtained by grinding the bore. This method applies to soft or case-hardened material and is quicker than lapping. While somewhat foreign to the subject, mention will be made of truing holes in rods for knuckle bushings. These are now ground true on planetary grinders of the type shown in Fig. 5. In some cases the bushing bore is ground after the bushing is pressed into the rod. The internal grinding machine mentioned is also used for several other operations.

Driving Boxes. It was customary at one time to bore driving box brasses and afterwards spot face and file them to fit the axles. It has been found that brasses can readily be bored to correct size for the axles and eliminate filing. The best plan is to measure the axles with micrometer calipers and then bore the boxes to micrometer measurements from 0.020 to 0.030 in. larger. Experience has shown that boxes can readily be bored in this manner so that filing is not necessary.

Valve Motion Levers. When repairing valve motion levers it is often necessary to renew the bearing pins and bushings, re-ream the taper holes and true up the holes for bushings. For fitting pins and bushings satisfactory results are obtained with the 10 by 36 in. grinding machines and the internal grinder. The pins and bushings are readily blanked out to step sizes on turret lathes or automatic screw machines and placed in stock. The external bearing surface of pins and the bore of bushings are ground at the time of manufacture. When applying, the tapered

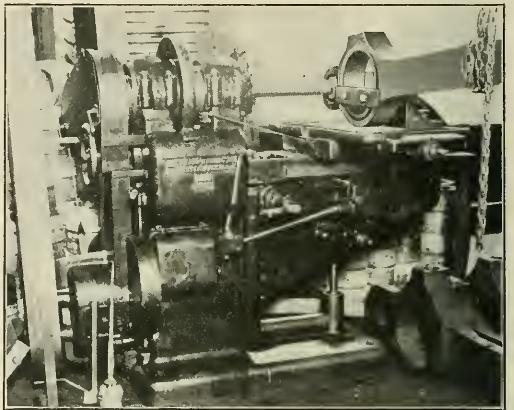


Fig. 5—Planetary Internal Grinder Truing Side Rod Knuckle Pin Hole

surfaces of pins and the outsides of bushings are ground to fit the levers. Should the holes in levers, into which the bushings fit, be out of true, they are ground true on the internal planetary grinding machine.

Guide Bars. At the present time, guide bars are almost universally finished on surface grinders, one type of which is shown in Fig. 6. With machines of this nature, guides are placed directly on the machine and ground to a true surface, no matter how badly worn. This has been found quicker than taking a rough cut on a planer and afterwards filing or grinding.

Air Compressor Pistons. Worn air compressor pistons are refinished on plain cylindrical grinding machines in a superior manner as compared to turning and filing. Air pistons, when head and rods are assembled, are awkward to hold in a grinding machine owing to the absence of lathe centers in the head end of the rod. In order to properly hold them in grinding, the machine should be equipped with a live spindle attachment which resembles a lathe head stock. With this device the piston head is held in an independent jaw chuck as in regular lathe practice, the opposite end being supported on a regular grinder center. When held in this manner the rods are quickly ground to any degree of smoothness desired. In order to swing the low pressure piston head of 8½-in. compound air compressors, it is necessary to use at least a 16-in. machine. This work, however, can readily be done on the 20-in. axles and piston rods. While this may look small for the grinder mentioned in connection with finishing locomotive machine it makes a good fill-in job.

Air Brake Internal Grinding. Good uses are made of the planetary internal grinder (Fig. 5) for grinding cylinder bushings of triple valves, feed valves, distributing valves and, in fact, the bore of all parts subject to wear. This makes an important additional use for this machine.

Power Lapping. In order to reduce hand work, not necessarily filing, the practice of power lapping valves and valve seats of all kinds is now coming into use. There appear to be great possibilities for this method of substituting machines for hand work.

Car Work. The amount of filing required for repairs to car work is limited, the machines mentioned above being the most suitable for work in their line. Large cylindrical grinding machines can be used to good advantage for grinding car axles. However, special grinding machines have been designed for this purpose and look very promising.

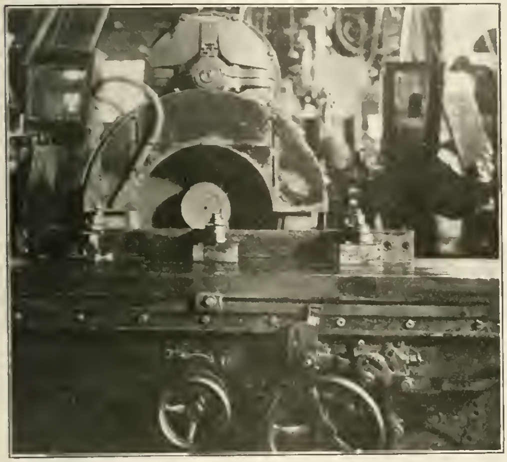


Fig. 6—Horizontal Surface Grinder Truing Worn Guide

No doubt they will be more commonly used when grinding becomes as popular in railway shops as it is now in manufacturing shops.

New Work. Most of the larger shops manufacture many new parts such as main and side rods, valve motion levers, piston rods, guide bars, and the parts fitting the same. These shops are generally equipped with slab and large vertical millers and other machines for this work. The question arises, are we finishing the articles in the most economical manner and reducing filing to a minimum? What machines should be added to increase output or reduce costs?

If the most approved practice of progressive manufacturers are followed, the file will scarcely ever be used on round work such as is turned in lathes, made on turret lathes, or automatic machines. This work will all be ground.

Flat work, such as main rods, side rods, valve motion levers, guide bars, etc., should be made principally on milling machines on which the surfaces are machined sufficiently smooth to meet all requirements, except possibly where polish is a consideration as in passenger service. In that case a swing grinder can be employed.

Main and side rods and guide bars are at present largely milled on their flat surfaces on slab milling machines. The ends and irregular surfaces are partly completed on these machines and partly on large vertical milling machines. The jaws at the present time are largely slotted, where, owing to rough surfaces, it has been customary to use a file in order to obtain the required smooth surfaces. More attention is now being paid to suitable cutters and as a result, the coming practice is to mill the rod jaws in place of slotting, as illustrated in Fig. 7, this having the advantage of producing smoother surfaces in less time. This milling is done on large vertical milling machines, or the larger vertical knee type machine.

Valve motion levers are smaller editions of main and side rods. The surfaces of the shorter levers up to 4 ft. long are readily milled on the large plain knee type milling machines, longer levers on slab milling machines, the jaws or clevises being milled from the solid. Owing to the small diameter of cutters, the surfaces are quite smooth; therefore, the file is necessary only for removing burrs.

The operations mentioned are representative but by no means complete. The machines referred to are general in character and suitable for repairs and manufacture of many other parts. When summing up it will be found that nothing radical is called for, nor any machine operation differing to a great extent from up-to-date machine shop practices.

Modern Machines Save Money

The 10-in. by 36-in. plain grinder, or machines of other sizes, are more common than lathes in many manufacturing concerns. They are used for finishing practically all cylindrical work, filing being a lost art where work can be finished by grinding. This is not owing to good looks or fancy finish, but as a plain every-day business proposition which may be put in five words, "It is cheaper and better." The same argument holds good with the large grinders. Surface grinders are now replacing planers, shapers and milling machines for all machine operations where a small amount of metal is to be removed, say 1/16 in. or less.

The planetary internal grinder is used for grinding all

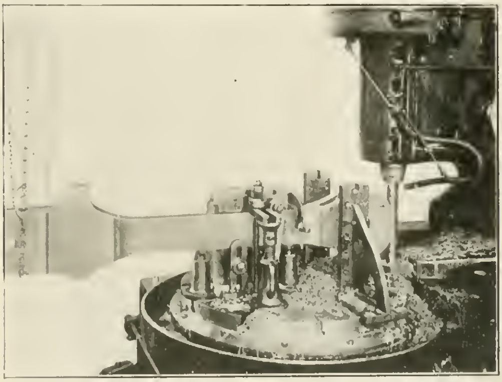


Fig. 7—Vertical Miller Machining Side Rod Fork End

kinds of internal work that cannot be revolved. Hundreds of these being used in automobile repair shops scattered all over the country. The best argument in their favor for railway work is to visit an up-to-date automobile repair shop in the home town and see the machine working.

Slab and large vertical milling machines are too common to call for special mention. The large knee type milling machine of both the horizontal and vertical types are finding their way into railway shops. These machines have sufficient strength to mill practically any locomotive part coming within their range up to the limit of the cutters. Owing to the ease of handling, a greater output for average railway work is obtained than on the slab machines. Likewise the output is much greater than by a reciprocating machine like a shaper. This is not said to cast any reflections on the slab machines or shaper, as they all have their place. Owing to the smoother surfaces, finishing after milling is rarely necessary.

Some Suggestions for Improved Shop Efficiency

Comparison of Practices and Time Studies on Different Roads Essential; Shop Schedules; Improved Personnel

By S. W. Mullinix
Supt. of Shops, Chicago, Rock Island & Pacific, Silvis, Ill.

LOOKING back to my apprentice days, I recall the wonderful opportunities of improving methods of performing various operations connected with the repair of locomotives and cars. During that period many improvements were made but we still have similar wonderful opportunities and will have in years to come, as each new year and each new lot of locomotives brings forth new problems to be met. Only by greater efficiency can we hope to keep the cost of repairing and operating locomotives within a reasonable figure compared with earning power. Important maintenance problems can be met and overcome by railroads individually, or better still by combining individual efforts, giving each the benefit of the other's experience.

I might even suggest that a number of railroads, operating under similar conditions, employ at least one capable and progressive shop man, thoroughly familiar with all departments of railroad repair shops, whose sole duty would be to study in the different shops the methods of performing various operations, recommending those which are best. It is good practice to send foremen to shops of other railroads to obtain information on shop kinks and methods of doing shop work, but the limited time does not permit these foremen to go into details, and the finer points of applied practices are not developed to any great degree.

> SEVERAL striking statements of great interest and suggestive value are made in this article by a well-known railroad shop superintendent. All of our readers may not agree that it is possible to specify standard practices which will be most economical in all the repair shops of one road, to say nothing of all the shops on different roads. Of the present widely diversified practices, however, many are plainly inefficient and wasteful and should be superseded by the best modern methods. Time studies, shop schedules, machine feeds and speeds, personnel and co-operation are some of the other subjects briefly, but forcefully, discussed by Mr. Mullinix.

Such a man as suggested should be selected by the mechanical heads of the railroads which would participate in the benefits obtained, as well as in the expense of financing the move. The man's duties would be to make a careful study of the best and most economical methods of performing all classes of shop work, submitting his reports with a view to having standard practices adopted. The beneficial results would no doubt be surprising, in many cases resulting in important economies. While the above suggestion is along a new line of thought and may not be looked upon with favor by all, it seems to be a move in the right direction.

Railroad shops have as many different ways of performing work as there are shops. Surely some of these ways are wrong. In many cases it is no doubt "Do the best you can with the facilities available," and probably some shops could not take advantage of the suggestions made on account of not having the necessary or proper equipment. *They would at least have something to guide them in purchasing new equipment.* There is but one best method, for example, of machining cylinder castings. Why not study this operation in the different shops and find out just which method is most economical and practical; also what kind and size of machinery is best suited for the work. Another item is the boring, applying and turning of driving tires. Some roads bore all tires to a standard gage; others caliper each wheel center; some bore tires with a small lip or retaining ring; others bore them straight through; and many roads have different types of tire heaters. Some use crude oil; some kerosene, and others gasoline. Which is the most practical? Which one pays best in the long run?

Regarding the building up of worn or sharp flanges, each wheel shop foreman has his own idea and will surely believe he is right until shown otherwise. What is the best method of getting the centers, laying out and machining shoes and wedges? There are many ways of doing it. Which one will give the best results? When shall axles, crank pins, piston rods and other like material be consigned to the scrap heap? Some roads use "limit of wear" others use "limit of age." What method of reclaiming large axles and crank pins is the most economical?

What is the best method of reclaiming, repairing and welding flues, both large and small; threading, applying and driving staybolts; building new fireboxes? Should extra fireboxes for standard engines be carried in stock? What is the best method of repairing springs, welding frames, forging side and main rods?

There are also many smaller items, such as turning of piston rods, piston heads, crank pins, the machining of crossheads and knuckle pins. Some are made from bar stock, others forged in the blacksmith shop. What kind of material is best suited for all these various parts? Some shops use iron; some, soft steel; some, common gray iron; others brass or bronze. So why not get together and establish, so far as possible, a standard practice for performing all the various operations necessary in the repairing and maintaining of locomotives and cars. A standard bill of material for the different parts is also desirable. Something very similar to this was carried out by the Society of Automobile Engineers, which compiled what is commonly known as the S. A. E. Standards.

Comparative Time Studies Essential

Another great help would be an actual and honest comparison of the time required to perform the different operations, as nothing will spur men to greater efforts than to know that they are not up and coming with the other fellow. You may ask a man in one shop how long it takes to machine a 56-in. steel driving wheel center and he will tell you six hours; ask another on some other railroad and he will say ten hours. One may figure on merely boring a hole and roughing off the outside, as some roads mount the wheels on the axles before finish turning. The other will figure the time required to finish it complete on a boring mill. Some wheels are cut out for hub liners; others are not. This all makes a difference. A 24-in. piston head may be machined complete in 48 min. and still the average production be a long way from eight heads in eight hours. What is needed is a comparison of time based on the actual performance covering a stated period. Recently we kept data on the number of driving tires turned on a wheel lathe at Silvis shops during a two weeks' period. The average obtained was 5½ pairs a day. Some railroads may be doing better than this and I know that some are not doing as well.

Good results can be obtained from a standard scheduling system for routing engines and material through the shop. Some shops have an elaborate system; others have none at all. Some standard system should be followed and whatever system is selected, it must have the support of the shop organization from the top to the bottom. A lack of co-operation is the direct cause for 90 per cent of the scheduling or routing systems proving unsatisfactory. There must be some way to get together and solve these various problems.

Are machines and equipment operating at the efficiency which the company has the right to expect? Is advantage being taken of modern machines equipped with push button control and improved gear shifting devices enabling a shifting lever to change the speed and feed on the machines? Do machine operators use these new appliances to increase production, or do they figure on doing just about so much work per day regardless of the facilities furnished them.

Among railroad employees are men who are dissatisfied with themselves, antagonistic to the company and in reality a detriment to their fellow workers. Their dismissal would be justified, yet some may be made to see the error in their attitude and in the end be made true and loyal employees. Absolute fairness on both sides will do much to foster a friendly feeling, enabling foremen and men to work in harmony.

Most railroads were certainly hard hit when so many men employed by them were classified and paid the mechanics' rate, doing work which required no special skill and which was formerly done by first-year apprentices, helpers and laborers. The larger shops were not affected as much as the smaller ones, except in the increased cost. In large shops the volume of work enabled men who became mechanics over night to be constantly employed on particular jobs in which they specialized. In the smaller shops, however, the variety of work was practically the same but the quantity much less. Therefore, the men had to work on different jobs with which they were unfamiliar.

Sometime ago while passing through the shop, I heard a crane signal by a heavy machine operator who wanted a crane to remove material from a machine. Twenty minutes' time was consumed before a crane was released and moved to handle the work. When asked if he suffered many such delays, the operator answered, "Yes," and was told to keep a record of all time lost from this cause. At the end of a month 7 hours and 20 minutes were lost. At the operator's suggestion a two-ton pneumatic hoist was installed, eliminating the lost motion there.

No doubt there are many similar conditions which can be improved. Small items which we often think are not worth while are of great aggregate importance. How often does a planer tool travel from two to six inches beyond the work and the same at the opposite end of the stroke? It would be interesting to know just how much time could be saved in the course of a year if the proper stroke were used at all times.

In endeavoring to increase speeds and feeds on various machines, the operator says, "This one casting may stand the extra speed or feed, but the next one may be hard." Speed up on the soft one and slow down on the hard one. *Just because a certain speed or feed, or method of performing some operation has been used for the past 10 years is no reason why it should be continued.*

Supervisory and Working Forces Must Co-operate

The foregoing paragraphs have indicated a few ways of improving shop practices and yet without some reference to the question of co-operation or team work, the story would be only partly told. Co-operation is just as essential in successful railroading as in any other activity.

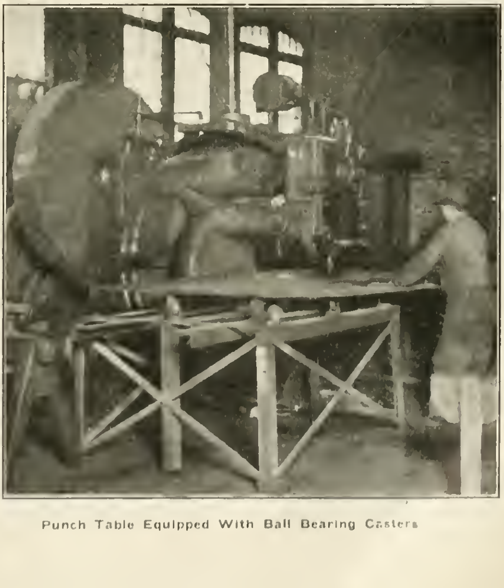
Take for example the relation of the supervisory forces to shop employees in general. What one thing could work to a greater all around advantage than real co-operation? The fact that one man happens to be a supervisor and the other a machine operator should not erect a barrier between them. They both work for the same road and should have the same general objective.

While co-operation is essential between departments and foremen, it is just as essential between the men themselves. Lack of co-operation means lost motion and works a tremendous hardship on one and all to say nothing of the direct loss to the railroad through decreased production. An improved personnel is needed. It may not be a matter of history but there was a time when men in authority criticised, found fault with and literally cussed out the men under them and fellow foremen at other points along the line. Those days have gone. Constructive criticism is all right but it must be constructive and not destructive.

For the good of each railroad there should be harmony from the president to the humblest employee. One and all should work together to the best of their ability. A shop may be strictly up to date in every way, equipped with the most modern machinery, and manned by the best of skilled mechanics but with failure to co-operate, the individual efficiency as well as the output will be seriously affected.

Ball-Bearing Casters on Punch Table Facilitate Handling Boiler Plates

A device which will save considerable labor in boiler shops and steel car shops consists of the punch table provided with ball-bearing casters as illustrated. In shops where jib or overhead traveling cranes are not available, it is customary to have several men support the outer ends of



Punch Table Equipped With Ball Bearing Casters steel boiler plate sections while rivet holes are being punched. The labor cost for this work can be greatly reduced by means of the table illustrated which enables comparatively large and heavy plates to be handled to the punch by one or not more than two men. As shown, the table is built up of 2½-in. angle iron, braced by 1½-in. iron straps. Ball-bearing casters are firmly fastened in an inverted position on top of the table, their height being arranged so that the top of the casters is at the same elevation as the bottom punch die. This device greatly facilitates the handling of large sheet metal plates to punches and shearing machines.

The Efficacy of Annealing Overstrained Steel*

By Irving H. Cowdrey

WHY is it that anchor chains, hooks, hoisting tackle and many other iron and steel parts are periodically annealed by careful contractors and engineers? To what extent is this treatment successful in producing the expected restoration of the original properties of the parts in question? These two questions must have suggested themselves many times to the intelligent man who has been brought into contact with the commercial heat treatment plant or who has been called upon to make use of the various parts commonly subjected to the treatment under consideration. Numerous answers have been tendered in the past; some of them contain a generous portion of truth, and some, in the light of modern knowledge and ideas, are quite erroneous.

In the earlier days when steel was held to be fit for cutlery and tools alone, and nothing but wrought iron would be for a moment considered as a material for structural members, it is not at all surprising to find queer ideas concerning the constitution of these different though related products. The blacksmith nicked the iron bar, broke it across the anvil's edge and noted the stringy ragged fracture like a piece of tough hickory. Hence he held that wrought iron was essentially a fibrous material. When the piece of steel rod from which he was to forge a chisel or other like implement was broken, resulting in shiny sparking surface of coarser or finer grain he said the steel was crystalline. When the chain link parted or the hook snapped, perhaps on a cold frosty morning, showing a bright sparkling, granular texture, what was more natural than to say that the iron, which he supposed to be a fibrous metal, had by some mysterious process, crystallized. We find then such terms as cold crystallization, fatigue, etc., constantly appearing in the older literature on the subject. The advent of the microscope into the field of engineering made it possible to explain much, which had before been veiled in mystery, concerning the behavior of metals both under stress and heat treatment.

Periodic annealing has for many years been the prescribed remedy for overstrain. The question may very properly then be raised as to the efficacy of such treatment, and the extent to which metal may be overstrained and still be restored by annealing. While it has been admitted by most engineers that the effect of slight over strain may be in part, if not wholly, removed by annealing, yet there have been a certain number who have held that very excessive distortions produce results which cannot be nullified by such treatment. Moreover many have declared annealing to be completely effective only for the very lowest carbon steels. To prove or disprove this stand, a set of tests was lately conducted at the suggestion of the writer in the testing materials laboratory of the Massachusetts Institute of Technology.

The material selected was a 0.20 per cent carbon steel with the normal content of silicon, manganese, sulphur and phosphorus. This was purchased as hot rolled steel 1½ in. in diameter and about 7 ft. long. From this tensile test specimens were fabricated to determine its physical properties as received and also after careful annealing. The remainder of the bar was then subjected to torsion, and twisted cold until fracture was produced. From the over strained material, tensile specimens were taken which were tested in this cold worked condition and also after having been carefully annealed. The Brinell hardness was determined under all the various conditions and photomicrographs were made to study the structure of the metal. At least two specimens were tested in each case and in every instance the values checked admirably. All tensile specimens conformed to the dimensions of the U. S. standard test bar having a 2-in. gage length and a 0.505 in. diameter with threaded ends and were tested in a universal autographic testing machine of 60,000-lb. capacity. Such a method of testing does not permit the determination of the true elastic limit. That the properties of the material were determined under tension while the over strain was produced in torsion may seem paradoxical. Such, however, is not in reality the situation since, according to Upton all permanent distortion is a result of internal shear regardless of the actual external loading. As a matter of fact it is probable that over strain by such a means is more severe than when the specimen is stressed axially, since fissures, if produced, will be inclined to the axis of the subsequent tensile specimen. While of no special significance, it may, however, be of interest to note that the bar as received, twisted through nearly 16¾ complete turns in a length of 4½ ft. or nearly 3¾ turns per foot of length.

The annealing was done in accordance with one of the two following methods which will be designated as Treatment I, and Treatment II respectively.

I. Specimen wrapped in carbon and asbestos, heated for one hour at 1,760 deg. F. and air cooled.

II. Specimens packed with cast iron chips in a loosely closed tube, heated at 1,760 deg. F. for 1½ hours and air cooled. The first method gave considerable surface oxidation, while the specimens treated by the second method showed no discoloration whatever. The results of the above tests appear in the following tabulation. The values in each instance are the averages of at least duplicate tests.

TABLE I

Results of Tensile Tests

	Yield Stress lb. per sq. in.	Ultimate Stress lb. per sq. in.	Elong. per cent	Red. Area per cent	Brinell No.
Bar as received	46,000	67,850	35.7	64.4	131
As received plus Heat Treatment I	40,000	68,250	33.7	62.5	130
Twisted Bar	86,500	95,633	15.8	54.3	180
Twisted Bar plus Heat Treatment I	42,200	67,200	36.5	62.5	128
Twisted Bar plus Heat Treatment II	43,150	69,450	37.0	62.0	127

The various data will now be analyzed and discussed. Throughout the discussion it should be kept clearly in mind that it is in general impossible to obtain perfect checks in the testing of any material whatever. With very homogeneous steels variations of several per cent must be expected even when tests are conducted on adjacent specimens. Hence variations of two or three thousand pounds per sq. in. in yield stress and ultimate stress and one or two per cent in elongation and reduction of area are entirely negligible, within the above limits, then, there is perfect agreement between the figures in the first two and last two rows. Among other things this would indicate that the material was very well annealed when purchased. The results recorded in the center row showing properties after cold twisting are of an

*Abstract of a paper presented before the Indianapolis Convention of the American Society for Steel Treating. The author, Irving H. Cowdrey, is assistant professor testing materials, Massachusetts Institute of Technology, Cambridge, Mass.

entirely different order. The yield stress has been doubled while the tensile stress and hardness have been increased about one-half. On the other hand, the ductility is less than half that evidenced by the normal metal. This difference is entirely in accord with results obtained from tests on cold worked material in general, such as cold rolled steel, extruded metal and wire provided the material is of such dimensions and so fabricated that the effect of cold working has penetrated well into the interior. With the increased hardness and decreased ductility it would seem obvious that the metal is in a state quite unsatisfactory for resistance to shock even though its static strength has been increased. Overstrained hooks, chains and-so-forth, have suffered alteration in their physical properties along just such lines as this, the difference being solely one of degree. As before intimated, the last two rows show that the original properties have been completely restored by the heat-treatment to which the steel was subjected.

As a result of the foregoing theory, description and analysis the following conclusions are in order.

1. Overstrain of metal when its temperature is below the transformation range, results in the production of undesirable properties tending to render the metal unfitted to withstand sudden and shock loads. 2. If possible such effects should be eliminated for the safety of those using devices which have been so abused. 3. Proper annealing suffices to completely restore the normal properties of low carbon steel even after the most severe over strain.

Pneumatic Power and Transmission Losses

Part Two. Dealing with Losses in Compression: Indicator Cards a Valuable Means for Checking Results

By B. C. Bertram

General Locomotive Inspector, Erie, Youngstown, Ohio

This is the second installment of an article of particular interest to railroad shop and power plant men in view of the present coal shortage and necessity of conserving fuel in every possible way. With excess compressor capacity, air leaks do not seriously interfere with the operation of pneumatic tools and devices. The result is that such leaks do not generally receive prompt attention. Many leaks in underground and inaccessible lines are never discovered and through the coal pile cause a constant drain on railroad resources. This article was begun on page 529 of the September number, the first installment being devoted to a detailed study of methods for locating and stopping air losses common in railroad shops and yards. As explained editorially in the September number, the air losses described are typical of those which may be found in almost any railroad shop and which should be corrected by some such means as those indicated.—Editor.

PROPER care and maintenance of air compressors is of vital importance. There are few machines as universally abused, being operated in many instances 24 hours a day with necessary repairs frequently deferred until the machines become practically inoperative.

In purchasing an air compressor, present requirements should never be considered as a basis in estimating the capacity of the machine required. Future needs should be anticipated. In most cases the demand for compressed air outgrows the capacity of the initial compressor installation within a comparatively short time. As a rule, however, the necessity for additional compressor capacity can be obviated by applying exact and systematic methods in stopping and preventing air leakage due to defective transmission lines and by rectifying certain other defects, thereby increasing the capacity of the compressors. It is not uncommon to find that only 50 per cent efficiency is being obtained from compressors due to some internal defects which continue to be unnoticed by power plant engineers or others in supervisory capacities.

To ascertain whether an air compressor is delivering its maximum capacity, an orifice test should be made. This may be accomplished by shutting off all lead lines from the air receiver, making sure that valves in the line do not leak, and screwing a plug provided with a sharp edge circular orifice into the drain pipe connection at the bottom of the receiver. For example, in the case of a compressor having a capacity of 1,000 cu. ft. per min. at 140 r.p.m., a ¾-in. orifice should be used, the compressor being run at 100 r.p.m. and the pressure maintained in the receiver at that speed carefully noted.

The amount of free air displaced each revolution by the compressor can be readily computed from the piston diameter and length of stroke, being in this case approximately 7.14 cu. ft. At 100 r.p.m. the compressor would be expected to displace 714 cu. ft. per min. If, therefore, it was found that the gage registered only 50 lb. at this speed with the ¾-in. orifice open, it will be seen from Table I that the compressor is only displacing 521 cu. ft. per min. while it should have displaced 714 cu. ft. It will then be apparent that the compressor is only a little more than 75 per cent efficient, due to some defects in the air end.

To figure the theoretical capacity of an air compressor, it is simply necessary to find the piston displacement in the low pressure cylinder and multiply by the number of revolutions per minute at which machine is being operated.

To ascertain the number of cubic feet of free air contained in an air receiver filled with compressed air, multiply the pressure of the air by the corresponding multipliers shown in Table II. This result multiplied by the cubic contents, or number of cubic feet contained in the receiver, will give the number of cubic feet of free air.

Indicator Diagrams Prove Invaluable

In testing for various air compressor defects, the steam engine indicator has proven of inestimable value and some of the revelations made by the indicator diagrams have been startling.

Facsimiles of actual indicator diagrams, showing the effect of varied defects in the cylinders of air compressors, are introduced in this article and each represents a condition which actually existed and some of which undoubtedly exist at present in compressors in many other railroad shops or wherever considerable attention has not been given these matters.

Fig. 1 is a reproduction of an indicator card taken from the low pressure air cylinder of a compressor employing the ring type intake valve in the piston. The diagram clearly indicates that the valve ring was sticking and it will be noted

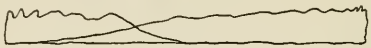


Fig. 1

that compression in that particular end of the cylinder did not start until the piston had advanced half way on its stroke.

Investigation revealed that the cause of this defect was the use of heavy oil as a lubricant, causing carbon deposits and dust to accumulate on the piston, cylinder heads and in the air passages. Only a light oil with a comparatively high flash point should ever be used in air cylinders and even light oil should be used sparingly. Six drops a minute is usually sufficient.

Fig. 2 is a reproduction of the indicator diagram taken

Fig. 2

from the same cylinder after deposits had been removed and the valve made to operate freely. This defect alone decreased the efficiency of the compressor more than 25 per cent.

The compressor referred to was being operated 24 hours a day to supply air to a large roundhouse and car yard. The bore of the cylinder being 25 in., the stroke 16 in. and speed 140 r.p.m., the loss of air occasioned by this defect on each stroke was approximately 1.136 cu. ft., or 159.04 cu. ft. per min., or 229,008 cu. ft. per day. This defect was also principally responsible for the fact that insufficient

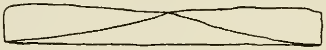


Fig. 3

pressure amounting to only about 50 lb. was all that could be obtained. After the defect was remedied, a pressure of 100 lb. was easily maintained, resulting in a corresponding increase in the efficiency of all air tools being used in the shops.

Another great loss in compressor efficiency is illustrated in Fig. 3, which is a reproduction of an indicator card taken from a low pressure air cylinder in which new type plate valves were substituted for the old poppet type. In this instance the valve cage seats had been re-cut several times to

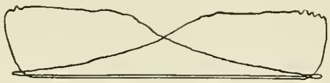


Fig. 4

re-establish a perfect seat for the cage and in so doing, so much metal had been removed that when the new type valves were installed, they did not clear the piston. Each time the piston advanced it came in contact with the valve cage, forcing it off its seat and allowing air to bypass the valve unit. The effect is clearly shown in Fig. 3. The contrast after the defect was remedied is shown in Fig. 4. Most compressor manufacturers furnish an extra slip ring to meet the above mentioned condition.

Table I—Volume of Air (Cu. ft. of free air per min.) That Will Flow Through Round Holes in a Receiver into the Atmosphere

Diameter of Orifice	GAGE PRESSURES IN RECEIVER—POUNDS																	
Inches	2	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100	125	150	200
1/64	.038	.0597	.0842	.103	.119	.133	.156	.173	.19	.208	.225	.26	.295	.33	.364	.40	.486	.57	.76
1/32	.153	.242	.342	.418	.485	.54	.632	.71	.77	.843	914	1.05	1.19	1.33	1.47	1.61	1.97	2.33	3.07
3/64	.342	.545	.77	.94	1.07	1.21	1.4	1.56	1.71	1.91	2.05	2.35	2.68	2.97	3.28	3.66	4.12	5.20	6.9
1/16	.647	.965	1.36	1.67	1.93	2.16	2.52	2.80	3.07	3.36	3.64	4.2	4.76	5.32	5.87	6.45	7.85	9.20	22.2
3/32	1.37	2.18	3.06	3.75	4.28	4.84	5.6	6.24	6.84	7.6	8.2	9.4	10.7	11.88	13.1	14.5	17.5	20.8	27.5
1/8	2.435	3.86	5.45	6.65	7.7	8.6	10	11.2	12.27	13.4	14.5	10.8	19	21.2	23.5	25.8	31.4	36.7	48.7
3/16	5.45	8.72	12.3	15	17.1	19.4	22.4	25	27.4	30.4	32.8	37.5	42.9	47.5	52.4	58	70	83.2	110
1/4	9.74	15.4	21.8	26.7	30.8	34.5	40	44.7	49.09	53.8	58.2	67	76	85	94	103.2	125.5	147	195.8
3/8	21.95	34.6	49	60	69	77	90	100	110.5	121	130	151	171	191	211	231	282	330	440
1/2	39	61.6	87	107	123	138	161	179	196.4	215	232	268	304	340	375	412	502	588	782
5/8	61	96.5	136	167	193	216	252	280	306.8	336	364	420	476	532	587	645	785	920	1220
3/4	87.6	133	196	240	277	310	362	400	442	482	521	604	685	765	843	925	1127	1322	1760
7/8	119.5	189	267	326	378	422	493	550	601	658	710	622	930	1004	1145	1260	1161	1804	......
1	156	247	350	427	494	550	645	715	786	860	930	1070	1215	1360	1500	1648	2000	2350	......
1 1/8	196	310	440	538	620	692	812	900	987	1082	1170	1350	1530	1710	1890	......	......	......	......
1 1/4	242	384	543	665	770	860	1000	1120	1230	1345	1455	1680	1900	2130	2350	......	......	......	......
1 3/8	291	464	660	803	929	1040	1200	1350	1480	1630	1760	......	......	......	......	......	......	......	......
1 1/2	350	550	780	960	110[illegible]	1240	1435	1600	1700	1930	2085	......	......	......	......	......	......	......	......
1 3/4	473	752	1068	1304	1505	1680	1960	......	......	......	......	......	......	......	......	......	......	......	......
2	625	985	1395	1700	1967	2200	2586	......	......	......	......	......	......	......	......	......	......	......	......

In another very large compressor employing plate type valves of about 10 in. diameter, it was found that new valves which had been applied bottomed in the recess of the valve chamber and were, therefore, prevented from making a proper seat on the copper gasket provided for that purpose. This also allowed air to bypass the valve cage and investigation developed that a loss of approximately 20 per cent of compressor efficiency resulted from this defect. In both the foregoing instances the shop line pressures were greatly increased and the revolutions per minute of the compressors considerably reduced by correcting the defects.

All leading manufacturers of air compressors are now employing the plate type valves which have proved a great

Table II—Multipliers for Transforming Volumes of Compressed Air at Various Pressures into Corresponding Volumes of Free Air at Atmospheric Pressure of 14.7 Lb.

Pressure, lb	Multiplier	Pressure, lb	Multiplier	Pressure, lb	Multiplier	Pressure, lb	Multiplier	Pressure, lb	Multiplier
1	1.068	26	2.768	51	4.469	76	6.170	101	7.870
2	1.136	27	2.836	52	4.537	77	6.238	102	7.938
3	1.204	28	2.904	53	4.605	78	6.306	103	8.006
4	1.272	29	2.972	54	4.673	79	6.374	104	8.074
5	1.340	30	3.040	55	4.741	80	6.442	105	8.142
6	1.408	31	3.108	56	4.809	81	6.510	106	8.210
7	1.476	32	3.176	57	4.877	82	6.578	107	8.278
8	1.544	33	3.244	58	4.945	83	6.646	108	8.346
9	1.612	34	3.312	59	5.013	84	6.714	109	8.414
10	1.680	35	3.380	60	5.081	85	6.782	110	8.482
11	1.748	36	3.448	61	5.149	86	6.850		
12	1.816	37	3.516	62	5.217	87	6.918		
13	1.884	38	3.585	63	5.285	88	6.986		
14	1.952	39	3.653	64	5.353	89	7.054		
15	2.020	40	3.721	65	5.421	90	7.122		
16	2.088	41	3.789	66	5.489	91	7.190		
17	2.156	42	3.857	67	5.557	92	7.258		
18	2.224	43	3.925	68	5.625	93	7.326		
19	2,292	44	3.993	69	5.693	94	7.394		
20	2.360	45	4.061	70	5.761	95	7,462		
21	2.428	46	4.129	71	5.829	96	7.530		
22	2.496	47	4.197	72	5.897	97	7.598		
23	2.564	48	4.265	73	5,965	98	7.666		
24	2.632	49	4.333	74	6.033	99	7.734		
25	2.700	50	4.401	75	6.102	100	7.802		

Formula $\frac{1}{14.7} \times \text{Pressure} + 1 = \text{Multiplier}$

Atm. Pres.—14.7 lb. Barom. Pres.—30 in. Temp.—60 Deg. F.

improvement over the old poppet type. Old compressors still using the poppet type valves should be equipped with the new valves at the earliest opportunity since they add materially to the efficiency of the compressor.

Additional Defects Shown by Diagrams

The indicator is also valuable in locating broken or defective cylinder packing, broken or leaking valves and for

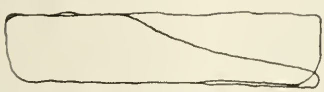


Fig. 5

setting mechanically operated air valves. Its use in correcting the setting of steam valves is more common than for locating air troubles.

Figs. 5 to 10 are reproductions of diagrams taken from steam cylinders of several air compressors employing Corliss

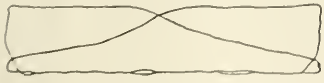


Fig. 6

and Myer valve gears. Fig. 5 shows a diagram from a Corliss valve which, on account of certain defects, was not tripping, live steam being used the entire length of the stroke. Fig. 6 shows the diagram taken from the same cylinder after the correction was made.

Fig. 7 was taken from the high pressure steam cylinder of a compound compressor. In this case the engineer of his own volition had reset the eccentrics in order to operate the machine in an opposite direction from which it was designed to run, stating that it ran quieter in that direction. The

Fig. 7

main and cut-off cams were turned from a solid casting. In slipping the eccentric back, the desired lead could be obtained on the main valve cams only, and when this was done, due to the fixed angularity between the main and cut-off cams, the cut-off cams were opposite the position which

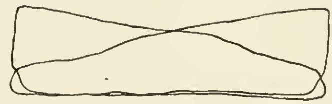


Fig. 8

they should have assumed in a correct setting of the valves.

The distortions shown in Fig. 7 will indicate the efficiency losses resulting from this defect, and present a marked contrast with Fig. 8, which shows a card taken from the same cylinder after the valves had been reset to operate

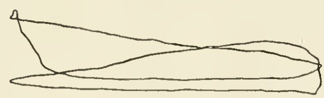


Fig. 9

the machine in the proper direction. It will be noted from Fig. 7 that all port events were greatly deferred.

Figs. 9 and 10 are reproductions of indicator cards taken from the steam cylinders of compressors in actual service in railroad shops in different parts of the country, their distortions indicating many and varied defects.

While the foregoing illustrations present some rather un-

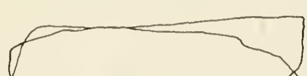


Fig. 10

usual cases, yet they are not at all uncommon, and any of these conditions may exist for long periods of time, costing many thousands of dollars each year and continuing unnoticed unless concerted action is taken to detect them. In many instances steam valves have not been reset in years.

Valves Set Every Six Months

A good practice is to check the valve setting every six months or more often, either by use of the indicator or by removing the steam chest cover and making the adjustments necessary. Cut-off adjusters should always be kept free from corrosion and in working condition to facilitate the resetting of the valves.

In connection with the testing for defective air valves, it is advantageous to have globe valves applied to indicator taps in air cylinders. By stopping the compressor when the pressure is pumped up and opening these globe valves, the high pressure discharge valves can be tested for leaks, for it is obvious that all the air emitted from the globe valves has leaked past the discharge valve.

The setting of mechanically operated air valves should be checked up at frequent intervals since it must be remembered that adjusting or keying up of the shackle (sometimes called stub end) bearings on valve rods, changes the travel of the valves.

Suggestions for Improved Compressor Operation

Poppet type valves should be inspected and cleaned every 30 days.

Globe valves applied at the indicator taps in the steam cylinder will permit of the testing for a leaky throttle, worn or broken cylinder packing or leaking steam valves.

Excessive water in air lines and receivers may be caused by defective cylinder head gaskets or leaking intercooler tubes. These defects may be detected by observing the overflow from the water jackets. If there is any communication from the water chambers into the cylinder or other air spaces, the stream of water from the overflow will be greatly disturbed and irregular.

Wherever the overflow water is piped to a water heater or for any reason there is liable to be a slight back pressure in the overflow line, the circulation is liable to be interrupted, preventing proper cooling of the cylinders.

Water jackets should be cleaned out at frequent intervals.

In case of a defective front cylinder head gasket, the trouble can be eliminated easily by applying a dovetailed gasket and if care is taken in its application, it will be just as permanent as a solid gasket.

Knocks in the air compressor may be caused by any of the following defects: Lost motion in crank pin, crank shaft or wrist pin bearings; crosshead gibs loose on crosshead; crosshead gibs adjusted too tightly (this will cause a severe knock); crosshead too loose in guides; piston loose on rod; piston striking cylinder heads; flywheel loose on crank shaft and end play in mechanical valves. The latter defect may be overcome by inserting a fibre washer between the end of the valve and the valve bonnet, care being taken to see that the valve operates freely.

If the flywheel is loose on the crank shaft, it can be remedied by inserting a thin sheet of tin between the crank shaft and the bore of the wheel. Care should be exercised to see that the shim extends the full width of the hub to prevent the wheel from running out of true.

In tightening piston rod packing, care should be taken to draw up evenly on the packing gland so as not to score the piston rod.

Lubrication System Must Be Kept Clear

Where a force feed lubrication system is used, the pipes should be blown out at regular intervals as bearings are frequently burned out caused by oil pipes becoming stopped up and preventing oil from reaching the bearings. Except in the case of the enclosed crank case type compressors, gravity sight feed oil cups are usually found to be more satisfactory than the force feed system.

Frequently there is no air gage on a compressor to indicate the first stage pressure in the receiver or intercooler. It is of vital importance that compressors be equipped with a gage in order that this pressure can be noted at frequent intervals, since by this method any irregularity or defect to any of the air valves will become instantly noticeable. The correct pressure in the receiver or intercooler between the high and low pressure air cylinders of a two stage compressor varies slightly with different types and makes of machines, but is usually from 23 to 30 lb. Any variation from these figures invariably denotes some sort of an air valve defect.

It is also of great importance to see that governors are functioning properly. Frequently it is found that governors are improperly adjusted or out of commission entirely. Air compressors should never be controlled by the method of hand throttling, as it is found that in these cases, air pressure usually varies directly with the steam pressure as there is no action of the governor to compensate for the varying steam pressure. Also, when the air pressure increases, the compressor will run slower and the desired pressure is seldom obtained. To successfully operate an air compressor by hand throttling, would demand constant attention on the part of the engineer, which is practically impossible and is seldom, if ever, given.

Operate Compressors at Rated Speed

It is highly important that engineers understand at what speed the compressor is designed to operate. Instances have been known where, due to an erroneous opinion of the engineer, compressors have been operated at a much lower rate of speed than they should have been, with the result that an insufficient pressure was maintained on the shop lines. Many engineers are of the opinion that 75 or 80 lb. is a sufficient pressure to operate the shop tools. This is not sufficient, however, and there is no excuse for insufficient air pressure as long as compressors are not operated up to speed. The old time idea that a good engineer is one who, by operating his compressor slowly and cautiously, makes it last for many years at the expense of the shop line pressure has given way to the more modern idea that the good engineer realizes that there are just so many units of power in his machine. He sees to it that the maximum pressure is constantly maintained even though it becomes necessary to operate the compressor at its maximum speed, thereby preventing thousands of dollars' loss in production each year, a sufficient amount in some instances to buy several new compressors.

Another matter of importance is to see that the flywheel does not run out of alinement. If it does, it sets up a stress on the crank shaft when it is rapidly rotated, sometimes severe enough to break the crank shaft. In any event, it detracts from the smoothness of the running of the machine as well as causing a loss of power.

A flywheel can easily be trued by the method of piening the spokes as near the hub of the wheel as possible. The principle of this operation is that by compacting the molecules of iron, the side of the spoke being piened is elongated and throws that portion of the rim of the wheel directly above it into alinement. In undertaking an operation of this kind, care should be taken not to throw the rim too far. Between piening operations the wheel should be rotated and marked with chalk similar to the method employed in setting up a piece of work in the chuck of an engine lathe.

The air line to the gage indicating storage reservoir pressure should be run directly from the reservoir and not tapped into the discharge line as is frequently done. By tapping into the discharge line close to the compressor, the gage hand is caused to pulsate and besides being injurious to the gage, a correct reading cannot be taken. Also the air regulator of the governor is generally actuated by the pressure in the gage line and the pulsations interfere with its proper regulation.

Reduce Idle Running Time If Possible

It is frequently found that compressors driven with constant speed motors and employing automatic pressure control or unloading devices usually run idle the greater portion of the time, especially in car yards or wherever the demand for air is comparatively small. While the machine is running idle, it is consuming electric power as well as uselessly wearing out the compressor.

One specific instance was in the case of a compressor operating at a speed of 270 r.p.m. It was cut in only one minute out of fourteen, and as this machine was located in a car yard where it was necessary to maintain the pressure night and day, the machine was operated constantly. The loss in this particular case is very apparent. In instances of this kind, the ratio between the drive pulleys or gears on the motor and compressor should be increased in order to decrease the speed of the compressor until its capacity more nearly equals the demand for air.

It has been found much more satisfactory to employ variable speed motors or equipment employing an automatic cut-out to stop and start the motor when air pressure rises or falls below the desired pressure. The first cost of such installation is higher, but it is a great economy in the long run.

Principles of Oxyacetylene Fusion Welding
Part 6—Welding Cast Iron, Continued

By Alfred S. Kinsey*

THE five chemical elements in cast iron have their own peculiar influences on the metal as may be seen by the following:

Carbon. When a welder gets cast iron in the molten condition he has affected the carbon to such an extent that it is all of one form and entirely absorbed by the pure iron. But when the molten iron solidifies, some of the carbon stays combined with the pure iron and is called combined carbon, while the remainder of the carbon stays free of the iron and is sometimes called free carbon, but as it is of the nature of graphite like the lead of a pencil, it is more often called graphitic carbon. It is the amount of these two carbons and their proportions to one another which makes cast iron hard or soft, strong or weak.

Improvised Preheating Furnace for Cast Iron Welding

Now the amount of carbon which remains combined and that which becomes graphitic depends on the way the welder allows the iron to cool. If it cools fast, most of the carbon will remain combined with the iron and the cold casting will be so hard it cannot be machined. On the other hand, very slow cooling will allow the proper amount of combined carbon to be released from the pure iron and become graphitic carbon, which will give the casting the degree of softness it was intended to have.

There is also another characteristic of carbon which the welder must consider, and that is that it will burn. When cast iron is melted with a welding torch some of the total carbon burns out, the amount varying from 0.2 to 0.5 per cent of say the 4 per cent in good cast iron. This loss depends on two things in welding, first on the nature of the flame of the torch. If it is a carbonizing flame, the loss of carbon from the iron would be largely prevented by the acetylene of the flame. Second, if the iron casting is being preheated by charcoal, the molten metal will absorb carbon from the charcoal and the loss of total carbon would be much less. Here is the main reason why iron castings to be welded should be preheated in a charcoal fire. It is therefore probable that in most cases of the welding of cast iron with the proper torch flame and preheating gases the loss of total carbon from the iron is not more than 0.10 or 0.20 per cent. However, if the torch works with an oxidizing flame and the preheating is done with a non-carbonizing heat the loss of total carbon from the molten iron may run as high as 1.00 per cent, which would make the weld hard and brittle. Then if the job was interrupted and allowed to cool and be reheated two or three times, the loss of carbon would be much greater, and the weld would be ruined.

Pure iron can absorb as high as about 4.6 per cent of total carbon.

Silicon. This element is absorbed by the iron, that is, it is not between the grains but is soaked up by and becomes part of the grains of pure iron. Silicon is valuable in cast iron as a sort of governor of the carbon. Every time a welder melts a piece of cast iron there is a loss of about .25 per cent of the usual 2.50 per cent of silicon, and as the total amount of silicon decreases it causes the combined (hardening) carbon to increase and the graphitic (softening) carbon to decrease, which leaves the metal harder each time. So that a welder should be careful to make as few melts as possible in completing a cast-iron weld.

Manganese. This chemical element is used in cast iron to avoid shrinkage and gas troubles in the finished casting. The amount of manganese usually runs from .50 to .70 per cent. If the amount falls below .50 per cent, the casting will be liable to shrink unevenly and form cracks. Now every time cast iron is heated from the solid to the molten condition it loses about .10 per cent of its manganese. So that if a welder was busy on a casting which contained an average of .60 per cent manganese and he remelted a couple of times, he would demanganize the iron below the safe limit of .50 per cent and shrinkage cracks would be liable to occur, even though the job was carefully covered and unheated very slowly.

Manganese assumes two forms in cast iron. In one it com-

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bines with the sulphur and assists in removing that harmful element. In the other form manganese absorbs the oxygen and prevents oxides from forming in the iron. In the right proportions manganese becomes part of the grains of pure iron and combines with the carbon and thereby completes its beneficial influences on cast iron.

Phosphorus. The first thing to remember about phosphorus is that it makes cast iron hard and brittle. But it is also true that it will make molten cast iron more fluid and thereby cause it to flow easily and be useful in the making of castings having very fine details. While pure iron will absorb 1.70 per cent of phosphorus, the amount of this element in cast iron should not exceed 0.70 per cent and the usual figure is from that down to 0.20 per cent.

Sulphur. This element is a dangerous one to cast iron, as its tendency is not only to make the metal hard, separating the grains and weakening the whole structure, but every time the iron is melted the amount of sulphur is increased instead of being decreased as in the case of the other elements. Now of course a welder is not likely to add sulphur to the cast iron as he welds with an oxyacetylene torch, but if he preheats the casting as is customary, the charcoal or coke fuel will contain sulphur which will be absorbed by the molten iron. This will not be so detrimental if the sulphur in the iron at first is kept as low as 0.05 per cent, which is the amount to be found in good quality cast iron. The sulphur content should not go over 0.12 per cent.

In detailing the characteristics of the five chemical elements and their influence on cast iron we have had in mind to impress upon the welder: (1) That there are some simple physical laws which govern the melting of cast iron, as in the making of a weld; (2) that the best welds can be made by the welder who understands the influences of these chemical elements and respects them; (3) that the oxyacetylene flame can largely control the influences of these elements and produce a satisfactory weld.

Physical Nature of Cast Iron

We have seen how cast iron is influenced by its chemical ingredients, now let us consider the typical physical characteristics of the metal.

Growth from Heating. Cast iron will increase in length and breadth every time it is heated red hot and allowed to cool. That is, when a welder heats a piece of cast iron red hot it expands and then when it gets cold it contracts, but the contraction is never as much as the expansion, so the size of the casting gradually increases in all directions, until finally after many heatings the grain structure of the metal breaks down, cracks are formed and the casting is spoiled. To get this growth the iron does not need to be heated as high as the melting temperature, as the greatest rate of growth occurs at a red color which is at temperatures between 1,400 and 1,600 deg. F.

The growth of cast iron probably is due to the oxygen from the air getting between the grains of the pure iron when hot and forming iron oxide, or scale. Such oxides, gradually increasing in size, spread the grains apart and thus enlarge the casting. It has been found by long experiments that cast iron can be made to grow as much as 45 per cent in volume and 15 per cent in length.

Of course a welder will not only be interested in this physical characteristic of cast iron, but he also will see the application of the knowledge of his work. If he heats a casting to the red color as is usually done for preheating and allows it to cool, and then repeats this before completing a weld, he may expect the original size of the casting to be increased each time it is reheated, and at the same time the iron will become weaker and spongy. In a locomotive cylinder, for example, this growth might be irregular enough to throw the cylinder bore out of round and make it oval in shape, and the straight parts of the casting may be thrown out of line, or warped. The simple rule to follow is to get the welding done as soon as possible after the casting is preheated to the right temperature.

Fluidity. The melting point of cast iron varies with the quality of the metal, it being about 2,200 deg. F. for the gray cast irons like Nos. 1, 2 and 3, and about 2,000 deg. F. for the white cast irons like Nos. 4 and 5. Now it is to be noted that this is the *melting* point of cast iron; that is, the temperature at which the iron changes from the solid to the liquid condition, but it is not the *welding* temperature of cast iron. The molten metal should be superheated; that is, heated about 200 deg. F. hotter than the melting temperature. This will give the necessary fluidity to the metal to allow the grains of the two ends being welded and the welding rod to run together, fusing into one solid piece.

Of course a welder would have no accurate means of measuring the temperature of the molten iron in order to secure the 200 degrees of superheat, but a little practice in melting cast iron with an oxyacetylene torch will enable a welder to see the difference between dull liquid iron and superheated or hot liquid iron as it is called in foundry practice. Under the torch flame, dull liquid iron has the appearance of motion, like thick coffee, for example, while hot liquid iron flows as freely as clean water.

Welding 8½-In. Cross Compound Air Compressor Head

Now the chief physical difference between hot and dull iron is the attractive power of the grains of the metal. In the cold, solid condition of cast iron it would take about 20,000 lb. per sq. in. to overcome the power of attraction, and this is gradually reduced as the metal is heated until at the dull liquid state the attractive power is probably only a few ounces per sq. in., and at the hot liquid condition all of the attractive power is just about gone, and the grains will separate very easily. But if they do the air will enter and the surfaces of the grains of iron will be coated with iron oxide so that the metal will be *burnt* and ruined.

The welder will therefore see first the importance of welding cast iron with the metal in the superheated condition, and second, the necessity of not overheating the metal and thereby entirely destroying its plasticity.

Freezing Point of Cast Iron. We have written of the change in cast iron by the raising of its temperature from that of the cold, solid condition to that of the hot molten state, and we have noted the importance of making such a change with consideration of the physical nature of the metal. Let us see what happens when a piece of cast iron is unheated, that is cooled under control.

The freezing point of cast iron is the place at which the metal sets or changes from the liquid to the solid condition. It is not the same as the melting point. For example, if the melting point of a good gray iron is 2,250 deg. F., the freezing point will be about 2,100 deg. F. This difference between the melting point and the freezing point is known to the foundryman as the *life* of the metal, and the success of the making of an iron casting depends on the length of its life. This also is of much importance to an oxyacetylene welder, for if the life of the metal is normal the possibilities of obtaining a good weld are excellent. Now the first thing air will do to molten cast iron is to raise its freezing point and thereby shorten its life. Then the metal will set so quickly that its fusion or running together will be poor and the weld will be unsatisfactory. Of course it may therefore be seen that the welder should not allow the molten metal to be attacked by the air and become oxidized, if he expects to keep it under control while making a weld.

Gray cast iron has the highest melting temperature and the lowest freezing point, which make it have a longer life than the white cast irons, and this to the welder means that the soft gray irons will weld easier than the hard white irons.

Before starting to weld cast iron try it with a file. If it does not file easily the welder will know that it has a short life, and he will have to weld quickly and be very careful of the molten metal freezing or taking *sets* as he goes along. If such sets should occur, they will form a *cold shut* in the metal, which is two masses of molten iron partly solidified and run together. They make an imperfect junction, sometimes shown by deep lines on the surface of a casting, and cause the metal to be so weak that it may easily be broken apart by a moderate blow or jar.

The Chill of Cast Iron. By this term is meant the nature of cast iron to get hard on its surface when as molten metal it is cooled at a rapid rate. For example, if some molten cast iron were poured into a mold made of cold iron instead of the common sand mold, it would become solid very quickly wherever it came in contact with the cold iron mold, and that part of the casting would also be so hard it could not be filed or machined. At the same time the remainder of the casting would be of soft iron. This difference of the hardness and softness of the same casting is called the *chill*.

What really happens to produce the chill is that when the cast iron is melted its carbon is all in the form of combined carbon which, if allowed to cool slowly as in sand molds, would nearly all gradually change back to graphitic carbon. But if the molten metal is cooled quickly, practically all of the carbon stays as combined carbon and as this is the hardening carbon of cast iron the metal is changed from a soft gray iron to a white iron, chilled to a hard state.

The depth of this chill from the surface down into the metal chiefly is governed by the amount of silicon in the iron. With about 1.00 per cent silicon the iron may be chilled ½ in. deep, while with 0.10 per cent silicon the chill would go in 3 in. deep.

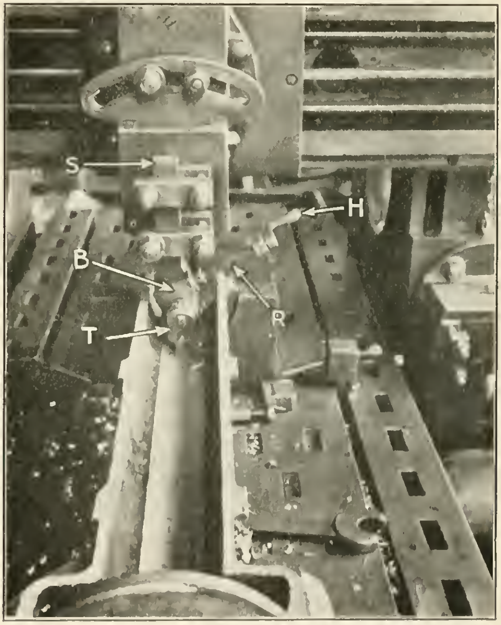
Now the oxyacetylene welder may wonder how this applies to his work. Suppose he was called on to weld the cast iron bed of a common engine lathe in a machine shop or some manufacturing establishment. If he did not know he might consider the job as an ordinary iron casting and spoil it for, while such lathe beds are mostly of soft gray cast iron, the top part, called the shears, is of chilled iron to resist the wear of the machine parts which are moved over its surface. The same thing would apply to a cast iron car wheel, as its face is chilled, and there are many other iron castings which have certain parts chilled. It is always safe for a welder to assume that an iron casting having parts of its surfaces subjected to severe rubbing, called abrasive wear, will have such surfaces chilled.

It will now probably occur to the welder to ask if the preheating to a dark red of a chilled iron casting for welding would not reduce the chill and soften the iron, to which the answer is no, as the reason the metal is hard is because its carbon is chiefly in the combined state, and the only way to retransform it is to melt the iron and allow it to become solid very slowly which would allow most of the hard combined carbon to change to soft graphitic carbon and thus avoid the chill.

The welder should remember this when he attempts to weld a combined soft and chilled iron casting. If he heats the chilled iron to the molten condition and covers it as is the custom for ordinary castings, the part melted by the torch, and the weld, will be as soft as the rest of the casting. The correct way is to leave the melted chilled-iron part of the weld uncovered so that it will cool down quickly in the air, while the soft-iron part of the casting is covered and cooled slowly.

Radius-Planing Tool

An efficient radius-planing tool for machining extended piston rod guides and other similar work is illustrated herewith. The principle of operation of this tool will be readily apparent from the illustration in which the main body of the tool *B* is held in the planer tool post by clamps on the tool shank *S*. The tool head *T* is so arranged as to revolve,



Planing the Radius of An Extended Piston Rod Guide

the cutting tool being held in this head and adjusted to such a length as will give the required radius. The revolution of tool head *T* is obtained by means of handle *H* which turns rod *R* and a worm and worm wheel within the body of the tool. The feed of the cutting tool is obviously obtained by turning handle *H* a fraction of a revolution for each stroke of the planer. This device has been in service for a long time with satisfactory results. On the particular job illustrated it planed the extended piston rod guide in 55 min., 30 min. being required for the roughing cut and approximately 25 min. for the finishing cut.

Quality of Steel Determined by Fracture Test*

By W. J. Priestley

THE bulk of steel entering into finished machine parts in this country is forged, heat treated and machined in other plants than the plant in which it is melted and cast. Large quantities of high grade alloy steel, high carbon steel and tool steel are handled in this manner. The consumers, of whom railroads are one of the largest, purchase steel on its chemical analysis and surface inspection, no reference being made to the record of manufacture other than that the steel shall be made by the acid open-hearth, basic open-hearth, electric or crucible process. In some cases, the method of melting is not specified.

Frequently it happens that steel purchased in this manner is rejected after heat treatment or after machining due to defects which were not apparent in the purchased bloom, billet, or bar stock. Due to the fact that a customer may purchase only a small portion of the original heat of steel, it would be impracticable to demand with the purchased order of steel, its melting record. Furthermore, if this record were furnished, the consumer might not be able to interpret the same intelligently and know whether or not he was getting a satisfactory heat of steel.

Fig. 1—Test Discs Broken with Great Difficulty After a Single Quench and Draw

In cases where complete detailed record of manufacture of steel forgings have been available, it has been found that a simple fracture test taken from the end of a forging, billet, or rolled bar stock, furnishes more conclusive data than many other tests which are more elaborate and more expensive. This test has been used for some time past for determining pipe in rolled stock. In this instance, the plane of the fracture is at right angles to the direction of rolling. Purchasers of high grade alloy steel and tool steel will find a fracture test equally serviceable and practicable for a determination of slag, inclusions, flake, blow holes, pipe, and excessive segregation, if taken so that the plane of the fracture is parallel to the direction of forging or rolling.

The test consists of sawing a disk about 1¼ in. thick from one end of the forging or bloom. If this small disk is quenched slightly above its critical temperature, drawn between 900 and 1,100 deg. F., and then broken in two, it will give a fracture parallel to the direction of forging or rolling which will disclose the texture of the metal. Flake, slag, blow holes, pipe and excessive segregation may be detected easily by means of this fracture test.

This test should supplement the usual test for chemical analysis and surface inspection. It affords a means of rejecting, before forging, heat treating and machining, any steel which contains any of the foregoing defects. In many cases steel with inherent defects is taken up for manufacture and when finally rejected, is blamed upon improper heat treatment on account of not having knowledge of these inherent defects.

Fig. 2—Test Discs Taken from Blooms

Figs. 1 and 2 show disks taken from forgings as large as 10, 13 and 18 in. in diameter. It will be seen from Fig. 1 that the disks were broken with great difficulty after a single quench and draw. The way in which these disks bent without breaking gave almost positive proof that subsequent tensile tests from these forgings would be satisfactory. Four bars taken at right angles to the direction of forging of these blooms showed the following physical results:

Tensile strength, lb. per sq. in.	Elastic limit, lb. per sq. in.	Elongation, per cent	Reduction in area, per cent
95,400	61,000	25.2	53.2
97,500	68,300	26.	58.1
100,000	62,500	23.6	50.8
100,100	68,400	23.6	50.5

Attention is invited to the fact that these bars were taken at right angles to the original axis of the ingot and across the grain with respect to the way the metal was forged. This steel was 0.38 per cent carbon, and contained about 2.75 per cent nickel.

Fig. 2 shows three similar disks taken from other blooms. The top disk discloses minute inclosures of slag in the fracture. These may be seen by closely examining the illustration. They are about as wide as a needle and vary from ¼ to ½ in. in length. Physical test bars taken from this forging at right angles to the axis showed the following physical tests:

Tensile strength, lb. per sq. in.	94,000
Elastic limit, lb. per sq. in.	70,000
Elongation, per cent	12.2
Reduction in area, per cent	30

The middle disk, Fig. 2, shows a fracture of steel which is almost entirely free from slag or other impurities. Tensile bars taken from this disk showed the following:

Tensile strength, lb. per sq. in.	97,000
Elastic limit, lb. per sq. in.	70,000
Elongation in area, per cent	11.4
Reduction in area, per cent	24.9

*A paper presented before the convention of the American Society for Steel Treating at Indianapolis, Ind. The author is superintendent of the hot metal division, United States Naval Ordnance Plant, Charleston, W. Va.

The bottom disk, Fig. 2, contains bright silky spots, generally termed "snow flakes." These are very easily distinguished in the photograph. A tensile bar taken at right angle to the axis of this forging showed the following:

Tensile strength, lb. per sq. in.	94,900
Elastic limit, lb. per sq. in.	67,500
Elongation in area, per cent	11.4
Reduction in area, per cent	24.9

This information is furnished with the idea that it may be of some benefit to heat treaters who do not melt their own stock but purchase it in the form of blooms or billets. This is an inexpensive test and could be taken at the rolling mills or forge plants before shipment to the ultimate consumer. The saving effected by rejecting unsatisfactory steel before machining and heat treating would more than offset the slight cost of taking fracture tests of forgings, blooms or bar stock.

Head and Eye Protection*

The first steps in the direction of head and eye protection for shopmen were taken in 1912. Eye injuries were very numerous and as they were generally serious and involved long periods of disability, we adopted the use of goggles as a preventative measure. At first it was thought that only a few pairs would be needed but as the demand for them increased we extended that policy so that today goggles are furnished to each individual whose duties require this kind of protection.

In order to prevent fogging of the lenses due to moisture in the atmosphere, anti-sweat pencils are furnished which consist of a glycerine soap preparation to be rubbed over the entire surfaces of the lenses and wiped off dry. Where men are engaged in hot work, a special type of goggle, known as boilermakers' goggles, having extended frames providing additional ventilation and with all portions which come in contact with the face insulated with padding, have been found superior to the ordinary machinists' type goggles as they do not fog quickly.

Where there is considerable dust, as in the operation of blowing out boiler tubes, etc., rubber-mounted goggles are furnished which have no ventilation provided, and, of course, can only be used for short periods at a time without cleaning. Where sand blast operations are carried on, a helmet covering the head and supplied with fresh air from a forced ventilating system, is employed.

Head Protection

For the protection of the heads of men engaged in electric welding work it is necessary to provide a face mask. A protection glass, which excludes ultra-violet and infra-red rays from the iron arc, is mounted in the front of wooden or fibre shields held before the face by hand or by head attachments, the important features being the non-conductivity of electric current of the material used in the mask, ventilation, and the easy removal of the protection from in front of the face when the arc is not being used. One of the best masks for this purpose on the market, having a drop frame for holding the protective glass, was devised by one of our employees at the Columbus shops.

For oxyacetylene welding, eye-cup type goggles are used, the cups being made from material which is a non-conductor of heat or electricity. In order to determine whether the degree of protection afforded to men engaged in the oxyacetylene and electric welding processes was sufficient, quarterly examinations for acuity of vision were made by the relief department physicians on the eastern lines and the reports were favorable in respect to the results being obtained.

At oil mixing plants where hard grease is manufactured a few employees handle caustic soda in large quantities and for their protection rubber hoods, fitted with face masks having respirators and clear glass lenses, are provided. Special instructions are issued to the men in charge of these plants relative to prompt action in case of caustic soda burns. A drop test machine has been built and installed in the test department at Altoona where goggles are tested for strength of lenses. A list of approved goggles has been compiled and placed in the hands of the purchasing agent.

Abrasive machines are equipped with glass eye shields attached directly to the frame and at some shops exhaust systems are in use which carry away the dust. Chipping screens and rivet catchers are other forms of secondary protection which are quite generally in use for the prevention of eye injuries.

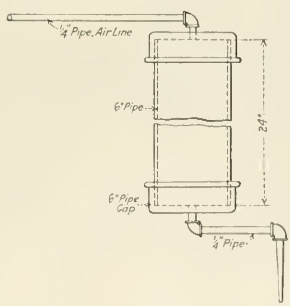
Screens are provided to be placed around electric welders for preventing the light from their operations reaching the eyes of men working near them. Separate rooms or screened areas are set aside for working on parts which have been removed from equipment. Propaganda against the use of match sticks, dirty handkerchiefs or other unsterilized implements for the removal of foreign bodies from the eyes should be continued.

*Report issued by the Insurance Department of the Pennsylvania System.

Air Motor Grease Gun

By B. C. Bertram
General Locomotive Inspector, Erie, Youngstown, Ohio

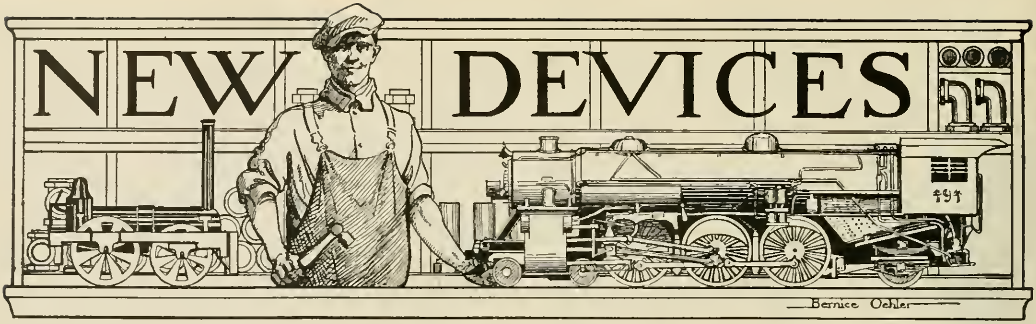
It has frequently been noticed that the grease for air motors, when allowed to remain around in open containers in tool rooms, collects more or less of the dust and grit flying about the shop. The illustration shows a device by which this grease may be confined in an enclosed grease gun to be injected into pneumatic motors by air pressure, as desired. The device is extremely simple, consisting of a piece of 6-in. pipe, 24 in. long, provided with a cap on either end. By opening a valve a ¼-in. pipe to the upper end admits air under pressure which forces the grease through the lower ¼-in. pipe and nozzle. A flexible rub-



Pneumatic Gun for Supplying Grease to Air Motors

ber hose connection can be arranged from any of the shop lines, enabling this device to be used at any part of the bench where air motor repairs are being carried on.

A particular advantage of this method of applying grease to air motors is that the plates on the side of the motor are not removed, as is customary when packing by hand. In using this pneumatic device, it is simply necessary to unscrew the dead handle of the motor and insert the nozzle, admitting air until the required amount of grease has been forced into the motor. The nozzle of this grease gun is made from a piece of ¼-in. pipe, drawn down.



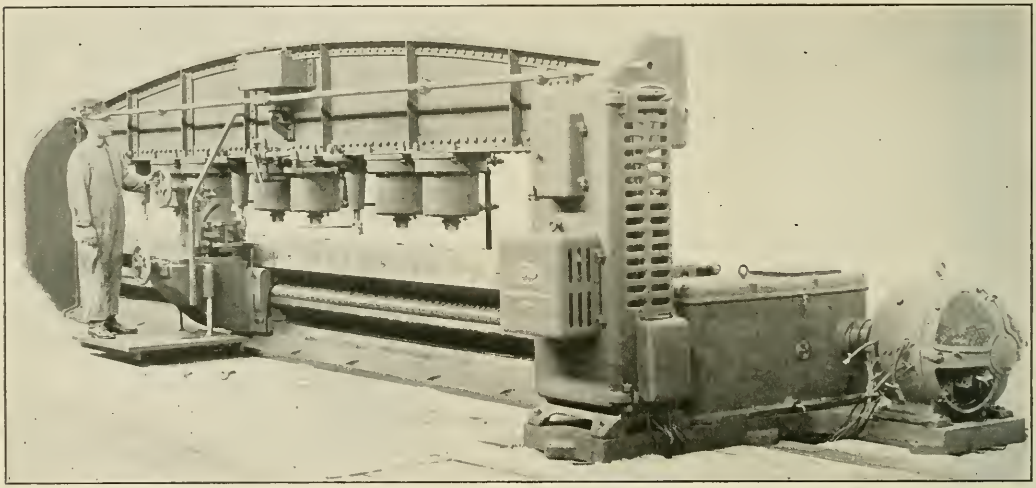
Recent Improvements in Plate Planer

IN the new plate planers made by the Niles-Bement-Pond Company, New York, it will be noted that the design of the bed and carriage is such as to prevent chips from getting on the bearing surface of the carriage and screw. This adds materially to the life of these parts. The tool carriage is attached to the front vertical side of the bed, and is guided by square shears. It is secured at the top and bottom by removable bearing supports which will permit the carriage to be taken from the bed at any part of its length. The bearing surfaces are provided with taper gibs for taking up wear.

Two relieving tool holder slides are mounted on a standard, and have simultaneous vertical adjustment by means of a screw and hand wheel, and horizontal adjustment to the standard through a screw and hand wheel. Both tool slides are arranged to swivel for planing bevels.

The drive screw is supported in a trough with an oil channel of sufficient depth to cover the full depth of the thread with oil. Roller bearings are provided to take the end thrust of the screw. The pneumatic jacks are of the two-way type, i.e., air is admitted in the top for clamping the plate. For unclamping, the air is admitted at the bottom. The carriage is reversed automatically at any desired position by contact with stops adjustable on the shifter rod. The operator can start, stop, or reverse the carriage by manipulating this shifter rod by hand. This can be done with very little effort on the part of the operator.

The main driving gears are enclosed in a box, and run partly submerged in oil. The motor is controlled by a master switch attached to the shifter rod, and an enclosed panel with forward, reverse, accelerating, and dynamic brake contactor. A push button is mounted on the right hand housing, so that the machine may be started and stopped without manipulating the shifter rod. The cutting speeds range from 20 to 40 ft. per min.



Niles-Bement-Pond Plate Planer of Improved Design; Arrangement for Keeping Chips Out of Carriage Ways and Screw a Valuable Feature

The housings for the clamp beam overhang the bed so that plates of any length can be planed by shifting them along the bed and taking a series of cuts. These planers are equipped entirely with pneumatic jacks, or with hand-operated screw jacks, or with both types as illustrated in the photograph.

This type of plate planer is built to plane plates from 1 in. to 2 in. thick in five standard sizes, the maximum length planed at one setting ranging from 12 to 25 ft.

Coping Machines for Steel Car Shops

Many, and perhaps it is safe to say most, railroads are poorly equipped with shops and particularly machinery for making repairs to steel cars. This lack of facilities will be keenly felt especially in the next few months when an abnormally heavy coal traffic and crop movement will create a big demand for freight cars. Bad-order cars must be repaired and returned to service as promptly as possible and one of the best ways to facilitate this work is by installing a sufficient amount of modern labor-saving machinery.

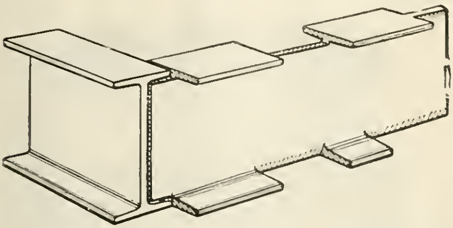


Fig. 1—Shaded Sections Removed by Coping Machine

In steel car construction and repair work, coping machines of the type illustrated perform a valuable function. They are used in miscellaneous blocking-out work and, as shown in Fig. 1, for cutting beams and channels in such a way that they will fit together accurately in a car without subsequent machining, sawing, or filing. Certain operations on channels are troublesome since it is necessary in an end sill, for example, to cut away the flange and a considerable portion of the web of the channel in the center of the section where it fits over the draft gear. The coping machine will perform this work on an end sill member in less than one minute, whereas, if the work is done with a cold saw, it will take from 20 to 30 min. to accomplish the same result.

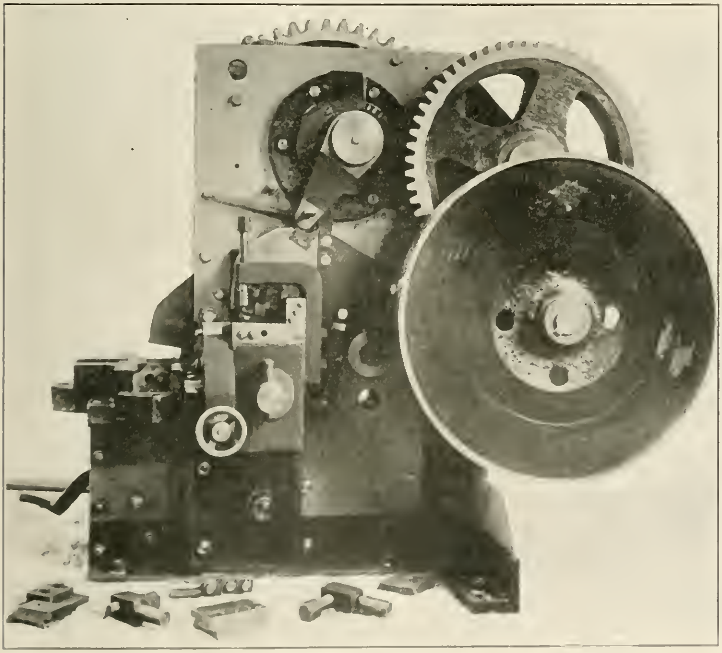


Fig. 2—Pels Coping Machine for Blocking Out Steel Beams and Channels

A single-end coping machine, designed for the above purposes and of the same general type as coping machines successfully used by prominent car companies for many years, is announced by Henry Pels & Co., New York. It is illustrated in Fig. 2 with certain parts of the tooling equipment in the foreground. This machine is made in four sizes and in double end as well as single end design, being intended as explained above for handling structural framing and coping operations which in many shops are slow and expensive to perform. Cutting away the flanges and beveling the webs of beams or channels (Fig. 1), for example, is a lengthy operation unless use is made of the coping machine which takes off each flange with a single stroke of the machine, the web being rounded with the knives shown on the side of the machine.

Rugged Frame Construction a Special Feature

As with the Pels triple combination punching and shearing machine, described on page 537 of the September *Railway Mechanical Engineer*, the coping machine is made of heavy steel plates of definitely calculated tensile strength and elastic limit. In the larger sizes the plates are hydraulic forgings. The frames are designed with an unusually high factor of safety, the intention being to provide frames which no duty, planned or accidental, can fracture. The gears are made of steel with accurately cut teeth, the pinions being forgings. All shafts of large diameter are also forgings. Bushings are made of phosphor bronze and the main bearings are provided with ring oilers. The machine is designed to perform continuously and with ease at the highest capacities named and, on account of their construction, the frames are guaranteed without reservation to be unbreakable.

One of the features of this coping machine is its ability to remove the entire flange of a channel or beam if this is desired. The front knives are so constructed that the entire fillet is removed with the flange. This is a feature said to be characteristic of the Pels machine alone. The coping machine, illustrated, is known as the type Reat No. 45 B and will make standard coping cuts on beams and channels up to 20 in. 75 lb. Flats, angles and plates up to 3/4 in. thick can also be accommodated. An eight-horsepower driving motor is used, the speed of the fly wheel being 260 r.p.m. The diameter of the driving pulley is 25½ in., the driving belt being 4 in. wide. The machine will make 18 strokes per minute. Its overall dimensions are 68 in. long, 50 in. wide, 76 in. high. The net weight is 9,700 lb. When desired, the machine can be easily mounted on a turntable but this is seldom necessary for railroad shops.

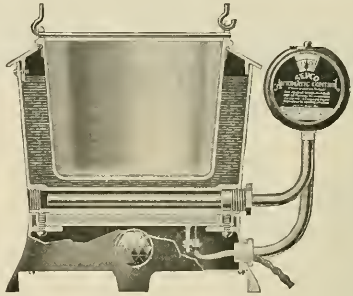
Glue Pot with Automatic Heat Control

GLUE attains its greatest flexibility and viscosity at about 140 to 150 deg. F. At a temperature of 176 deg. F. glue loses its tensile strength. Similarly, if it is cooled to 104 deg. or less, there would be a decided fluctuation in the strength or holding quality. Obviously, some kind of heat control in glue pots is desirable and this is obtained in the one illustrated, made by J. D. Wallace & Co., Chicago.

This glue pot is provided with a tube immediately above the electric heating element containing a sensitive volatile substance which contracts and expands with the slightest change in temperature and provides a dependable action of ample power to actuate the control switch. When the water around the glue pot reaches the proper temperature (150 deg.), the control turns off the current. When the temperature falls a few degrees, the heat is turned on again. Since this action is automatic, workmen need not watch thermometers and an increase in production is the direct result. The temperature gage dial always shows the heat attained and, together with the jewel set in the base casting, acts as a visible check on the heat maintained.

The glue pot operates from any electric lighting circuit and is put in operation by merely turning the switch. This glue pot functions either as a water bath, hot air, or dry heat pot and whichever way it is used, does not overheat, even if the current be left on indefinitely.

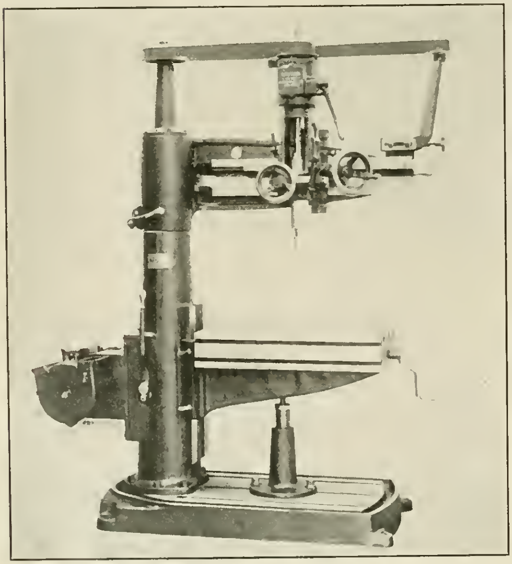
The durable cast aluminum glue container is supported by special lugs which prevent floating when the pot is only partly filled with glue. The escape of moisture is minimized by this method. The base cover forms a dead air heat insulating chamber between the heating units and the bench, and the air gap which surrounds the heating unit provides further insulation between the heat units and the base casting. The method of insulating electrical parts provides ample fire protection. This glue pot is adapted for heating any substance which requires a definite working temperature, such as glue, wax, pitch, tar, sealing compounds, or resin.



Wallace Glue Pot Arranged for Automatic Control of Temperature at Any Desired Point

Ball Bearing Sensitive Radial Drill

THE object of a new high speed radial drill, developed by the Fosdick Machine Tool Company, Cincinnati, Ohio, is to drill and tap work of too large an area for the high speed sensitive upright drill. The rapidity of positioning the drill, together with ease and convenience of operation minimizes the time "between holes," while high speeds and excess power reduces the actual drilling time.



Fosdick Radial for High Speed Drilling of Large Work

The table is readily removed, allowing 49½ in. between the spindle and base, which has a working surface of 28 in. by 36 in. and is planed and provided with T-slots. The vertical movement of the table is 16 in. through a ball-bearing telescopic screw. The working surface is 20 in. by 33 in. with 21 in. maximum to the spindle.

The arm, sensitive in its movement, may be swung completely around the column, and is supported on both annular and thrust ball bearings on the column, which extends through to the top. The spindle, as all other revolving members, is equipped with ball bearing journals. It has a No. 2 Morse taper, and a vertical traverse of 8 in. The horizontal movement of 28½ in. along the arm is through rack and spiral gear with the handwheel to the right. This position of the hand wheel enables the operator to swing the arm and move the head simultaneously with the right hand, while the left hand is free to raise and lower the spindle, and clamp the arm.

The sensitive feed and quick return are operated by the lever at the right, or the handwheel at the left. Friction back gears, a new feature for a machine of this type, permit instantaneous shifting from high drilling speeds to slow speeds for tapping or drilling large holes, the ratio being 4½ to 1. The tapping attachment frictions, like those of the back gears, are easily adjustable with an ordinary screw driver. The drive is regularly through tight and loose pulleys on the machine which gives both a high and low speed forward and reverse. The pulley guard and belt shifter are adjustable to meet the belt from any angle.

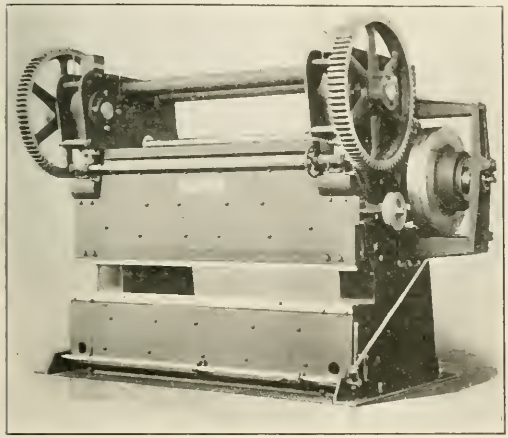
Another important improvement is the full tractive contact of the belt, which maintains a uniform tension at every position of the head. A reservoir for coolant is cast in the base, and a pump with nozzle to the drill point can be supplied.

Separate box or universal tables can be furnished as extras in place of the regular elevating rectangular table.

Motor driven machines require a 1 hp. motor, either constant or variable speed, as desired. The machines are built with either 3 or $3\frac{1}{2}$ ft. arms; the dimensions mentioned above being for the 3 ft. size, which weighs 2,650 lb.

Cincinnati All-Steel Power Press Brake

An interesting development in the manufacture of heavy brakes has just been disclosed by the Cincinnati Shaper Company, Cincinnati, O., with the introduction of the Cincinnati all-steel press brake. This line of brakes has been designed with an open side in order to facilitate the handling of material. As most bends are made near the edge of the plate, the full length of the die-holding surface can be utilized. Thus, for most classes of work, a machine can be rated with respect to the length of the die-holding surface instead of the distance between housings, which means the use of a narrower, more rigid machine, and a saving in cost and floor space.



Cincinnati Power Press Brake With Multiple Disc Clutch

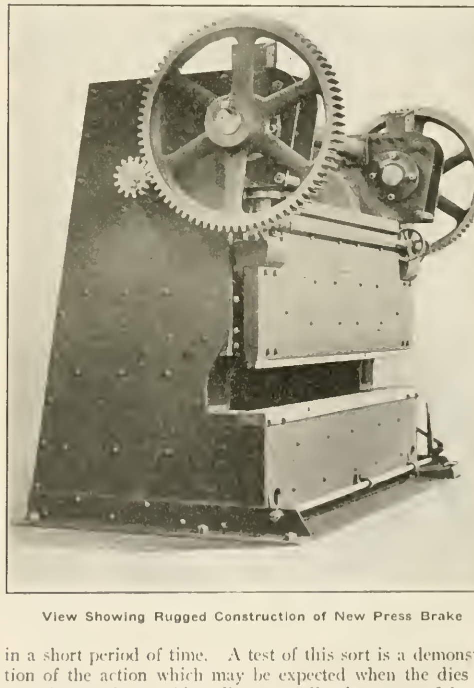
In addition to freedom from all interference at the front of the machine, there is an absolutely clear space between the housings at the rear for convenience in stacking finished work. Where more than one operation is required, the work can be passed back and forth through the machine, avoiding the inconvenience of turning end for end.

The bed and ram are constructed entirely of heavy steel plates and billets, which, together with cross ribs, are welded to each other, thus making what is virtually a heavy solid steel beam of box section with the metal placed to the best advantage. The housings are framed of steel plate, having cast steel members interlocked and welded to the plates. These members are provided with heavy trunnions for supporting the bed. The machine is designed for maximum simplicity, and all elements are combined to secure the essentials of power, rigidity, speed and convenience of operation. Automatic sight feed lubrication is provided on all power driven bearings. The fly wheel, clutch, worm and worm wheel ram adjusting device, and the power drive for this, all run in a bath of oil.

All main drive bearings are of special bronze. A splined trip shaft runs the full length of the machine, on which is mounted an adjustable foot treadle which enables the operator to engage the clutch from the most convenient position. The ram is gibbed endways as well as sideways. This is essential when using the machine as a gang punch. When the machine is to be motor driven, the motor is mounted on a bracket attached to the housing. The drive is through a belt, held in tension by a weighted idler pulley applied on the slack side.

To meet the demand for increased production these machines have been designed to operate at a greater number of strokes per minute than has been customary in brakes heretofore. The fly wheel is mounted on high duty ball bearings having hardened steel inner and outer races. All gears are accurately cut and the pinions are of steel. The clutch is of the multiple disc type, especially designed and developed for this particular tool and operated in oil. It is accessible and simple to adjust. The clutch is designed to be highly efficient, very low unit pressures being used in its operation and shows remarkable results under tests.

For instance, the clutch, while adjusted to pick up the full load under a standing start with the ram down against the work, is said to have been repeatedly thrown into engagement when the dies were together, thereby stopping the fly wheel in a short period of time. A test of this sort is a demonstration of the action which may be expected when the dies are brought together accidentally, generally the cause of breakage in machines of this type.



View Showing Rugged Construction of New Press Brake

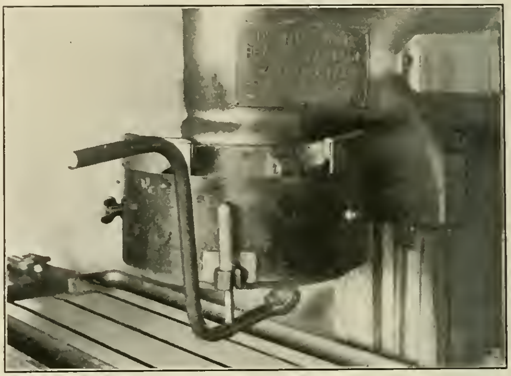
The advantages of this steel brake include: maximum strength and power with minimum weight; greatly reduced deflection over that generally found on machines of corresponding capacities; the open throat type of machine permitting continuous work, or the forming of sheets of greater width than the clear distance between the housings; reduced amount of head room required; quick action and increased operating speed; ease of installation and erection; and a high factor of safety against accidental injury to the machine.

These brakes are built in capacities ranging from 80 to 600 tons for working material from 10 gage to ¾ in. in thickness. The widths between housings are 6 ft. 6 in. to 14 ft. 6 in.; the weights 18,000 lb. to 120,000 lb.

Safety Wheel Dresser for Surface Grinders

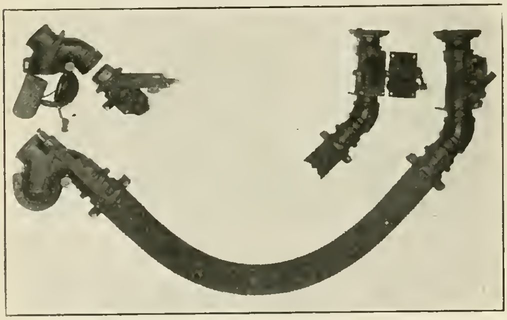
Many operators claim that satisfactory results cannot be obtained except by the hand method of wheel dressing, but this is more or less unsafe and is never advocated. The new style dresser brought out by the Pratt & Whitney Company, New York, for use on its vertical surface grinders is designed to give all the advantages of hand dressing without danger of injury to the operator. It consists of a bracket bolted or riveted to the wheel guard which supports the stem of the dresser. The dressing wheels are held in one end of the device, the bar being bent to fit under the wheel. The other end forms a handle so that the attachment can be easily moved into position. No change in the work and wheel relation is necessary and the device is said to be quick acting and thoroughly efficient. It may be readily applied to grinders now in use and is furnished as regular equipment on new machines.

Perhaps the most important feature of grinding machine operation is keeping the grinding wheels in proper condition. For smooth and accurate work the wheels must be true. Frequently, especially when grinding relatively soft metals, the grinding wheel surface becomes clogged and must be dressed. For this purpose the safety wheel dresser illustrated is effective and always ready. It can be used frequently on account of the ease and safety of operation, thus keeping abrasive wheels in first class condition.


Pratt & Whitney Safety Grinding Wheel Dresser

Safety Locomotive Feed Water Attachment

Simplicity of operation, the absence of threads, and all parts secured in position are three features of a new safety feed water connection between engine and tender, recently patented by W. F. Potts, Kansas City, Mo. This device has been tested for two years on a prominent railroad in the Middlewest with entirely satisfactory results. In the new design hose nuts and gaskets are eliminated by arranging a body casting having a taper socket which engages the hose sleeve; and a yoke that connects to the hose sleeve at lugs, swinging over a projection on the body. The yoke is provided with a taper key notched to engage a spring pawl. When the key is driven in place it draws the hose sleeve into the socket fit, making practically a solid connection with the spring pawl and automatically locking the key in the closed position. The key is provided with a cotter pin as security and has a fool proof stop preventing its abuse. A dowel through the key prevents it from being dropped out of the keyway.


Engine Connection (left); Tank Valve and Connection (right)

For examination and cleaning of the strainer, a screwless opening is provided in the body casting. The strainer is set on an angle allowing foreign matter to wash from the surface. The strainer opening also is provided with a depression cover which forms a trap, retaining the dirt that is drawn from the tank and washed from the strainer face. This also prevents the substance from returning to the low portion of the hose. The strainer cavity cover is held in position by a yoke, drawn up with a key and secured with a cotter pin. The strainer and yoke key are chained to their position, securing them from being lost or dropped. This arrangement forces the operator to replace the strainer before the dirt trap can be closed. The possibility of hose slipping off a hose sleeve is prevented by introducing a special clamp, made in halves and bridled to lugs on the hose sleeves. A durable clamp, easy to remove, is thus secured, clamping advantages being obtained by the use of two bolts with extension heads. The rear hose nut and gaskets are eliminated by screwing the hose sleeve on the pipe connection.

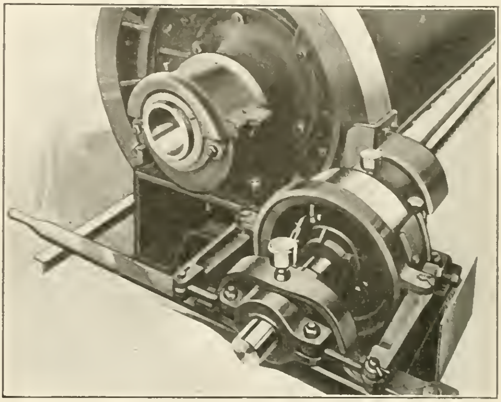
The tank valve body complete is placed on the bottom and outside of the tank. The valve is of brass and is held on a brass lever by cast yokes on the top of the valve, eliminating nuts and pins. The construction of the valve body is such that it is impossible to disconnect the valve while the valve hood cover is in position on the body casting. The valve in open position is back in the hood and engages a brass spring, which holds the valve and prevents vibration. The lever shaft is of brass arranged to be disassembled before it falls apart from the valve lever or handle.

The tank valve like the other parts was built to overcome common weaknesses and eliminate the necessity of going inside of the tank to make inspection and repair. The tank valve can be applied without getting on or going inside of the tank. It prevents frozen decks or steps due to leaking water bottom stuffing boxes and tank valve stems. It removes an obstruction, adds a valuable space on tank legs for engine equipment and gives an opportunity to locate the tank valve where it will not be damaged in derailment. It provides a standard valve for all engine tanks. The apparatus tested was put in service October 15, 1920, and is reported to have been in continuous operation since without developing a defect or costing anything for repairs. It is claimed that the tank valve can be closed, using so simple a tool as a rail spike, the yoke key tapped out, the strainer removed and replaced and the tank valve reopened ready to operate the injector in 17 seconds. This ease and speed of manipulation is a valuable feature for preventing locomotive delays.

Clutch and Brake for Tumbling Mills

THE desire to insure safety has resulted in many improvements in foundry and shop equipment as, for example, the combination clutch and brake mechanism for tumbling mills illustrated. This is a simple device, controlled by a hand lever and said to be fool proof. Shifting the lever towards the mill engages the clutch and starts the mill. To stop the mill, the lever is moved in the reverse direction, passing through neutral to the braking position.

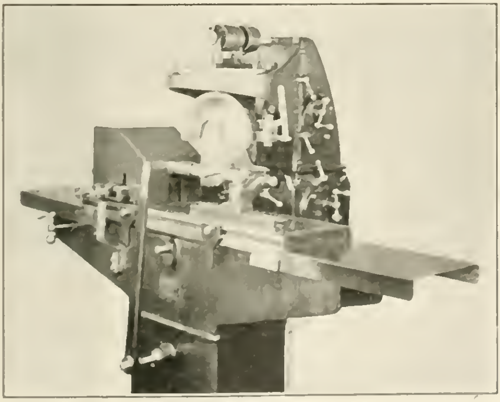
The advantages of such a mechanism are easily seen. A loaded mill can be brought to rest at exactly the right point for unloading and without loss of time. Holding the mill in place by a wood prop or a bolt thrust into the gearing, as is commonly done, is always dangerous. With the combination clutch and brake it is impossible for the barrel to turn after the brake is set, even though the barrel is unequally loaded. The new Whiting clutch and brake could doubtless be applied with advantage to tumbling mills used for various purposes in railroad shops and would be especially valuable if used in connection with the large number of flue rattling devices now in service. This mechanism has been devised and placed on the market by the Whiting Corporation, Harvey, Ill.



Whiting Safety Clutch and Brake

Machine for Sharpening Hobs and Form Cutters

TO meet the demand for an efficient hob grinder for use in shops where the number of hobs and form cutters to be ground does not warrant the purchase of a full automatic grinder, the Harris Engineering Company, Bridgeport, Conn., has developed the semi-automatic machine illustrated. The hob or cutter to be sharpened is carried on an arbor with a taper shank fitting into the work-carrying spindle; the outboard end of the work is supported by a center in an adjustable tailstock. On account of the table being mounted on ball-bearings, the action is so sensitive that the operator can tell from the feel on the handle of the long lever whether the grinding is too heavy or too fast.



Harris Semi-Automatic Hob and Form Cutter Sharpener

Hobs having helical flutes are rotated during the travel of the table by a sine bar, instantly adjustable to different angles, which actuates a cross-slide carrying a rack meshing into a gear on the work spindle. Two sets of notches are provided on the index plates, one for indexing and the other for escapement. They are designed to prevent wear on the notches used for indexing. The indexing mechanism is semi-automatic and can only operate at the end of the return stroke. At this point the operator with his left hand pulls the hand wheel as far forward as it will go and the hob is then indexed to the next flute.

The grinding wheel spindle is driven by an endless open belt of heavy leather without twists or idler pulleys and of sufficient thickness to transmit the necessary horsepower to the 8-in. special form wheel used. An important feature is the diamond truing device for dressing the wheel, built into the head and always in position or use without disturbing the work. Another advantage is the arangement to true the wheel to grind the faces of hob teeth radial, or with a top rake if desired.

These machines are furnished with countershaft drive or individual motor drive. The table travel is 15 in. with a maximum diameter and length of work of 8 in. and 10 in. respectively. Hobs with 4 to 26 flutes may be accommodated. The maximum helix of the flute is 47 deg. and 8 in. diameter. The wheel is designed to be run at a speed of 2,700 r. p. m.

GENERAL NEWS

The Erie has cancelled its contract with the Hornell Machinery Company which has been operating its shops at Hornell, N. Y., and at one or two other terminals.

The shopmen of the Central of Georgia have organized two unions, one the Central of Georgia carmen's organization and the other the Central of Georgia metal trades' organization. C. O. Voss, of Savannah, is chairman of the carmen, and W. J. Bice, also of Savannah, a boilermaker, is chairman of the metal trades. It is said that the new unions have already made contracts with the railroad company, which conform to the rulings of the United States Labor Board.

The Engineering Institute of Canada held a general professional meeting at Winnipeg, Man., on September 5-7, with headquarters at the Fort Garry Hotel. The program on Tuesday included descriptions of the Winnipeg hydro-electric plant and the Manitoba Power Company's development at Great Falls. On the following day these plants were visited by special train. On Thursday papers were presented on the construction of the Moncton yard and engine facilities of the Canadian National by S. B. Wass and on automatic grain car unloaders for the Canadian National Railways at Port Arthur by Fred Newell.

The Paris-Orleans Railway (France) has placed an order for 80 electric locomotives with the Société Oerlikon and the Société de Construction des Batignolles, both of Paris; these locomotives are each for a one hour rating of 1,720 hp. The Société Oerlikon is to supply and erect the electrical equipment, while the Société de Construction des Batignolles deals with the mechanical part. Except in the case of the five first locomotives, which will be completed at the Swiss works of the Ateliers de Construction Oerlikon, and will serve as models, the whole electrical equipment will be built in France, to the Oerlikon design, at the works of the Société Oerlikon. The locomotives are specially intended for freight trains and are to be capable of hauling a load up to 1,200 tons; they are, also, to be suitable for passenger service, in which case a speed of about 68 miles per hour must be attainable.

Ball Bearings for Journal Boxes

The Swedish branch of the Skefko Ball Bearing Company, Limited, has secured an order from the Swedish States Railways for 1,360 journal boxes for passenger coaches.

British Concern Gets Order for 21 Locomotives

The British firm of Sir W. G. Armstrong, Whitworth & Company has, according to The Engineer (London), received from the Bengal North Western Railway an order for 21 locomotives.

English Coal Strike's Cost to Railway Employees

According to the financial report of the National Union of Railwaymen, the miners' strike of last year cost the railwaymen's organization nearly £750,000 ($3,645,000 at the normal rate of exchange) in unemployment payments.

New Union on M. & St. L.

The shop employees of the Minneapolis & St. Louis have organized a new union under the leadership of W. A. Liehl, who has been elected president. "We have formed this association at the suggestion of the wage board," Mr. Liehl said. "We have a set of officers who can be dealt with and, in a diplomatic way can settle disputes, thus avoiding friction and strikes. Our organization will extend to all the shops of the road. I believe that 75 per cent of the striking shopmen who are out did not go out of their own free will; and they fear the torrent of abuse they would get if they went back to work."

Two Swiss Railways Electrified Throughout

The St. Gotthard line in Switzerland is now completely electrified for both freight and passenger service. The line extends from Lucerne to Chiasso on the Italian border, a distance of about 180 miles. Grades of 2.5 per cent are common and there are many tunnels, the longest of which is 9¼ miles. Completion of the electric operation of the Rhaetian Railways in Switzerland was celebrated in May of this year.

Technical Details of Portuguese Railway Equipment

Consul General Hollis at Lisbon has prepared a report called "Equipment on Portuguese Railways," which can be obtained by any interested manufacturer by applying to the Bureau of Foreign & Domestic Commerce, Washington, D. C., and asking for exhibit No. 64991. This report shows the various standard types of locomotives and freight and passenger cars in use on Portuguese railways, giving complete technical details.

Northern Pacific Sued by Strikers

Former Northern Pacific shopmen at Pasco, Wash., 28 in number, have filed suits against that railroad for $1,000 each, as damages for alleged refusal of the company to employ them. After the strike was declared the railroad management decided to build a fence around the shops at Pasco, and a contract for building the fence was let to a construction concern. The 28 idle shopmen applied for work on this job, but were rejected.

Study of Alloy Steels

The results of studies in the experimental production of certain alloy steels are given in bulletin 199, by H. W. Gillett, chief alloy chemist, and E. L. Mack, assistant alloy chemist, which has just been published by the United States Bureau of Mines. It contains detailed information regarding tests made with uranium, silicon, manganese, molybdenum, chromium, nickel, copper-nickel, aluminum, zirconium, cerium and boron as alloying agents.

Handbook of United States Safety Appliances

In response to demand from the members, another edition of the small Safety Appliance Handbook, covering all classes of cars and locomotives, for use of inspectors and others, similar to that issued in 1915 by the Master Car Builders' Association, revised to date, has been issued by the Mechanical Division of the American Railway Association. These books will be supplied on requisition to members or others by the secretary.

Indian Railways to Buy Locomotives and Cars

The East Indian Railway, according to Modern Transport (London), will during the fiscal year 1923-24 add 37 locomotives to its supply of motive power and contemplates similar additions annually for the next few years. From 2,000 to 3,000 goods wagons will be acquired annually during the next five years, and 136 passenger cars will be purchased before March, 1923. The road is also doing a considerable amount of double tracking.

The Bengal-Napur Railway will spend 1,567,000 rupees for passenger cars and 11,630,000 rupees for goods wagons (one rupee equals 32.4 cents at par).

New Cars in 1922

The railroads of the United States, in the seven months from January 1 to August 1, this year, had 25,763 more new freight cars, either ordered and under construction or installed in actual service, than during the entire year of 1921, according to a statement issued by the Association of Railway Executives; seven months this year, 95,199 cars; 12 months of 1921, a total of 69,436.

Of the total ordered or installed this year, 41,405 were coal cars and 39,612 were box cars. The railroads are also augmenting their supply of refrigerator cars. On August 1, 3,870 had actually been placed in service, while 6,428 more had been ordered.

Coroner's Jury Reports on P. R. R. Car Shop Fire

The fire at Pittsburgh, Pa., on September 3, in which seven employees of the Pennsylvania Railroad were burned to death in their lodging room, has been investigated by a coroner's jury and a verdict was rendered on September 13 to the effect that the origin of the fire could not be discovered. The verdict censures the officers and employees of the railroad company for housing 25 men in a building containing a large quantity of inflammable material, including oil-soaked waste and petrolite; for making changes to convert this shop or storehouse into lodgings without securing a permit from the city, and for maintaining an exit stairway too narrow. The verdict also said that the railroad company had fire-fighting equipment in and near the building, but had no efficient organization for handling the apparatus.

French Railway Orders Control Equipment for 120 Electric Locomotives

An order covering the complete control equipment for 120 electric locomotives, now under construction, has been received by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., from the Paris-Orleans Railway of France, as part of an electrification contract amounting to approximately $8,000,000.

The Paris-Orleans Railway, which is one of the largest systems in France, operating over 5,000 route miles of track, is electrifying 125 miles of its main line between Paris and Vierzon. This is the first of an extensive program laid out by the Paris-Orleans for the electrification of its lines.

The complete order of control equipment will be manufactured in the United States and shipment of this order will commence in January, 1923, and extend to December, 1924.

Labor Board Again Rules Against Contracting

Several decisions directed against the practice of contracting on various railroads were handed down by the Labor Board on September 11 and subsequent days. These decisions, involving the Erie; the New York Central; the San Antonio, Uvalde & Gulf; the Great Northern; the Chicago and North Western; the Cincinnati, Indianapolis & Western; the Chicago, Milwaukee & St. Paul, and the Chicago Great Western, follow, practically word for word, the Board's ruling in the Indian Harbor Belt case, described in full in the *Railway Age* of May 13, page 1111.

In every case the practice complained of by the employees had been discontinued before or soon after the strike of shopmen began on July 1. At the Board's inquiry on June 31 into the strike situation all of the roads involved in these decisions, except the Erie, announced the discontinuance of the practice of contracting or made a promise to do so as soon as possible.

South African Railways Ask Bids on Power Plant Equipment

Tenders are invited for the supply and erection in South Africa in connection with the electrification of the South African Railways and for use in the Maritzburg-Glencoe power house, of the undermentioned plants: coal handling plant, ash handling plant and circulating water plant. Specifications, blue prints and forms of tender for each of the above sections may be obtained from the office of the High Commissioner for the Union of South Africa, Trafalgar Square, London, W. C. 2, England. The charge for each specification is £5:5:0 for the first copy and £2:2 0 each for any further copies. Sums paid for any number of each specification up to three will be refunded on receipt of bona-fide tenders. Sealed tenders are to be addressed to the Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, London, England, and to be delivered in duplicate not later than noon on Wednesday, October 18, 1922.

Suspension of Hydrostatic Tests of Tanks of Tank Cars and Safety Valve Tests

The Mechanical Division of the American Railway Association has announced that upon recommendation from the Committee on Tank Cars, that part of Sections 23 and 24 of the Standard Specifications for Tank Cars, Classes I, II, III and IV, covering the requirements of testing of tanks hydraulically and testing of safety valves, has been suspended as to tanks for which such tests shall become due prior to January 1, 1923, except when such cars are shopped for repairs.

The requirements of Section 23 of each of the specifications named, that new tanks shall be tested before being put into service, and that tanks damaged to the extent of requiring patching or renewal of one or more sheets, or extensive reriveting or recalking of seams, shall be retested before being returned to service, are not suspended.

The requirements of Section 24 of each of the specifications named, that safety valves on new cars shall be tested and adjusted before cars are placed in service, are not suspended.

Australian Road Uses Motor Cars

The Victorian Railways, Australia, have adopted the rail motor car to handle passenger traffic on short spur lines and over other sections where it is uneconomical to provide a service of steam trains, says the Times (London) Trade Supplement. Experiments in the past have been made with steam and gasoline cars, but for various reasons these have failed to give satisfaction. In the new system an ordinary motor-truck chassis is used as the power unit, the steering gear being removed and standard railway tires fitted to the wheels. The car, which has been designed to provide the maximum of floor space, has a seating capacity for 43 persons and all unnecessary tare weight has been eliminated. It is open at the sides, but is provided with blinds, which can be lowered for protection against inclement weather. The seats all face to the front and are of the usual tramcar type, and while they afford little lodgement for dust, provide ample comfort for short journeys. Hand luggage and parcels can be accommodated under the seats and the doors have been arranged near the front end so that the driver may be able conveniently to collect fares and issue tickets to passengers. A trailer built on similar lightweight lines has also been constructed and will be attached to the rail motor-car as traffic requirements warrant. Both the motor-car and the trailer are lighted by electricity. The maximum speed will be from 25 to 30 m. p. h., but the average speed will be considerably less, depending on the frequency of stops.

Continuous Brakes Advocated in England

The beneficial effect likely to be exercised upon safety in railway operation by the use of automatic brakes upon freight trains cannot be appreciated without taking into consideration other statistics than those furnished by an examination of the accidents officially inquired into, said Col. J. W. Pringle, chief inspecting officer of the Ministry of Transport (England), in addressing the British Institute of Transport. It has been mentioned that, in the year 1921, there were 8,876 cases of trains dividing. Of these, 6,354 were concerned with freight trains (not equipped with automatic brakes), and 2,522 with passenger trains. The accidents resulting from these cases of division were 50 and 5, respectively. The liability to accident from division appears, therefore, to be four times as great in the case of trains not equipped with automatic brakes. It is estimated that, in the 50 cases of accident due to break-in-twos of freight trains, more than half would have been prevented by use of an automatic brake. A number of crossing accidents also yearly result from difficulties experienced in controlling, or by misjudgment of breaking effect upon, trains not equipped with air or vacuum brakes. These would also be prevented by use of a continuous brake. Apart altogether from the increased capacity upon lines of railway which would result from the use of continuous brakes upon freight trains, it may be noted that the cost of introducing an acceptable system of automatic train control will be approximately doubled as the large majority of freight trains are unfitted with a continuous brake.

Electric Trains May Be Run Over M. K. & T. Line

A contract is now in process of negotiation between the Missouri, Kansas & Texas and electric power interests which if consummated will furnish electric passenger service between Dallas and Denton, Tex., a distance of 48 miles.

It is proposed that the electrical interests shall lease the trackage rights and that electrification of the line will in no way interfere with the operation of freight trains on the line, nor with the operation of through passenger trains. Z. G. Hopkins, manager, Department of Public Relations, M. K. & T., states that at the present time no change is contemplated in the operation of M. K. & T. trains.

C. E. Calder, president of the Texas Power & Light Company and of the Dallas Power & Light Company, stated that a contract with the railroad for electrification would comply with an agreement made with the city of Dallas for the construction of an interurban line at least 30 miles in length which the Dallas Railway is under bond to build in order to fulfil the terms of an agreement entered into in connection with the granting of the franchises to the Strickland-Hobson interests in 1917. Electrification of the M. K. & T. from Dallas to Denton, according to Mr. Calder, will be an economic proposition from the standpoint of the railroad, as well as the electrical interests.

The railroad now operates six passenger trains on this line, two of which are night trains. It is the intention of the power company to run electric trains hourly. The cost of electrifying has been estimated at between $800,000 and $1,000,000.

Meetings and Conventions

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

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City. 1923 annual convention; Denver, first Tuesday in May.

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

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

Division V—Equipment Painting Division.—V. R. Hawthorne, Chicago. Annual meeting postponed.

Division V—Purchases and Stores.—W. J. Farrell, 30 Vesey St., New York.

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

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, A. F. Steubing, 2201 Woolworth Building, New York.

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

American Society for Steel Treating.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention and exposition postponed until October 2-7, 1922, Detroit, Mich.

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

Canadian Railway Club.—W. A. Booth, 53 Rushbrook St., Montreal, Que. Regular meeting second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal. Next meeting October 10. William Carter, assistant general sales manager, Canadian Ingersoll-Rand Company, will present a paper on Some Elements in Economy in Air Compression.

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

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo.

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill. Annual convention, November 6-8, Hotel Sherman, Chicago.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Regular meetings second Tuesday, February, May, September and November.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabash Ave., Winona, Minn. The 1922 annual convention has been cancelled.

Master Boilermakers' Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston Mass. October meeting postponed.

New York Railroad Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Regular meetings third Friday of each month, except June, July and August, at 29 West Thirty-ninth St., New York.

Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Next meeting October 26. Annual meeting. Election of officers. Smoker.

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

Traveling Engineers' Association. W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio. Annual meeting changed from September 12-15 to October 31 to November 3, 1922.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Regular meetings third Monday of each month, except June, July and August.

SUPPLY TRADE NOTES

H. C. Thomas, general superintendent of the United Alloy Steel Corporation, Canton, Ohio, has been promoted to assistant general manager.

The merger of the Bethlehem Steel Corporation and the Lackawanna Steel Company has been ratified at recent meetings of the stockholders of these companies.

The Chicago Flexible Shaft Company, Chicago, has opened a new district sales office at 305 Merchants Bank building, Indianapolis, Ind., in charge of F. W. Odemar.

The Economy Fuse & Manufacturing Company, Chicago, Ill., has moved its Detroit sales offices from the Majestic building in that city to the First National Bank building.

J. H. Rodger, western manager of the Safety Car Heating & Lighting Company, with headquarters at Chicago, has been promoted to vice-president with the same headquarters, in charge of that company's western business. Mr. Rodger entered the railway supply business in 1899, in the service of the Standard Coupler Company, which company he left in 1905 to become assistant to the president of the Monarch Machine Company, New York. In 1911, he became a sales agent of the Safety Car Heating & Lighting Company in its Chicago offices. He was promoted to western manager of that company in 1919, which position he was holding at the time of his recent promotion.

J. H. Rodger

Jay L. Hench, who resigned recently as Chicago district sales manager of the Lakawanna Steel Company, has formed Jay L. Hench & Co., 208 South La Salle street, Chicago, to engage in the purchase and sale of various iron and steel products including steel sheet piling, light and heavy tee rails, sheets, plates, shapes and bars with an additional line of open-hearth electric castings. Mr. Hench was born on April 11, 1885, at Hinsdale, Ill. He attended Cornell University from 1903 to 1905, specializing in iron and steel analysis. From 1905 to 1906 he was employed in the open-hearth and Bessemer departments of the Illinois Steel Company, and from 1906 until 1911 he was connected with the sales department of Joseph T. Ryerson & Son. He left in 1911 to become a sales agent of the Lackawanna Steel Company, having jurisdiction over the Indiana and Michigan territory. In May, 1919, he was promoted to district sales manager in charge of the Chicago office, which position he held up to the time of his resignation.

The Illinois Car Manufacturing Company, Hammond, Ind., has purchased the American Nut Company of Columbus, Ohio. It is said that the acquired business will be moved to Hammond.

The American Brake Shoe & Foundry Company, New York, has bought 17 acres of land at Portsmouth, Va., where it is proposed to erect a new plant in the near future for the manufacture of brake shoes.

The Norwalk Iron Works Company, South Norwalk, Conn., has been consolidated with the Automatic Carbonic Machine Company of Peoria, Ill. The plant and equipment of the latter company has been moved to South Norwalk.

The Ramapo Iron Works with plants at Hillburn and Niagara Falls, N. Y., and Niagara Falls, Ontario, and the Ajax Forge Company of Chicago with plants at Chicago and Superior, Wis., have been consolidated under the name of the Ramapo-Ajax Corporation, with J. B. Strong as president and headquarters at Hillburn. The control of the new company will be held by the American Brake Shoe & Foundry Company, New York.

J. M. Potter, treasurer of the Northwestern Malleable Iron Company, Milwaukee, Wis., died on September 6, at the age of 61 years. He had been connected with the above company for 32 years.

H. M. Aubrey, manager of the packing department of the Union Asbestos & Rubber Company, Chicago, has been appointed sales representative of that company in charge of the recently opened New York office, 30 Church street, New York City.

H. C. Mull, in charge of railway sales for both the Reliance Manufacturing Company, Chicago, and the Warren Tool & Forge Company, Warren, Ohio, with headquarters at Chicago, has resigned from the former and will hereafter represent only the latter, with headquarters at Warren, Ohio.

Frank Burr Smith, works manager of the Bullard Machine Tool Company, Bridgeport, Conn., died on August 16 at New Haven, Conn. Mr. Smith was born at Mohican Springs Farm, Fairfield, Conn., November 22, 1872, and obtained his early education in the public and high schools of Bridgeport, Conn. He entered the employ of the Bullard Machine Tool Company at its old Broad street plant in 1890 as a machinist apprentice. Upon completion of his apprenticeship he was connected with its engineering department. In 1894 he went to Colorado for his health and while there turned his attention to prospecting and mining for gold. Returning east in 1896, he was employed by various machine shops and at one time was prominently connected with the Atlantic Iron Works of Boston, Mass. He later entered the Laird Gold Production Company as a mechanical engineer in connection with its operations in the reclamation of gold from sea-water on the Maine coast. He was then transferred to the west coast, operating dry placer mines in Southern California. In 1903 he joined the De LaVergne Machine Company as an expert erection and installation engineer, and in 1911 returned to the Bullard Machine Tool Company, representing them in a sales capacity successively at Chicago, Cleveland, Philadelphia and in England. He then became manager of the employment and industrial relations department at the Broad street plant. When the Broad street plant was disbanded in 1920, and all manufacturing was transferred to the Black Rock plant, he was made works manager. Mr. Smith was prominently active in the mechanical development of Bullard products and his genius was further demonstrated by patents obtained in connection with mining and automotive industries. He was a member of the Algonquin Club of Bridgeport and of the Masonic Order.


F. B. Smith

C. T. Pratt, treasurer of the Brown Hoisting Machinery Company, Cleveland, Ohio, has resigned and A. C. Brown, president of that company, has assumed the additional duties of treasurer. J. F. Pierce has resigned as auditor and director of the same company. This latter vacancy probably will not be filled for the present.

The Walworth Realty Company, a subsidiary of the Walworth Manufacturing Company, Boston, Mass., manufacturers of pipe fittings, piping tools, etc., has awarded to Dwight P. Robinson & Co., Inc., New York, a contract for the design and construction of a warehouse, pipe shop and garage to be located at Jackson avenue, Long Island City, N. Y.

Russell, Holbrook & Henderson, 30 Church street, New York, has been appointed sales representatives for the territory in and near New York City of the Oilgear Company, Milwaukee, Wis. The Cadillac Machinery Company, Detroit, Mich., will handle Oilgear products in the state of Michigan and the R. E. Ellis Engineering Company, 621 Washington boulevard, Chicago, will represent the Oilgear Company in Chicago and the surrounding territory.

W. H. Woodin, president of the American Car & Foundry Company, New York, was appointed fuel administrator of the state of New York on September 5 by Governor Miller under the act of the extraordinary session of the Legislature. Mr. Woodin will serve without compensation and will succeed the governor's advisory coal commission.

The National Lock Washer Company, Newark, N. J., is building a new two-story brick structure, 84 ft. by 40 ft., at the corner of Pennington and Hermon streets, the top floor of which will be used for office purposes and the ground floor for shipments. The company is also putting up a steel storage building 100 ft. by 60 ft. for additional storage purposes, and is also rearranging the equipment in its fabricating machine shop and making general improvements throughout the entire plant.

John S. Ruble, who recently resigned as vice-president of the Austin Company, has been elected vice-president in charge of all construction of the H. K. Ferguson Company, engineers and builders, Cleveland, Ohio. Mr. Ruble was graduated in mechanical engineering from Pennsylvania State College in 1901. He was then engaged for four years in dock, ore storage and unloading equipment design and construction with Hoover & Mason, contracting engineers. He subsequently served for eight years as an engineer with the U. S. Steel Corporation at various places, then as construction engineer for the Tennessee Coal, Iron & Railroad Company, at Birmingham, Ala.

Frederick W. Cooke, formerly general manager of the Cooke Locomotive Works, died on August 30 at his summer home at Quogue, Long Island. Mr. Cooke was born on July 10, 1860, at Paterson, N. J., and graduated from Stevens Institute in 1882. He served as vice-president and general manager of the Cooke Works from 1883 until the plant was sold in 1901 to the American Locomotive Company and then was general manager until his resignation in 1912. The Cooke Works originated as the Charles Danforth Company, manufacturer of cotton machinery at Paterson, N. J. In 1852 John Cooke became associated with these interests and a new company was organized in July of that year under the name of Danforth, Cooke & Company, Paterson, N. J., to build machinery and locomotives; and it continued under this name until 1865 when the name was changed to the Danforth Locomotive & Machine Company, of which John Cooke was the head and active manager of the locomotive branch. The business soon outgrew the machine interest and the latter was given up entirely some years later. John Cooke died in February, 1882, and was succeeded by his brother, James Cooke, formerly superintendent. The latter died on August 2, 1883, shortly after which date the stock control passed into the hands of the Cookes and the corporate name was changed to the Cooke Locomotive & Machine Company with John S. Cooke, president, and Frederick W. Cooke, vice-president and general manager. The business increased and work was started in 1888 on new works on the present site. In 1901 the works were sold to the American Locomotive Company and became the Cooke Works of that company. Mr. Cooke continued as general manager until his retirement in 1912. During the late war Frederick W. Cooke took an active part in the raising of funds for the various war reliefs.


Frederick W. Cooke

John H. Flagler, who organized the National Tube Company and served as its president until it was merged with the United

States Steel Corporation, died on September 8 at his country home in Greenwich, Conn.

H. A. Matthews, formerly sales manager of the railway division of the U. S. Light & Heat Corporation, Niagara Falls, N. Y., has been elected a vice-president, sales railway division. Mr. Matthews entered the railway supply business in 1912 with the U. S. Light & Heat Corporation at Chicago. Prior to that time he had been employed by the Lake Shore & Michigan Southern as clerk to the general superintendent at Cleveland, and later entered the services of the Pullman Company. For seven years he was secretary to the president of the Pullman Company, which position he held up to the time he joined the U. S. L. forces at Chicago. In 1917 he was transferred to the factory at Niagara Falls and placed in charge of the railway sales department.

The American Flexible Bolt Company announces a complete reorganization with general offices at Zelienople, Pa. The reorganized company retains the original charter but has added additional working capital. There is also a complete change in the board of directors. Stephen Robinson, Jr., is now president and in charge of sales; H. T. Frauenheim, vice-president; Chas. A. Seley, consulting engineer and district representative at Chicago; J. A. Trainor, Eastern district representative; L. W. Widmeier, Cleveland district representative; E. F. Boyle, Western district representative; H. G. Doran & Co., Chicago, representative; W. F. Heacock, Chicago, representative. The plant management will be under the supervision of L. Finegan, formerly shop superintendent, Mt. Clare shops, Baltimore & Ohio. The purchasing will be handled by Jas. F. McGann at Zelienople, Pa.

Federal Trade Commission Opposes Steel Merger

The Federal Trade Commission on August 31 issued a formal complaint charging that the proposed merger of the Midvale, Republic and Inland steel companies would be an unfair method of competition in violation of the federal trade commission act. The companies are given 30 days to file answers, after which hearings will be held. The commission says that after preliminary inquiry it has reason to believe that the merger of these three competing companies will center the control of some 35 corporations in one group and eliminate competition, restrain trade and tend to create monopoly in iron and steel products in interstate commerce. The Department of Justice had previously made a favorable report on the proposed merger. Commissioner Van Fleet voted against the issue of the complaint.

TRADE PUBLICATIONS

Milling Machine.—The Pawling & Harnischfeger Company, Milwaukee, Wis., has issued bulletin No. 3-T covering a new table type horizontal boring, drilling and milling machine.

Drinking Water Systems.—A folder entitled, "A Neglected Source of Economy," has recently been issued by the Armstrong Cork & Insulation Company, Pittsburgh, Pa., which deals with the savings that can be effected in shops by the use of refrigerated drinking water systems.

Insulating Compounds.—A small 16-page booklet has just been issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., which describes the insulating and soldering compounds manufactured by that company. The materials treated in the publication are baking varnishes, air-drying varnishes, insulating compounds, finishing materials, insulating glue, soldering flux, and lubricating oil.

Boiler Tube Cleaners.—The problem of eliminating the heat waste due to the formation of scale in boilers is dealt with at length in a catalogue sent out by the Liberty Manufacturing Company, Pittsburgh, Pa. Water turbine cleaners of various types, equipped with different style heads are described with the special uses for which they are best adapted. Pneumatic cleaners of high power in which steam can also be used are also illustrated and described. Mention is made of pneumatic cleaners for fire tube and return tubular boilers, arch tube cleaners and special cutting heads.

Schoop Metal Spraying Process.—The Metals Coating Company of America, Philadelphia, Pa., has recently issued a large size, 18-page, illustrated bulletin descriptive of the metal spraying process developed by that company. The bulletin discusses fully the details of the process and the equipment, showing both by text and by numerous illustrations the various forms and classes of structures, such as bridges, pipe, car frames, towers, etc., which can be treated by this process of spraying on a thin coating of such metals as zinc, lead, aluminum, tin, copper, etc., for protection against corrosion and other destructive agents.

Direct Drive Axle Generator.—Specifications and description of a direct drive axle generator and system for the electric lighting of railway cars are contained in a 16-page bulletin published by the Products Distributing Corporation, 360 Madison avenue, New York, N. Y. The equipment described in this bulletin will be offered to the railroads by the above company and will be built by the Wagner Electric Company, St. Louis, under the E. M. Fitz patents. The booklet is profusely illustrated with photographs and line drawings and contains brief specifications and descriptions of the equipment. A blue print insert is included on which curves are shown giving the characteristics of the generator.

Train Lighting Equipment.—The Safety Car Heating & Lighting Company has recently issued two new catalogues and an elaborate folder which will be of interest to anyone connected with train lighting work and of especial interest to the users of safety equipment. One of the catalogues bears the title, "Operation of Under-Frame Car Lighting Equipment" and the other, "Pintsch Gas Car Lighting Fixtures." Both catalogues are profusely illustrated and contain 60 and 52 pages respectively. A novel and useful feature has been introduced in the Under-Frame catalogue, which consists of cross-indexed tables which show at a glance which of the various generator parts can be used interchangeably on two or more of the ten types of generators manufactured by the Safety Company.

Foundry Equipment.—The Whiting Corporation, Harvey, Ill., has issued four new catalogues which supersede previous issues on the same subjects. These cover the following types of apparatus: Catalogue No. 161, ladles, lists a complete line of metal and slag ladles, both plain and geared, of the hand, crane, truck, trolley and reservoir types; Catalogue No. 162, tumbling mills, describing many sizes and types of mills for cleaning castings, with information in regard to construction and illustrations of a number of installations; Catalogue No. 163, core oven equipment, is devoted to core ovens together with racks, cars, trucks and core benches, and includes a number of illustrations of different types of core rooms; Catalogue No. 164, trucks and turntables, covers details of industrial railways and their equipment for foundry uses.

Certified Malleable Iron.—The daily service that is being rendered by one of the most important branches of the iron and steel business is outlined in a book, entitled "Certified Malleable in Transportation and Industry," issued by the American Malleable Castings Association, Cleveland, Ohio. It tells in an interesting way the story of certified malleable castings and their contribution to safety, strength and economy.

The book points out the great responsibility that malleable castings assume when used for vital parts of railway and general industrial equipment, and also describes the methods employed by the American Malleable Castings Association in bringing the product of its members to a uniformly high standard and maintaining it at that point. By standardizing the manufacturing processes of an industry, scientists and practical foundrymen, operating through the American Malleable Castings Association, have produced certified malleable, a superior metal assuring high strength and ductility.

In the strict supervision of the product of its members, the work of the association parallels the activities of the trade guilds of the middle ages whose chief reason for existence was the guardianship of the consumers' interests. They saw to it that their members conformed to adopted standards of material and craftsmanship, and their supervision was accepted by the careful buyer as a certain guaranty of quality. The book is a complete treatise on the subject of malleable iron and gives information regarding the properties of the metal that are of interest and value to all users.

EQUIPMENT AND SHOPS

Locomotive Orders

The Atlantic Coast Line has ordered 25 Pacific type locomotives from the Baldwin Locomotive Works.

The St. Louis-San Francisco has ordered 35 Mikado and 15 Mountain type locomotives from the Baldwin Locomotive Works.

The Chesapeake & Ohio has ordered 50 Mallet type locomotives from the American Locomotive Company to be built at its Schenectady, N. Y., works.

The Pennsylvania has placed orders for 15 new locomotives for passenger service to be built by the company's forces at Altoona, and for 100 freight locomotives to be built by the Baldwin Locomotive Works.

The Delaware, Lackawanna & Western has ordered 15 Mikado type locomotives from the American Locomotive Company. These locomotives will have 28 by 32 in. cylinders and a total weight in working order of 355,000 lb.

The Baltimore & Ohio has placed an order for 50 Mikado type locomotives with the Baldwin Locomotive Works. These are in addition to the 15 Pacific type ordered from the Baldwin Locomotive Works as noted in the September issue.

The Norfolk & Western has ordered 30 Mallet type locomotives from the American Locomotive Company and 12 Mountain type locomotives from the Baldwin Locomotive Works. The Mallet type will have 25 and 39 by 32 in. cylinders and a total weight in working order of 531,000 lb.

The New York Central has ordered 90 locomotives—50 Pacific type and 40 Mikado type. The Pacific locomotives will have 23½ by 26 in. cylinders and a total weight in working order of 288,000 lb., and the Mikado locomotives will have 28 by 30 in. cylinders and a total weight in working order of 340,000 lb.

The Chicago & North Western has ordered 40 Mikado type and 10 Pacific type locomotives from the American Locomotive Company. The Mikados will have 27 in. by 32 in. cylinders and a total weight in working order of 307,000 lb., and the Pacifics will have 25 in. by 28 in. cylinders and a total weight in working order of 273,000 lb.

The Texas & Pacific has ordered 8 Pacific type and 8 switching locomotives from the American Locomotive Company. The Pacific type will have 26 by 28 in. cylinders and a total weight in working order of 281,000 lb. The six-wheel switching locomotives will have 21 by 28 in. cylinders and a total weight in working order of 164,000 lb.

The Missouri-Pacific has ordered 46 Mikado type and 4 Mountain type locomotives, from the American Locomotive Company. The Mikado type will have 27 in. by 32 in. cylinders and a total weight in working order of 320,000 lb., and the Mountain type will have 27 in. by 30 in. cylinders and a total weight in working order of 335,000 lb.

The Louisville & Nashville, reported in the September *Railway Mechanical Engineer* as having ordered 30 Mikado type locomotives, has ordered 12 additional Mikado locomotives from the American Locomotive Company. These locomotives will have 27 in. by 32 in. cylinders and a total weight in working order of 320,000 lb. This road ordered also 8 Mikado type locomotives from the Baldwin Locomotive Works.

Locomotive Repairs

The Erie will have repairs made to about 100 locomotives at the shops of the Crucible Steel Company, Harrison, N. J.

Freight Car Orders

The Northern Pacific has ordered 1,000 center constructions from the Western Steel Car & Foundry Company.

The Baltimore & Ohio has ordered 1,000 steel hopper cars of 55 tons' capacity from the American Car & Foundry Company.

The Texas & Pacific has placed an order with the American Car & Foundry Company for 150, 10,000 gal. tank cars of 50 tons' capacity.

The Czarnikow-Rionda Company, 112 Wall street, New York City, has ordered 40 cane cars of 30 tons' capacity from the Magor Car Corporation.

The Phillips Petroleum Company, Bartlesville, Okla., has ordered 75 insulated tank cars of 8,000 gal. capacity from the Standard Tank Car Company.

The Roxanna Petroleum Company, St. Louis, Mo., has ordered 50 insulated tank cars of 8,000 gal. capacity from the Standard Tank Car Company.

The Champlin Refining Company, Enid, Okla., has ordered 500 tank cars of 8,000 gal. capacity with 40-ton trucks, from the Pennsylvania Tank Car Company.

The Illinois Central has ordered 75 caboose cars from the American Car & Foundry Company. The cars are to have steel underframes and are to have a capacity of 30,000 lb.

St. Louis-San Francisco has ordered 1,000 hopper cars from the Chickasaw Ship Building Company and 500 hopper cars from the Pullman Company; 1,200 box cars and 1,000 hopper car bodies of 55 tons' capacity from the American Car & Foundry Company and 300 stock cars from the Mount Vernon Car Manufacturing Company.

Freight Car Repairs

The Wabash will repair 500 box cars, 300 stock cars and 250 automobile cars.

The New York Central has let contracts for repairs to a total of 11,100 cars as follows:

New York Central

2,000 box, Ryan Car Company.
1,000 box, American Car & Foundry Company.
1,000 gondolas, American Car & Foundry Company.
2,000 box, Illinois Car & Manufacturing Company.
500 box, Buffalo Steel Car Company.
1,500 box, Streator Car Company.
400 gondolas, Steel Car Company.

Michigan Central

200 box, Streator Car Company.
1,000 box, Illinois Car & Manufacturing Company.

Toledo & Ohio Central

500 gondolas, Ralston Steel Car Company.

Cleveland, Cincinnati, Chicago & St. Louis

1,000 box, American Car & Foundry Company.

Passenger Cars

The Chicago & Eastern Illinois has ordered 17 steel baggage cars, 70 ft. long, from the Pullman Company.

The Atlantic Coast Line, reported in the July *Railway Mechanical Engineer* as having ordered 20 express cars and 10 coaches from the Bethlehem Shipbuilding Corporation, Harlan plant, has increased its order to 25 steel express cars and to 25 steel coaches.

Machinery and Tools

The Illinois Central has completed negotiations for $250,000 worth of machine tools, exclusive of motors.

The Atchison, Topeka & Santa Fe has ordered a 10-ton hand power crane from the Whiting Corporation.

The Union Pacific has placed orders with various companies for approximately $200,000 worth of machine tools.

The Missouri Pacific has ordered one 2,500-lb. single frame steam hammer from the Niles-Bement-Pond Company.

The Los Angeles Railway Corporation has ordered a No. 1 car wheel lathe from the Niles-Bement-Pond Company.

The Chicago, Burlington & Quincy has placed an order with the Whiting Corporation for two 125-ton electric overhead traveling cranes, one 125-ton hoist and one auxiliary 15-ton hoist.

The Chicago & North Western has ordered a coal handling gantry crane with a 1½ yd. bucket from the Milwaukee Electric

Crane & Manufacturing Company. The crane will be leased to the Armour Grain Company for use at its grain elevator in South Chicago.

Shops and Terminals

Denver & Rio Grande Western.—The proposed rehabilitation program budget includes $2,736,900 for new shops.

Illinois Central.—This company has awarded a contract for the rebuilding of its water treating plants at Dunlap, Iowa, and Manchester, and at La Salle, Ill., and Scales Mound to the International Filter Company, Chicago.

Union Pacific.—This company has awarded a contract to the Graver Corporation of Chicago, for the erection of a 200,000-gal. steel water storage tank at Ogallala, Neb., and an 800,000-gal. steel water storage tank at Council Bluffs, Iowa.

Lake Superior & Ishpeming.—This company will construct a steel repair shop, 69 ft. by 301 ft., a paint and coach shop, 48 ft. by 100 ft., and a woodmill, 47 ft. by 100 ft., at Marquette, Mich., the total cost of which is estimated at $250,000.

The Richmond, Fredericksburg & Potomac has awarded a contract to the Roberts & Schaefer Company, Chicago, for the construction of two 1,000-ton coaling stations to be erected at Acca yard, Richmond, Va., and Potomac yard, Alexandria.

Atchison, Topeka & Santa Fe.—This company has awarded a contract for the construction of a new boiler shop at Albuquerque, N. M., to C. A. Fellows & Co., Los Angeles, Cal.; also a contract for a machine shop at Waynoka, Okla., to E. Ware, El Paso, Tex. Contracts for the sash for these shops have been awarded to the Truscon Steel Company.

PERSONAL MENTION

GENERAL

Robert Collett has been appointed superintendent of fuel and locomotive performance of the New York Central with headquarters at New York.

J. J. Hanlin has been appointed assistant superintendent of motive power of the Seaboard Air Line, with headquarters at Portsmouth, Va.

B. F. Bardo has been appointed superintendent of electric transmission on the New Haven in charge of operation and maintenance of the wire plant between New York and Cedar Hill with headquarters at Cos Cob, Conn.; reporting to H. A. Shepard, general superintendent of electric transmission and communication. Mr. Bardo was born in Wilkes-Barre, Pa., December 16, 1889. He was educated in the Morris High School, New York City, and Cornell University, being graduated from the latter institution with a degree of mechanical engineer in 1913. After graduation he served for a little more than a year in the testing department of the General Electric Company at Schenectady, N. Y., and at Pittsfield, Mass. In August, 1914, he entered the services of the New York, New Haven & Hartford in the office of the superintendent of power. In October, 1915, Mr. Bardo was appointed inspector of power plants and in November, 1917, was promoted to engineer of power plants, serving in that capacity until his present appointment.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

R. D. Smith has been appointed master mechanic of the Interstate Railroad, with headquarters at Andover, Va., succeeding O. S. Kuhn, resigned.

SHOP AND ENGINEHOUSE

H. H. Stephens, mechanical superintendent of the Southern lines of the Western district of the Atchison, Topeka & Santa Fe, with headquarters at Amarillo, Tex., has been appointed superintendent of shops at Topeka, Kan., to succeed W. B. Deveny, deceased. E. E Machovec, division master mechanic, with headquarters at Argentine, Kan., has been promoted to mechanical superintendent of the Southern lines of the Western district with headquarters at Amarillo, Tex., to succeed Mr. Stephens. W. R. Harrison, master mechanic with headquarters at Chanute, Kan., has been transferred to Argentine, Kan., in place of Mr. Machovec. G. F. Tier, general foreman at Emporia, Kan., has been promoted to master mechanic with headquarters at Chanute, in place of Mr. Harrison.

PURCHASING AND STORES


G. Kefer

George Kefer, whose appointment as purchasing agent of the Long Island with headquarters at Jamaica, Queensborough, New York City, was announced in the September *Railway Mechanical Engineer*, was born in New York City on November 22, 1870. His early education was obtained in the public schools of Whitestone, Long Island. After graduation in 1885 Mr. Kefer entered the employ of the Long Island Railroad as a messenger in the accounting department, then located at Long Island City. He subsequently served in various clerical capacities in the same department. On November 1, 1889, he was appointed chief clerk to the purchasing agent, which position he held for about 33 years until his recent promotion to purchasing agent upon the retirement of Harrison B. Hodges.


H. B. Hodges

Harrison B. Hodges, purchasing agent for the Long Island at Jamaica, N. Y., retired on September 1 under the pension rules of the company. Mr. Hodges was born at Barre, Mass., on August 14, 1858, and after completing his grammar school education he attended the Boston Latin School and then specialized in the study of chemistry at the Universities of Leipsic, Heidelberg and Bonn in Germany. He also studied the engineering side of chemistry and building construction at the Polytechnicum in Aix-la-Chapel. He was then for five years instructor in chemistry and German at the Harvard University. In 1886 Mr. Hodges began railway work as chemist and superintendent of tests on the Union Pacific, remaining with that road until 1892 when he went to the Baltimore & Ohio as engineer of tests. In 1895 he was appointed superintendent of tests on the Southern Railway and on January 1, 1897, he became purchasing agent of the Long Island Railroad.

OBITUARY

W. B. Deveny, superintendent of shops of the Atchison, Topeka & Santa Fe, with headquarters at Topeka, Kan., died on August 22 as the result of an automobile accident.

John R. Schrader, general car foreman of the New York Central at Mott Haven, N. Y., died Friday, August 11. He was also second vice-president of the Central Railway Club.

Robert Quayle, who retired as general superintendent of motive power and machinery of the Chicago & North Western on May 1, 1922, died at his home in Oak Park, Ill., on September 13 at the age of 69.

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Why Not Grind Air Compressor Cylinders?

In few, if any, railroad shops are air compressor cylinders finished by grinding, although this is a practice which could apparently be introduced with considerable profit. It is true that with the powerful modern boring machines and heavy multiple-cutting tools rigidly supported, cast-iron air compressor cylinders can be bored with accuracy, smoothness and speed. In all three of these respects, however, a suitable grinding machine should be able to show substantial improvement. In fact, internal grinders have already demonstrated their ability to provide accuracy and smoothness in the bore of cylinders which so vitally affect air compressor efficiency. In addition, grinding undoubtedly affords a means of truing worn cylinders with the loss of the least amount of metal and consequently would give a substantial increase in the life of cylinders and bushings. When the enormous number of air compressors in use on American railroads is taken into consideration, it is evident that any method which increases compressor efficiency and provides a greater cylinder life will result in aggregate savings of large proportions.

Steel Treaters' and Drop Forgers' Conventions

Inspiring and instructive conventions were held by the American Society for Steel Treating and the American Drop Forging Institute last month in Detroit as described elsewhere in this issue. While much of the discussion pertained to production, forging and heat-treating problems seldom presented to railroad men, a large amount of information was brought out which would prove of immense value if applied in ordinary railroad shop practice. Because railroad shops are operated for the most part as repair units is no reason why they should not be conducted on a business basis, and no modern business man, doing as much forging and heat-treating work as the mechanical department men on the railroads, would miss an opportunity to attend the conventions mentioned and keep in touch with the latest thought along forging and heat-treating lines.

The railroads should encourage their blacksmith foremen, heat treaters and forging experts to belong to the American Society for Steel Treating and attend these conventions in order that they may benefit by hearing the papers on case-hardening, heat-treating, furnace construction, flow of metal under pressure, etc. The information which they would bring back to their shops and incorporate in local shop practice at the earliest possible opportunity would unquestionably save the railroads large amounts of money annually. These men should be allowed time and expenses for the trip, as is done by industrial concerns, because while it is true that the men benefit personally by the information and knowledge obtained, a far greater benefit accrues to the railroad which uses their knowledge. While all this is largely "water over the dam" as far as this year's conventions are concerned, responsible mechanical department officers should consider whether they have not missed a valuable opportunity to save money for the railroads by too rigid limitation of expense accounts. Steps should be taken to insure a good representation of railroad men at the Steel Treaters' and Drop Forgers' conventions next year.

"Haste Makes Waste"

The old saying that haste makes waste was never more true than when applied to the speeding of locomotive and car repair work to such an extent that proper care cannot be given the details. With an abnormally heavy coal traffic due to reopening the mines and a steady pickup in general business, there is little question that the railroads will be called upon this winter to handle a traffic in excess of their capacity. The great demand for locomotives and cars, therefore, will present a temptation to speed this equipment through the shops at such a rate that adequate repairs cannot be given. This practice should be guarded against as it is expensive in the long run and absolutely fails to relieve the situation, since equipment not properly repaired is almost sure to get out of order after being in service a short time. In that case, train delays occur while cutting out the defective equipment, which it would have been far better not to put in service. The truth of this statement has been amply demonstrated in the past when an overambitious shop superintendent, for example, has established a record (on paper) by turning out locomotives with undue haste. There is no excuse for slighting the repair work on cars and locomotives and no useful purpose is ever served by this practice.

Condenser Types for Locomotive Use

The steam locomotive with its reciprocating engine is unique in that it is the only form of large power plant where a condenser does not constitute a part of the equipment. In the marine and stationary fields, it has long been standard practice to condense the steam and utilize the heat drop through the lower range of pressures. That a condenser has not been used in locomotive practice is not due to a failure to recognize the economies that might be obtained, but to very real and important space and weight limitations. A condenser of any ordinary type is both heavy and bulky, while the large size of low pressure cylinders would present a difficult problem of design and considerably increase the dynamic augment. As soon as consideration is given to a turbine-driven locomotive, the situation changes noticeably. If a turbine is to be used, it becomes necessary to employ a relatively high vacuum if the real economies of the turbine are to be realized. When it is recognized that the relationship between the turbine and the condenser is so intimate that the success of the turbo-locomotive depends upon the degree of vacuum, the provision of a suitable condenser becomes of prime importance. Designing such a condenser is, however, a difficult problem.

The barometric type often used in stationary plants is clearly impractical. Surface condensers of the water-tube type are standard for marine service and extensively employed in stationary plants. Unfortunately, they are bulky and require a large volume of circulating water, factors which are of secondary importance in many places, but not in the locomotive field. Where the supply is limited, the circulating water may be re-cooled and used over again. This cooling implies evaporation and the losses from evaporation are much greater than is commonly recognized. This principle is employed for the condenser used with one of the turbine locomotives now in service. In this design the steam is passed through thin tubes which are cooled by the evaporation of water trickling over them. The statement has been made that the losses from evaporation are almost equal to the weight of steam condensed. It therefore is still necessary to haul and to replenish a considerable supply of water, even though the condensate is used over and over and the formation of boiler scale correspondingly reduced. For the Ljungstrom turbine-driven locomotive the designers adopted an air-cooled condenser which is one of the striking features of this remarkable locomotive. In addition to the adoption of the air-cooled principle, provision was made for carrying a considerable volume of condensate to act as a cold reservoir and thus equalize the work on the condenser and keep the amount of vacuum more nearly uniform. The operative results obtained show a high degree of vacuum. The tests were, however, conducted during cold weather. The vacuum and efficiency data during summer months unfortunately are not yet available.

A Short-Sighted Policy

As noted in an editorial published last month, the prices of machine tools have shown a distinct upward tendency since February of the present year. This has been caused by gradually increasing labor costs, material costs, and demand. It is significant to note that a strong eastern railroad, recognizing this tendency, has within the past few weeks ordered a large amount of machinery and equipment for a new shop which probably will not be completed inside of ten months. The intention obviously is to secure machine equipment needed for this shop before prices go any higher, and doubtless other railroads can profitably follow this example.

A short-sighted policy, on the other hand, the exact opposite of the one mentioned, has been followed by at least one large railroad operating out of Chicago. This road has sent out new requests for bids on a large machine list issued last May and absolutely refuses to consider any company which has increased prices since May. This railroad has in the past achieved the enviable reputation of being willing to pay a little more than the average price for a machine tool in order to obtain one capable of greater production. In the present instance, the road fails to realize that machine tool prices in February, and to a degree in May, were abnormally low due to the liquidation of large stocks of new and second-hand machines and the absence of an active demand. Obviously new machines built since May must be priced in accordance with the increased labor and material costs.

As has been consistently pointed out in these columns, the first cost of a machine tool is relatively of small importance compared to its productive capacity over a period of 15 to 20 years and the refusal to consider the quotations of manufacturers who have made any price advances since May certainly represents a reactionary attitude which will be detrimental to all concerned. With the present close competition in the machine tool industry, price is a fairly accurate measure of serviceability and a railroad which calmly, and with due deliberation, selects the cheapest tools has only itself to blame if inferior types are foisted on the mechanical department, which will doubtless be expected to get results just the same.

Peak machine tool prices were maintained roughly from June, 1920, to August, 1921. Then there was a decline, with the lowest prices quoted about February, 1922. Present prices are slightly higher, varying with different companies, but are still from 10 to 25 per cent below the peak. Competition is the life of trade, but it is not fair for the railroads to attempt to drive machine tool manufacturers back to price levels that entail loss, and this unfair policy will prove a boomerang against the roads which follow it. Shippers of considerable importance will be injured and the roads will get inferior machine tools.

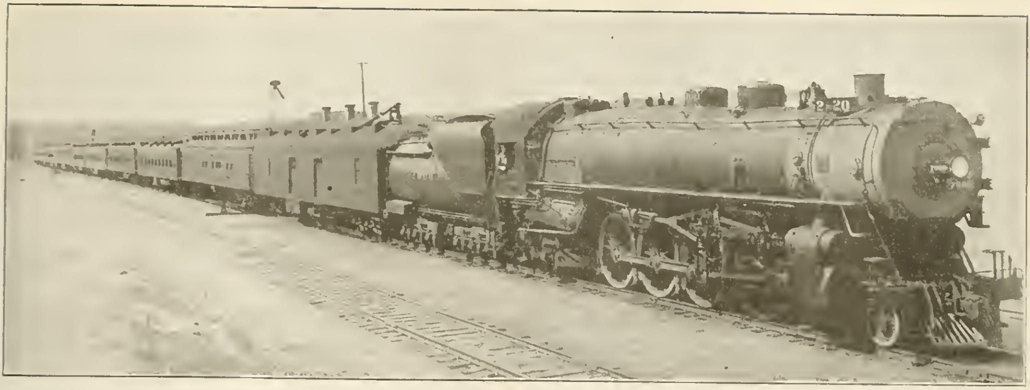
Stabilizing Shop Employment

A considerable fluctuation in the number of men employed and to a less extent a variation in the number of working hours per day at different times have caused many a good mechanic to quit railroad work and seek employment in industrial plants where working conditions were more stable. These conditions also have acted to deter new men from entering railroad work and have added to the difficulty of recruiting the ranks from outside sources during times of activity. A steady worker, especially one with a family, dreads the thought of unemployment. The practice of employing a full force of men and working overtime when traffic is heavy and income is good and on the other hand cutting forces to the bone and working short hours when traffic is unusually light, is far too common in all departments of railroad work. The practice is short-sighted and expensive in the long run, as well as demoralizing to the working forces.

It is not unusual to find a railroad shop running with a relatively small force during the summer and fall when working conditions are most favorable and then when a rush of traffic or severe winter weather have made demands for equipment that cannot be met almost anyone obtainable is hired and worked overtime. Work that is rushed is frequently slighted but time is the big element and locomotives and cars are turned out even though some of the work is poor and an engine failure occurs as a result. High pressure production is not economical beyond a certain point.

Another point that should not be forgotten although it is frequently overlooked by railroad mechanical officers is that overhead expenses go on steadily no matter whether a shop is operated at full capacity or whether it is shut down. It is there even though the methods of accounting do not cause it to stand out clearly. In some ways industrial plants may be no better managed than railroad shops, but there appears to be a more general and a better understanding of the importance of stabilizing production and thus avoiding either high or low peaks as much as possible. Wherever practical, manufacturing to stock or a diversification of product is resorted to in order to hold the working force together during periods of depression. If railroads would use a yearly budget system for shop operation expenses, instead of varying the amount from month to month dependent upon current earnings, equipment could be more economically maintained and could be put in better shape to handle a rush of traffic when it came. When cars and locomotives are needed badly on the road, is a poor time to take them in for an overhauling.

In the new shop agreement between the Union Pacific and its shop forces there is an article which provides by mutual agreement for a variation from a bulletined minimum of 35 hours to a maximum of 58 working hours per week before overtime is allowed. This will greatly reduce the necessity of increasing or decreasing the number of men employed at different periods and should result in the building up of a better organization with fewer floaters. At no time has there been a greater need of bringing about a better understanding between the managements and the men than the present, nor has there been a time when co-operation would result in larger benefits to all concerned. Nothing which tends to improve the relationship should be neglected.



Locomotive 7000 Hauls 11 Steel Cars Over a Heavy Grade Division

Service Records of U. P. Mountain Type Locomotive

Performance Indicates That No. 7000 Exceeds Both Theoretical Starting and Horsepower Capacity

THE lightest Mountain type locomotive in proportion to maximum horsepower capacity which has yet been built, was delivered to the Union Pacific by the American Locomotive Company late in May, 1922. From the date of breaking in during the last week in May to July 3, this locomotive made 10,000 miles, at the rate of 300 miles a day, and up to the end of August had made a total of 28,000 miles. Much of the service during this time has been made on runs of approximately 500 miles in length, some of which have been made without cleaning either the fire or the ash pan.

This locomotive, a description of which has already appeared in these columns,* has a total weight of 345,000 lb., of which 230,000 lb. is on the drivers, and a rated tractive effort of 54,800 lb. It has 73-in. driving wheels, 29-in. by 28-in. cylinders and a boiler pressure of 200 lb. per sq. in.

Engine No. 7000 and the 54 additional locomotives of the same type which have since been ordered, were built for use in passenger service between Cheyenne, Wyo., and Ogden, Utah, a distance of 484 miles in which are encountered numerous long grades. The character of the line, which is shown in the accompanying profile, is such that passenger trains have been handled by Mikado type locomotives. With these engines it has been necessary to maintain high running speeds on the down grades in order to maintain the passenger train schedules with the comparatively low speeds which can be made on the up grades. The high sustained capacity of the Mountain type locomotive was expected to maintain the schedules with less extreme variations from the average speed.

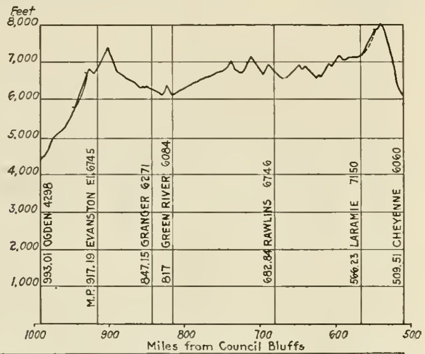
Locomotive 7000 made its first trip in passenger service on June 1. Following a trip from North Platte, Nebr., to Omaha, a distance of 281 miles, with a train of refrigerator cars weighing 2,460 tons, which took seven hours and fifty minutes, earlier in the day, the engine left Omaha at 4:30 P. M. with train No. 3 which it took through to Cheyenne, Wyo., a distance of 507 miles, arriving at 10:30 A. M. on June 2. On the same afternoon the locomotive left Cheyenne for Ogden, Utah, a run of 484 miles, with a train of 10 sleepers and two diners, a run requiring 15 hrs. 15 min. of continuous service from the locomotive, which was made with no trouble whatever from journals or bearings running hot.

One of the best runs indicative of the high sustained

* See the July issue of the *Railway Mechanical Engineer*, page 380.

This Locomotive Established New Records by Developing 3,500 Indicated Horsepower capacity of the locomotive was made on June 9, when it took second No. 19 from Cheyenne to Rawlins, Wyo. The train, made up of 11 cars, left Cheyenne one hour late. Over the 57-mile district from Cheyenne to Laramie the train made a little better than running time. For the first 31 miles out of Cheyenne is encountered a steady up grade with a total change of elevation of slightly less than 2,000 ft. and about 10 miles of 1.55 per cent ruling grade. The schedule calls for an average speed of 28.4 miles an hour with no stops over this district. From Laramie to Rawlins the grade is broken, with the difference in elevation slightly favorable to westbound movement. Several grades, however, one of considerable length, are encountered. Over this district, 116 miles in length, the running time is three hours and twenty minutes, including four stops. Engine 7000 made this run in two hours and twenty-six minutes. Deducting the time for the stops, this required an average running speed of 60 miles an hour. The highest speed attained was 75 miles an hour, at which the locomotive operated with remarkable smoothness.

On June 15, Engine 7000 took eastbound train second No. 20, consisting of 13 cars, from Ogden to Cheyenne. This train left Ogden 40 min. late, 25 min. of which was made up on the long heavy climb between Ogden and Evanston,



Max. Up Grade							
	West Bound	0.6	0.82	0.82	0.82	.82	1.55
	East Bound	1.14	0.82	0.82	0.82	.82	D

Profile of Union Pacific Between Ogden and Cheyenne

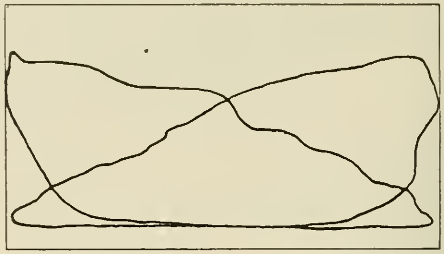
Wyo. In the first 65 miles of this 76-mile district there is a change of elevation against eastbound movement of 2,500 ft. with a 16-mile ruling grade of 1.14 per cent. The schedule of No. 20 calls for an average speed of 27.6 miles an hour with no stops. On this run engine No. 7000 maintained an average of 32.7 miles an hour over the district.

This 484-mile run was made without cleaning either the fire or the ash pan.

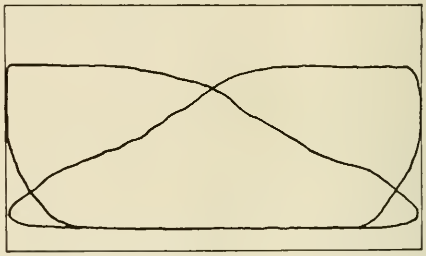
The locomotive has made a number of runs both on the Oregon Short line and the Oregon, Washington Railroad & Navigation Company. On a number of these runs its performance over 2.2 per cent grades has been observed. Although the locomotive is not primarily designed for service on long mountain grades of this character, but rather for its ability to maintain comparatively high speeds on grades requiring considerably less than the maximum starting tractive effort, it is interesting to note that the locomotive maintained 28-miles an hour with a train of 12 cars over a 2.2 per cent grade, and with 10 cars was able to start and rapidly accelerate to a speed of 10 miles an hour, at which it was working at less than half cutoff.

On another occasion this locomotive took a passenger train from Pocatello, Idaho, to Portland, Ore., a distance of 729 miles, including four engine divisions, without cleaning the fire.

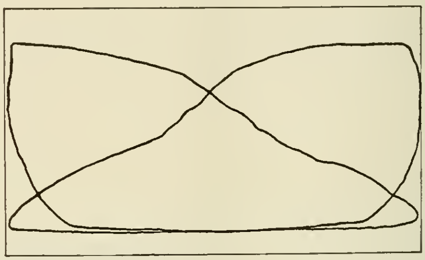
In recent tests this locomotive established a new record of power output for simple locomotives and also set a figure for weight per horsepower which is believed to be substantially lower than has ever been attained previously in road service in this country. On October 1 locomotive 7,000



Boiler Pressure—198 Lb.
Mean Effective Pressure—81.42 Lb.
Miles Per Hour—50
Indicated Horsepower—3500



Boiler Pressure—198 Lb.
Mean Effective Pressure—91.57 Lb.
Miles Per Hour—44
Indicated Horsepower—3464



Boiler Pressure—200 Lb.
Mean Effective Pressure—99 Lb.
Miles Per Hour—40
Indicated Horsepower—3404

Typical Indicator Cards Taken on Road Tests

hauling train No. 4, consisting of 11 cars weighing 816 tons, at a speed of 50 miles an hour on an ascending grade of 0.82 per cent developed 3,500 indicated horsepower. This is at the rate of one horsepower for each 98.6 lb. weight of the locomotive; moreover the power developed is 15.5 per cent greater than the rated cylinder horsepower and 17.2 per cent greater than the rated boiler horsepower according to Cole's method.

This performance has been nearly equalled on other occasions. On September 26, hauling 11 cars weighing 823 tons, 3,404 indicated horsepower was developed at 40 miles an hour, and 3,464 indicated horsepower at 44 miles an hour. The indicator cards taken at these three speeds are reproduced in one of the illustrations.

Although accurate test data are not available, it is evident from the operating results obtained that the locomotive is rendering a highly satisfactory performance both from the standpoint of fuel economy and starting as well as speed capacity.

On 19 regular trips on the Wyoming, Western and Colorado divisions this locomotive made 62,592 passenger car miles on a fuel consumption of 338 tons, or at the rate of 10.8 lb. of coal per passenger-car mile. Comparing this with the April average for the main line division of the Union Pacific, this shows a decrease of 26 per cent.

Based on train resistance calculations the performance of the locomotive on the 2.2 per cent grade of the Oregon Short Line between Pocatello, Idaho and Butte, Mont., indicates that the locomotive developed a starting tractive effort of 58,000 lb. as compared with the theoretical rating of 54,800 lb. on the usual basis of calculation. A steam gage on the throttle pipe indicates that when working full stroke at low speed the pressure drop between the boiler and the steam chest does not exceed five to ten pounds. This, together with the 90 per cent cut off of the Young valve gear is responsible for the high starting tractive effort.

Although open to some question as to accuracy, calculations based on theoretical train resistance on the 1.55 per cent ruling grade west of Cheyenne indicates that the locomotive developed something over 2,000 hp. at 25 miles an hour, or approximately 12 per cent more than called for by the American Locomotive Company's tractive effort curve.

The engine has made a splendid impression among the crews who have operated it. This is undoubtedly partially due to its smooth riding qualities, particularly around curves, as well as its steaming qualities and ability easily to maintain schedules. The well balanced proportions of the machinery is attested to by the ability of the locomotive to operate continuously on runs varying from 500 to 700 miles in length.

Characteristics of Three-Cylinder Locomotives

Three-Cylinder Locomotives Attain 15 Per Cent More Hauling Power for Same Adhesive Weight

By F. Meineke

THREE-CYLINDER locomotives are old, but have not been widely used, mainly because they were either applied in a wrong manner, or the three-cylinder arrangement was connected with freak designs. For instance, Webb built for the London and Northwestern some three-cylinder compound locomotives having a low-pressure cylinder between the frames acting on an uncoupled axle.

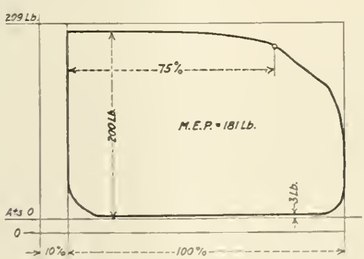


Fig. 1—Typical Indicator Card at Low Speed

Other English and Swiss railroads have used three-cylinder compound engines, mostly with a high pressure cylinder in the middle. Though these engines made better use of the adhesive weight than the ones designed by Webb, they still had a drawback on account of their tendency to slip the wheels. Experience with these locomotives caused the three-cylinder engine to have a bad reputation, with the consequent use of four cylinders in case two proved insufficient.

About six years ago the Prussian State Railway attacked the three-cylinder problem in the correct manner by combining three cylinders with the superheater, with the result of producing an engine which is economical to operate, has single stage expansion, three cylinders of equal size and three cranks at 120 deg. Simplification was obtained by driving the valve of the inner cylinder from the combined motions of the gears of the outside cylinders. From the beginning these 4-6-0 three-cylinder engines showed a far superior starting ability over the four-cylinder engines, which is simply on account of the more uniform turning moment produced by three cranks at 120 deg. Later during the operation of these engines it was found that they also possessed a larger hauling power than the two- or four-cylinder engines.

In order to demonstrate this point, it is necessary to follow the change in tractive effort of the engine during one revolution. As an example, a two-cylinder locomotive having

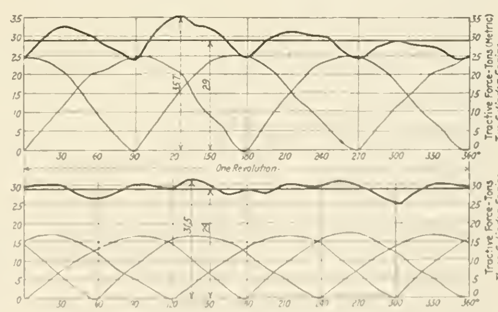


Fig. 2—Variations in Tractive Force for 2-Cylinder and 3-Cylinder Locomotives

cylinders of 27 in. bore and 28 in. stroke, driving wheels of 56 in. diameter and 200 lb. steam pressure may be compared with a three-cylinder locomotive having the same dimensions except that the cylinders have a diameter of 22 in. Both engines have the same displacement per stroke and therefore the same mean tractive effort. Assuming a cut-off of 75 per cent, an indicator card as obtained at low speed is shown in Fig. 1. This card evidently comes fairly close to the actual card since its mean effective pressure is 181 lb. or 0.90 times the initial pressure.

Assuming further a main rod of eight times the crank radius, the tractive forces obtained during one revolution are shown in Fig. 2. The tractive force of the two-cylinder engine shows considerable variation; its maximum value is 78,600 lb., the minimum 54,000 lb., with an average of 64,000 lb. The angularity of the main rod is shown clearly in the difference of the four maxima of the resultant tractive force curve. With the three-cylinder locomotive the tractive force having the same mean value only varies from 69,000 lb. maximum to 55,500 lb. minimum.

The important point is the maximum tractive force during one revolution, because if this is only slightly in excess of the adhesion the wheels will begin to slip and continue to do so in spite of the fact that during the following part of the revolution the tractive force diminishes; because a slipping wheel has a considerably smaller adhesion.

If now, in the case of the two-cylinder locomotive, a maximum tractive force of 78,600 lb. is permissible it will also apply to the three-cylinder locomotive. But in order to bring the maximum tractive force of the latter to the above value the mean tractive force has to be increased in the ratio of 78,600 to 69,000 or 1.14 to 1. For this maximum the mean tractive force of the three-cylinder locomotive will be 1.14 × 64,000 = 73,000 lb., or 9,000 lb. in excess of what it is for the two-cylinder locomotive for the same adhesive weight.

In order to see what this excess in hauling power amounts to on an up grade of 1.38 per cent it may be assumed that the locomotive and tender weigh 200 tons and use 8,800 lb. tractive force for themselves, which leaves for the train 64,000 — 8,800 = 55,200 lb. in case of the two-cylinder and 73,000 — 8,800 = 64,200 lb. in case of the three-cylinder locomotive. If the train resistance on the level is taken to 4.4 lb. per ton the total resistance due to the grade will be 27.6 + 4.4 = 32.0 lb. per ton, which gives a total train weight of 55,200 ÷ 32 = 1,720 tons for the two-cylinder and 64,200 ÷ 32 = 2,000 tons for the three-cylinder locomotive. The hauling power of the three-cylinder engine therefore is 16 per cent in excess of the power of the two-cylinder engine.

This result should give food for thought to every locomotive designer, since the maximum hauling power is the first requirement for a locomotive. After the advantages of the three-cylinder locomotive have been clearly recognized it must be considered wasteful to continue the construction of two-cylinder engines. The above calculations are not purely theoretical but give an explanation of the proven superiority of the three-cylinder locomotive.

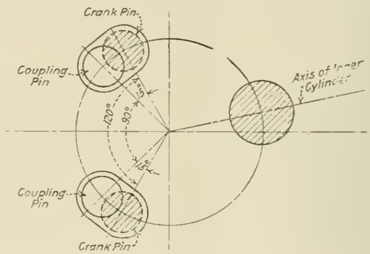


Fig. 3—Crank Pin Arrangement for Locomotives Converted from 2-Cylinder to 3-Cylinder Type

The three-cylinder locomotive appears to be the coming type in Europe. In fact there are more such locomotives in operation at present than one might suppose. Several types of modern three-cylinder locomotives are compiled in the table acompanying this paper. The latest standard types for the German railroads are a 2-10-0 type for freight and 2-8-2 and 4-6-0 types for passenger service.

A good example of a three-cylinder locomotive is the 2-10-0 type recently built in Germany for the Turkish Government. The inner cylinder is inclined so as to clear the axles. Its axis is 4 inches above the center of the driving axle. The inclination of this cylinder facilitates the removal of the piston. The simple form of the driving axle

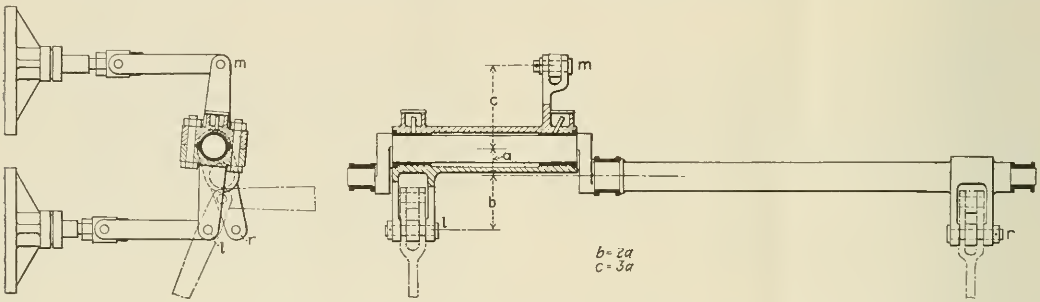


Fig. 4—Method of Driving Central Valve From Outside Gears

THREE-CYLINDER SUPERHEATER LOCOMOTIVES

Cylinder diameter, in.	Stroke, in.	Diameter of driving wheels, in.	Steam pressure, lb. per sq. in.	Tractive force, lb 85 per cent	Adhesive weight, lb.	Adhesive weight / Tractive effort	Wheel arrangement	Owner	Year of construction
19 11/16	24 13/16	78	198	31,300	117,000	3.74	4-6-0	Prussian State	1914
22 1/16	26	55	198	58,000	187,000	3.23	2-10-0	Prussian State	1915
20¼	26	55	198	49,000	150,000	3.06	2-8-0	Prussian State	1919
22 7/16	26	55	198	61,000	176,000	2.9	2-10-0	German Standard	1918
20½	26	68⅞	198	40,300	140,000	3.48	2-8-2	German Standard	1921
20½	26	78	198	35,500	114,000	3.2	4-6-2	German Standard	1921
19 11/16	24 13/16	75½	198	32,300	112,000	3.45	4-6-2	State R.R. of Saxony	1918
22 1/16	23⅝	49¼	184	55,000	173,000	3.15	2-10-0	Turkish Government	1917
18½	26	68	180	30,030	134,400	4.43	2-6-0	Great Northern (Eng.)	1918
18½	26	55¼	180	37,000	160,380	5.94	0-8-0	North Eastern (Eng.)	1919

is noteworthy. Contrary to the two-throw axles for four-cylinder locomotives this axle is a simple forging, easy to machine and is safe and reliable.

The three cranks are set at 120 deg., and with the inner cylinder inclined, its crank has to be offset a corresponding amount. The outer cranks always are at 120 deg., and this has shown no disadvantage for the coupled wheels as against the common angle of 90 deg. There may, however, be cases where it is necessary to retain the coupling pin of 90 deg. For instance, in case a two-cylinder locomotive is to be changed into a three-cylinder one, then it may be advantageous to use the old coupled wheels. As shown in Fig. 3 special crank pins with a slight offset accomplish this.

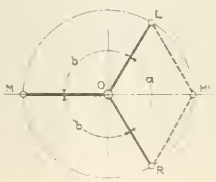


Fig. 5—Arrangement of Eccentrics for 3-Cylinder Locomotive

In order to save a third link, and avoid valve gear parts between the frames, the motion for the middle valve is taken from the two outside gears, Fig. 4. There are many different ways of doing this. The arrangement is correct if, with one outside gear held stationary, the motion imparted to the middle valve by the second gear is opposite to the one imparted to its own valve, since the two eccentrics *OL* and *OR*, Fig. 5 are combined according to the parallelogram of motions to one eccentric *OM'*. On account of the angles *a* and *b* being equal the triangles *OLM'* and *ORM'* are equilateral and all that is necessary to do is to reverse *OM'* to bring it into the position *OM*, which gives the correct motion. The valve gear used on the Turkish engine is designed along these lines and in fact all gears of the German locomotives and the ones of the Great Northern railway in England are using this principle.

For starting the maximum cut-off on a three-cylinder locomotive only need be 67 to 70 per cent, as against 75 to 80 per cent for two-cylinder locomotives, with a corresponding decrease in maximum tractive force and coal consumption due to the higher ratio of expansion. The latter point will be of even more importance in the future. The Pennsylvania railroad has made an important step in this direction with its locomotives with only 50 per cent maximum cut-off. This of course necessitates larger cylinders since the mean effective pressure in a cylinder is reduced from .85 to .55 times the initial pressure. Two-cylinder locomotives already require large cylinders with high piston load and heavy and awkward driving parts. The limit is almost reached, but there is no pause in the development and a three-cylinder locomotive satisfies the demand for larger cylinder capacity without incurring heavy driving parts, in spite of the fact that the total volume displaced per revolution is to be made larger in accordance with the larger hauling power. For instance, in the previous example the cylinders should be 23½ in. instead of 22 in. The newer German freight locomotives have considerably larger cylinders than the older ones since at that time the increased hauling power was not an established fact.

A further advantage of the three-cylinder locomotive is the more uniform draft in the smoke box. There are six exhaust puffs during one revolution as against four of the two-cylinder engines. There is less disturbance of the coal bed in the fire box and less spark throwing, with a corresponding decrease in coal consumption.

The essential advantages to be claimed for the three-cylinder type of locomotive therefore are: Considerably higher hauling power, reduction in coal consumption and lighter driving parts. The three-cylinder superheater locomotive therefore is the best form of the heavy locomotive and doubtless will be widely used in the future as its advantages become more generally recognized.

Unaflow Locomotives in Great Britain

In 1913 Sir Vincent L. Raven, chief mechanical engineer of the North Eastern Railway of England, applied the unaflow system to a 4-6-0 type locomotive with two outside cylinders, 20 in. by 26 in., and 73¼-in. driving wheels. A further trial of this system was made on the same road in 1919 when a 4-4-2 type locomotive with three 16½-in. by 26-in. cylinders and 82-in. driving wheels was built.

Comparative dynamometer car tests for both passenger and freight trains were made between the 4-6-0 North Eastern engine of 1913 and another engine of the same type with two ordinary outside cylinders, 20 in. by 26 in. The coal and water consumption was measured and it was found that the unaflow locomotive was the more economical of the two. At the present time the coal consumption of this engine is slightly lower than that of the ordinary engines of the same class. The three cylinder, 4-4-2 unaflow engine has been running satisfactorily since it was put into service in June, 1918. As compared with the North Eastern three-cylinder ordinary 4-4-2 type, it is showing a saving in fuel of 9 per cent. In upkeep and general efficiency it was found that there is virtually no difference in unaflow and non-unaflow locomotives on the North Eastern Railway for corresponding classes.

A Novel Tire Arrangement for a Road with Sharp Curves

By Edward Dawson

A method of reducing engine truck and driving wheel flange and hub wear, avoiding the widening of track and wearing of the inner face of the outside rails on curves, eliminating derailments and increasing the hauling capacity on curves has been in use on the Arizona & New Mexico for 13 years. The line has many 15 deg. curves and locomotives with more than two pairs of driving wheels which had plain tires on the center pairs.

To secure the benefits mentioned the treads of the plain tires were turned with a taper in the opposite direction from the A.R.A. standard, with only one half the taper but with the usual bevel on each edge. Boiler plate hub liners were applied to the wheels and bronze or babbitt on the outside of the driving boxes, allowing a total lateral clearance of 5/32 in.

These reverse taper plain tires on the center driving wheels (two pairs where four pairs of drivers are used) always have their larger tread diameter on the outer rail of a curve and the smaller diameters on the inner rails, which when running relieves the engine truck and forward driving wheels from any undue side pressure from the outside rail, and also brings the outer back driving wheel flange nearer the rail.

As all the driving wheels on the outer rail have their larger diameters in contact with it and those on the inner rail their smaller diameters, the engine will make its own curve, besides the greater the degree of curvature the greater is the difference between the larger and the smaller diameters of tires in contact with the outer and inner rails.

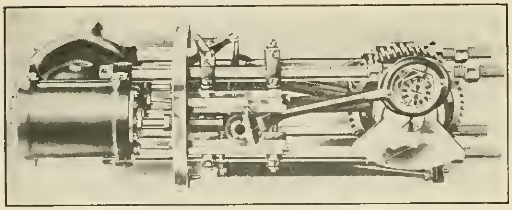
This plan was very successful on the locomotives on which it was first tried and when new tires were applied, the tapered plain ones were again used.

Unit Steam Motor Car Built for the Canadian National Railway

Steam-Propelled Unit Railway Motor Car

Improved Power Plant with Water-Tube Boiler and Oil Burner Characterize Canadian National Car

MANY railroads within the past year have turned to the self-propelled passenger car as a device which would aid materially in reducing operating costs on branch lines, or in sections where the traffic is light. Much of such equipment tried has followed closely the lines of development of the gasoline-engine motor bus used on highways with more or less modifications to adapt it for use on railroad tracks.

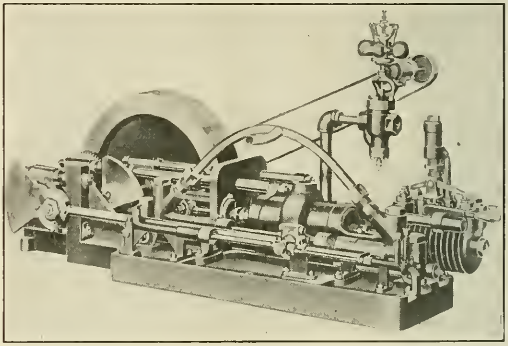


The Main Engine is of the Two-Cylinder Simple Type

A distinctly different car of the self-propelled type is the oil-burning, steam-driven car built by the Unit Railway Car Company, Boston, Mass. One of the early cars of this style was shown at the Atlantic City convention in 1919, a description of it being given in the Railway Age, June 18, 1919. From experience gained through observation of the cars which have been in service since that time, the builders have been able to make a number of improvements in details of design. These have been incorporated in the cars recently delivered to the Canadian National, the Boston & Maine and the Uruguayan Government.

The power plant in the Unit railway steam cars embodies the principles used in the Stanley steam automobiles and is built under the same patents. Ease and flexibility of control with large reserve capacity for quick acceleration, or for use on grades is a characteristic of these cars. They are usually operated as a single car unit, but have sufficient power for pulling a trailer, or can be used for switching purposes when necessary. Maintenance can be attended to easily by ordinary railroad mechanics and the costs should be low.

The delivery of the car to the Canadian National was hurried in order that it might be shown at the annual exposition in Toronto. Without waiting for a preliminary trial, it was started from Boston under its own power and ran to Toronto, a distance of 660 miles, without interruption, except for delays incidental to orders from the operating departments. The running speed for much of the distance was between 45 and 55 miles per hour.

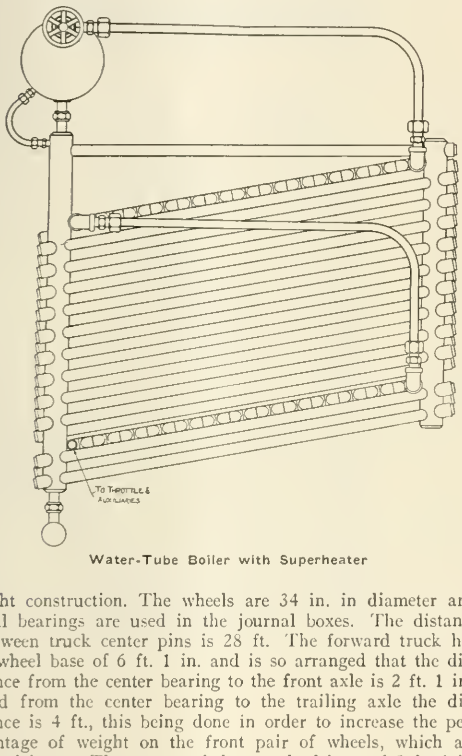


Auxiliary Steam Engine with Air Compressor, Feed Water and Oil Pumps

Car Body and Truck

In appearance, as will be noted from the photograph, the car bears a closer resemblance to the usual steam railroad passenger, or to an interurban electric car than is the case with many of the gasoline engine cars. The body is of steel construction and the car is equipped with standard couplers. The Canadian National car is 50 ft. 7 in. long over end sills and is divided into four compartments. Next to the driver's compartment, in which is located the boiler and auxiliaries, is a baggage compartment. There is also a smoking compartment separated by a partition from the main part of the car. There are seats for 38 passengers and, in addition, two folding seats are provided in the baggage compartment, which furnish room for eight additional passengers if desired. The rear platform is enclosed and provided with doors. A small toilet room occupies one of the rear corners of the passenger compartment. Current for electric lights is supplied by a small generator driven by the auxiliary engine.

The trucks are of a modified arch bar pedestal type of light construction. The wheels are 34 in. in diameter and ball bearings are used in the journal boxes. The distance between truck center pins is 28 ft. The forward truck has a wheel base of 6 ft. 1 in. and is so arranged that the distance from the center bearing to the front axle is 2 ft. 1 in., and from the center bearing to the trailing axle the distance is 4 ft., this being done in order to increase the percentage of weight on the front pair of wheels, which are the drivers. The rear truck has a wheel base of 5 ft. 6 in.



Water-Tube Boiler with Superheater

The car is designed for single-end operation, but may be driven at equal speed in either direction. The weight disposition is as follows:

Light weight of car complete	59,000 lb.
Weight on front driving axle	25,500 lb.
Weight on front trailing axle	12,400 lb.
Weight on rear truck	21,100 lb.

As the weight of the power plant complete with all auxiliaries is 13,000 lb., the weight of the body and trucks is but 46,000 lb.

The Water-Tube Boiler

The boiler is of the water-tube type and is made in 12 sections, being constructed throughout of Shelby seamless boiler tubes. Each section consists of a front and back vertical header, the two being joined by 22 water tubes inclined at about 11 deg. to the front header and a single connecting steam tube at the top inclined at about 1 deg. to the back header. All tubes are straight, in which respect they differ from the earlier design. The tubes are electrically welded to the headers and opposite each end of every tube an opening is provided in the headers through which the tube can be inspected, cleaned or in case of a rupture, can be temporarily plugged until a new tube can be welded in place.

Each boiler section when ready for assembly is subjected to a hydrostatic test of 3,500 lb. per sq. in., and while under this pressure is given a babbitt hammer test for leakage or defective tubing.

The front headers are connected by parabolic shaped tubing to a steam drum. The construction of the drum and connections is such that they act as a desaturator, and any moisture separated from the steam is returned automatically to the boiler. The lower ends of the front headers are connected to a mud drum.

From the steam drum the dry steam passes through the superheater in series, an arrangement which has been found materially to increase the life of the superheater units. As will be noted from the drawing, the superheater pipes are in two banks, one near the top and the other near the bottom. Unions are provided which permit of their easy removal. All unions and connections are of special construction and made of monel metal to resist the high temperatures. All the steam is superheated, no saturated steam being used for auxiliaries or for other purposes. By using superheated steam for all purposes, there is always some flow through the superheater for operating the auxiliary engine, atomizer, blower and ejector.

The steam pressure ordinarily carried is about 800 lb. per sq. in., while the ultimate temperature after passing through the superheater is from 650 to 800 deg. F. The steam from the engine is condensed as explained later, and fed back to the boiler. A gravity-feed oil separator is used together with a boiler compound to eliminate the effect of oil in the feedwater as oil tends to decrease the efficiency of the boiler and endangers the heating surfaces when exposed to high temperatures.

The boiler proper is placed on top of a fire-brick lined combustion chamber, shown in the photograph taken when partly assembled. Any crude or refined oil that can be pumped may be used for fuel, but the grades most generally used are kerosene or distillate. The oil is atomized by high pressure superheated steam. The supply of fuel oil is carried in a tank underneath the car, from which it is pumped as explained later.

Main Engine and Condenser

The car is propelled by a simple two-cylinder engine mounted on the front side of the forward truck, power being transmitted to the axle by a single spur gear pressed onto the center of the axle. The gear ratio ordinarily employed is approximately 1½ to 1. When the car is traveling at a speed of 30 m.p.h. the engine, which has an 8-in. stroke makes about 433 r.p.m., and has a piston speed of 577.5 ft. per min. The engine is entirely enclosed and thoroughly insulated. The gears run in a bath of oil.

The high pressure superheated steam is carried from the throttle to the engine by a flexible pipe having four special steam packed joints. The exhaust steam from the main engine and also from the auxiliary engine is conducted to an air cooled condenser located on the roof of the car at the forward end. The condensed water flows back to the tank underneath the car. There are two water tanks, one holding 175 gal. and the other 90 gal. In winter the exhaust steam may be passed through heating coils in the car. The supply is sufficient to keep the car comfortable in the most severe weather.

The auxiliary steam engine, which is located in the driver's compartment, needs little explanation. It drives the two feedwater pumps, the fuel-oil pump, the duplex cylinder lubricating oil pump, the air compressor, and the 2-kw. D.C. generator. The engine is run at a constant speed and governed by a ball type governor.

Boiler feed is accomplished as follows: The two pumps running at constant speed deliver the hot feedwater through the automatic by-pass to the condensate tank. When the water level in the boiler falls below the automatic by-pass tube, expansion of the tube closes the valve and the water is pumped into the boiler until the tube is submerged, or enough of it to establish and maintain a nearly constant water level irrespective of the load on the boiler. When the throttle is open under heavy load, there will be a slight drop of water level as indicated on the water column. This is absolutely reliable, for when the throttle is again closed the water level will rise to the normal or light load level. Due to the high pressure, a water gage is not used, but an indicator mounted on top of the water column and operated by the expansion of that portion of the water column above the water level has been substituted. The water column is equipped with trycocks which permit the water level to be checked for accuracy.

The fuel oil is pumped from the 175-gal. storage tank underneath the car, located in front of the rear truck, to a 20-gal. auxiliary atomizer tank bolted to the partition near the roof in the baggage compartment, which gives a constant head to the atomizer. From the tank the oil flows by gravity to the dual automatic control mechanism, which is actuated hydrostatically by the throttle operation, in that the slightest throttle opening causes a fluid pressure drop in the superheaters, thereby releasing the hydrostatic head on the dual automatic diaphragm permitting a simultaneous opening of the fuel oil and high pressure superheated steam passages to the atomizer. The atomized fuel is ignited by the pilot burner. The fire control is such that a light fire will be maintained for light loads and correspondingly increased for heavy loads. When operated at full loads, the temperature in the chamber is from 2,800 to 3,100 deg. F. and every brick and joint of fire clay is glowing with incandescense and radiates heat to assist in the combustion which is complete before the gases come in contact with the boiler-heating surfaces.

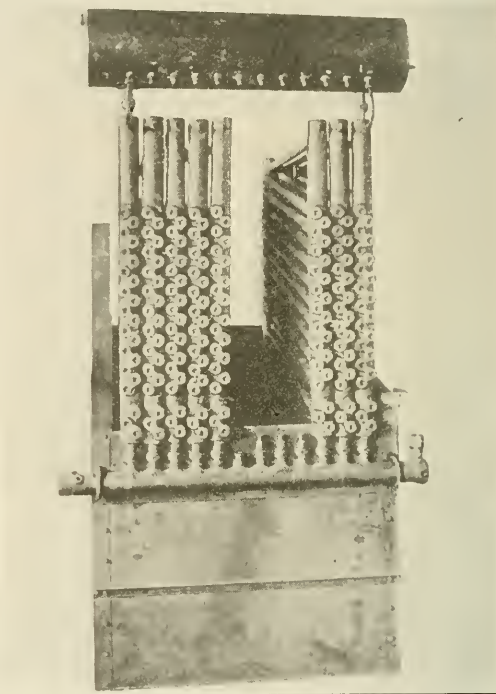
The air compressor, as will be noted from the illustration, is in tandem with the auxiliary steam engine cylinder, the air piston being mounted on an extension of the steam piston rod. The compressor is lubricated by an adjustable oiler in the air intake. A governor is located over the inlet valves, and when the desired pressure has been attained both inlet valves are held open, permitting cold air to circulate in the cylinder until the next pressure drop occurs. The compressor cylinder is air cooled. The capacity of the air compressor is 11½ cu. ft. of free air per minute, which is more than sufficient for the operation of the air brakes with which the car is equipped.

Lubrication of both main and auxiliary engines is by splash, thereby lubricating the housing or the driving axle as well as every portion of the engine with a flood of oil. The cylinders are lubricated through blinkers on the instrument board, thence to the steam lines to the main and auxiliary engine.

The low water automatic control is a device by which the flow of fuel oil to the atomizer is shut off before the water in the boiler gets dangerously low. The water connection to the low water automatic control is in series with the automatic by-pass in order to utilize the same temperature that operates the automatic by-pass. Therefore, should the automatic by-pass fail for any reason, or if the pumps should not supply the boiler with water to meet boiler evaporation requirements, the expansion tube of the low water automatic control is filled with steam at a high temperature, closing the valve in the head which at once cuts off the fuel oil supply to the atomizer. The value remains closed until the water level is restored, after which the atomizing burner will again function to restore and maintain the steam pressure.

Tests and Efficiency

Records taken from cars in service show an average consumption of approximately 0.7 gal. of distillate, or 0.65 gal. of kerosene per car mile. At the low price at which distillates can be obtained in many places, this represents a fuel cost of about four cents per car mile. For lubricating purposes two gallons of a special cylinder oil has been found to be sufficient for a 400-mile run and one gallon of engine oil for the same mileage.



Partly Assembled Boiler on Combustion Chamber

The mechanical efficiency in the main engine and drive is high. The boiler efficiency when using superheated steam at 700 to 800 deg. F. at the atomizer is said to be about 77 per cent. The time required to generate steam with storage air for the atomizer is from 20 to 25 min. and with steam at 200 lb. pressure, approximately 18 min. An evaporation of about 14 lb. of water from and at 212 deg. F. may be obtained per square foot of wetted heating surface. The main engine uses from 14 lb. to 19 lb. of water, depending upon load and grade conditions, to develop one horsepower hour.

The Eastern Railway of France now has more than one-quarter of its locomotives fitted with audible cab signals. The total number of locomotives in service at the present time is, for passenger trains, 1220; for freight trains, 798; total 2,018. Of these, 428 passenger engines and 144 freight engines are fitted with the signal apparatus. Ramps have been installed at 390 distant signals and at 130 home signals. The company plans to fit up 1,278 more locomotives before the end of 1923, and to install 1,560 additional ramps.

Details of Ljungstrom Turbine Locomotive

1800 Horsepower Turbine with Reversing Reduction Gear and Air-Cooled Condenser Shows Remarkable Test Results

THIS is a continuation of the article in the October number describing an epoch-making locomotive built by Aktiebolaget Ljungstrom Angturbin of Stockholm, Sweden, and now in service on the Swedish State Railways.

The Main Turbine

The main turbine is of the impulse-reaction type with axial steam flow and develops 1,800 b.h.p. at the maximum speed of 9,200 r.p.m., which corresponds to a locomotive running speed of 68.3 m.p.h. Superheated steam is carried from the boiler unit to the turbine by a steel pipe with a U-shaped bend to obtain the required flexibility between the two units of the locomotive. The cast-steel steam chest contains five nozzles, each of which is independently controlled by a valve operated by oil pressure through a rotary control valve conveniently located in the cab. The steam as it leaves the nozzles acts on a velocity compounded impulse wheel with two rows of rotary blades with one row of stationary blades between. After leaving the impulse blading the steam passes through 15 rows of reaction blades mounted on a built-up conically shaped rotor. A novel and ingenious method has been adopted to shorten the length of the turbine and bring the large exhaust opening in line with the center of the turbine. The last row of reaction blades carries another row of blades mounted on their tips. The steam after leaving the last inner row of blades goes through a reversing passage in the turbine casing and then backward axially through the outer row of blades to the exhaust passage which surrounds the turbine cylinder.

As will be noted from the sectional drawing of the main turbine the spindle or rotor is of the built-up type and is composed of the two impulse wheels, a series of interlocking rings which clamp the rows of reaction blades and end discs, the whole being held together by a center shaft and end nuts. These nuts also serve as glands and journals which run in plain fixed bearing boxes.

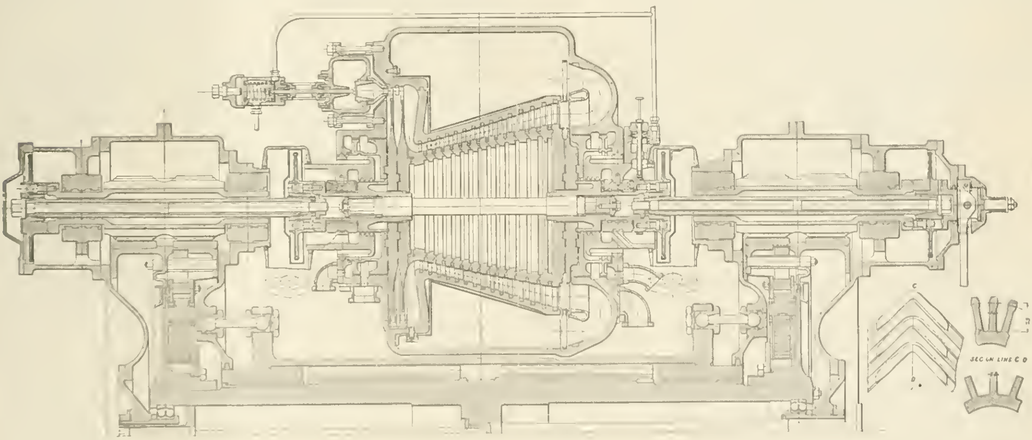
As a safeguard, the turbine is fitted with an overspeed governor which acts to shut off the steam should the speed exceed a certain predetermined amount above the normal maximum.

The Main Reduction Gear

A double reduction gear with a ratio of approximately 22 to 1 is used to bring down the rotative speed from 9,200 r.p.m. of the turbine to 420 r.p.m. of the low speed gear.

On either end beyond the turbine spindle and in line therewith, is a double helical high speed pinion in rigid bearings. Flexibility is obtained by mounting flexible couplings on the ends of the turbine spindle and on the outer ends of the pinions, each pair of couplings being connected by a shaft which passes through the hollow shaft of the pinion.

An interesting feature of the high speed pinions is the means resorted to in order to secure a certain amount of flexibility in the teeth. These teeth are first cut in the ordinary way and then the metal between the teeth is removed to a depth considerably in excess of the pitch so that the teeth form the tops of relatively thin metal walls. The amount of tooth flexibility required is exceedingly minute, yet some is necessary to ensure equalization of pressure the whole length of the teeth in contact. The form of the undercut teeth is shown in the enlarged views at the right of the turbine section. Previous to the adoption of this design a dummy pinion was cut and run to destruction in order to secure data on reliability and fatigue.

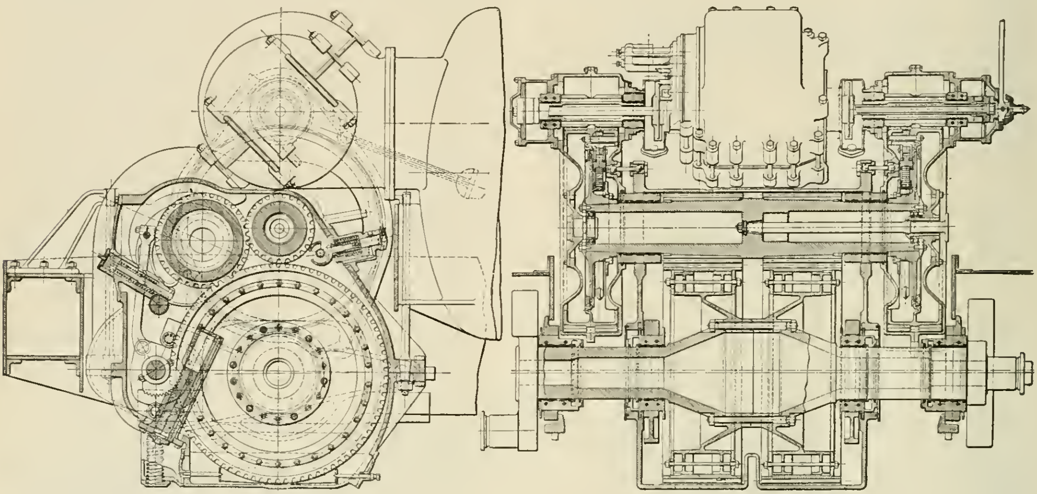


Section Through the Main Turbine

The high speed pinions mesh with the teeth of two gears mounted on a shaft, the center portion of which is the low speed pinion. A spring connection is interposed between the rims of the high speed gears and the shaft which forms the low speed pinion to cushion such shocks as may arise between the driving wheels and the turbine. The low speed pinion normally meshes with the low speed gears mounted on the jack shaft, at the ends of which are cranks at 90 deg angles. Connecting rods couple the crank pins to the three pairs of driving wheels. As an illustration of the precautions taken in designing this locomotive to exclude dust and dirt from all bearings, the cranks and connecting rods to the driving wheels are entirely enclosed. The lower part of the cover can be removed with little effort when inspection is necessary and in addition, small covers are provided for the inspection of the crank pins.

The center shaft attached to the web in the center of the second reduction pinion is employed to drive the fans for circulating air through the condenser and has nothing to do with the reduction gear itself.

As the turbine is non-reversing, it is necessary to provide means in the gearing for the reversing of the locomotive. The arrangement used is a novel and bold one, but apparently effective and reliable. When the engine is to be run in a backward direction, the crank shaft is first dropped slightly so that the low speed gear is thrown out of mesh with the pinion which drives it. After the gears have come to rest, an idler gear is brought into mesh with both the low speed gear on the crank shaft and the low speed pinion. As this idler gear has to connect with both the gear and the pinion in the train and as all gearing is of the double helical type, it has to be cut with helical teeth running in one direction and then recut with teeth running in the opposite direction. This doubling of the spirals reduces the tooth bearing to one-half of that used for driving in the forward motion, but as the idler pinion is only in use when the locomotive is backing, the strength is ample. The process of disengaging the pinion and bringing the idler into mesh is done automatically by oil pressure controlled by a simple movement of the handle of a control valve. The means employed for locking the gear in the two positions and for securing meshing without injury to the gears are interesting but not necessary to describe in detail. It is sufficient to state that the whole process of reversal is as quickly and as easily accomplished as with an ordinary locomotive equipped with a power reverse gear.



Arrangement of the Double Reduction Gear

The Condenser

The efficiency of a steam turbine depends upon the employment of a condenser which will ensure the maintenance of a high vacuum. The ordinary type of condenser used in stationary and marine installations with a large number of water tubes was considered to be impractical on account of the size, weight and large quantities of cooling water that would be required. An air-cooled condenser was consequently decided upon as the most suitable for locomotive use. In the condenser as in other parts, the design adopted shows good engineering, ingenuity and a willingness to depart from the conventional provided there is a clear advantage to be gained by so doing.

As has been stated, the condenser occupies most of the space of the second unit of the locomotive, the actual room occupied by the turbine and reduction gear being small. Running the full length of the unit and at the bottom is a cylindrical vessel about 66 in. in diameter which is normally half full of water of condensation. The turbine is bolted direct to a flange on the front of this vessel without interposed piping or expansion joints. The exhaust steam passes in on top of the water and then rises through two short connecting pipes to another cylindrical vessel about 22 in. in diameter which is located near the top of the unit.

Between the two drums are three fans which are driven from the main turbine by an inclined shaft and bevel gears. The fans themselves are driven by friction wheels which can be shifted to give the desired speed. Each fan has a capacity of 1,410 cu. ft. of air per second. The object of the fans is to induce a strong current of air over the cylindrical drums and past the copper tubes referred to later. The sides of the vehicle consist of vertical sheet steel guide plates which facilitate the entrance of air while the locomotive is running. The shape was determined by results obtained from experiments with a specially constructed wind tunnel.

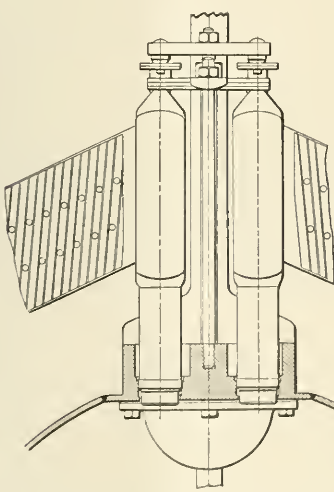
The roof of the vehicle consists of a large number of specially formed flattened copper tubes in which most of the condensation takes place. These tubes are closely packed together and contain about 10,760 sq. ft. of cooling surface over which the air from the fans passes.

Along the top of the upper drum are two rows of copper boxes which are held in place by studs and straps as shown in the drawing. These boxes are made from tubing, the upper part being formed into a square and the lower part left round and closed in to form a seating on the drum. As will be noted from the detail drawing, one side of the squared portion has six long, narrow slots into which the ends of the flattened condenser tubes are brazed. Opposite these slots is a large opening which is finally closed by a brazed plate after the boxes and condenser tubes have been assembled.

The condenser tubes are of copper about 0.030 in. thick and after being flattened, the walls are approximately 0.068 in. apart. Small diagonal fins are next formed on the flattened sides by specially designed machinery. When assembled, the fins on adjoining tubes are at right angles to each other. The air which is forced between the tubes by the fans thus has to pass along numerous small channels between the fins and is caused to eddy, thus materially accelerating the transfer of heat from the tubes to the air.

On the drawings of the condenser elements a number of small circles will be observed on the flattened tubes. These are depressions in the opposite walls which stiffen them and prevent collapse due to differences between external and internal pressures.

When in operation, steam flows from the upper drum into the copper boxes mounted on top and down through the flattened tubes. The condensed water passes into the lower row of boxes which are attached to horizontal pipes running lengthwise of the condenser unit. From these pipes the water drains into the larger lower drum which is always about half full of water. This body of water serves as a reserve for boiler feeding and also equalizes the work of the condenser and enables it to deal with heavy temporary overloads. This water is made more effective by being brought into intimate contact with the steam from the turbine by means of a centrifugal pump and spraying arrangement. The pump is driven by an extension from the shaft of the center air fan and will be noticed on one of the sections



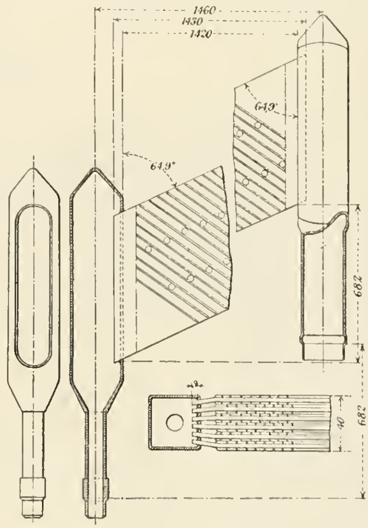
Attachment of Condenser Elements to Top of Upper Drum

accompanying the elevation drawings of the locomotive. The impeller runs in a cylinder, draws in the water at the bottom and delivers it over the top of the cylinder whence it falls onto a grating above the water level. The grating is thus kept cooled and the water as it drips back in a finely divided state mingles with the incoming steam.

The important function as a "coldness reservoir" performed by the mass of water contained in the storage drum has been demonstrated effectively by repeated tests. With the reservoir containing the normal amount of ten tons of water at an initial temperature of 91 deg. F. and condensation taking place at a rate of 14,250 lb. per hour, the temperature did not exceed 149 deg. F., which corresponds to a vacuum of about 24¼ in. of mercury, after a continuous run of 35 min. When steam is shut off or throttled, the condenser has an opportunity to cool down in readiness for the next heavy demand.

Feedwater Heater

After the steam has been condensed, it is fed back to the boiler and on the way passes through three feedwater heaters arranged in series. Each heater is supplied with exhaust steam at a different temperature so that the feed water is heated progressively from about 120 deg. F. to 300 deg. F. The heaters are circular and contain a series of brass tubes, surrounded by exhaust steam. The first heater is supplied with steam at approximately atmospheric pressure and 195 deg. F. from the condensate pump turbine, the air ejector for the condenser, the vacuum brake ejector, leakage from the dummy piston of the main turbine and steam from the other heaters. The intermediate heater is supplied with



Details of Condenser Elements

steam at approximately 9 lb. pressure and 230 deg. F. from the turbine boiler feed pump. The high pressure heater is supplied with steam at approximately 60 lb. pressure and 295 deg. F., being the exhaust from the induced draft fan turbine.

Pumps and Air Ejector

The condensed water is taken by a condensate pump and delivered to a boiler feed pump which forces it through the feedwater heaters into the boiler. The condensate pump which operates under a low head is of the single-impeller rotary type and driven by a small turbine, the speed being brought down by a single helical reduction gear. Saturated steam is used for this turbine although in practically all other places superheated steam is employed.

The boiler feed pump also is of the rotary type. It has three impellers in series and is driven by a direct-connected turbine. The boiler feed pump is mounted on a cast-iron oil reservoir. In this reservoir there is a rotary lubricating oil pump with a vertical spindle which is driven by a worm mounted on an extension of the boiler feed pump shaft. This pump supplies oil to the main turbine, the reduction gear, the various auxiliaries and also the important bearings on the locomotive. The use of force-feed lubrication in conjunction with the enclosure of running parts is expected to greatly increase the durability and make it possible to run the locomotive for long periods without requiring any attention.

An air ejector is used to free the condenser of air. This has two steam jets which work in series and is much simpler than an air pump. The discharge from the ejector is piped to the low-pressure feedwater heater so that there is little loss of heat.

The Heat Balance

Before taking up the heat balance of this locomotive, attention is directed to the diagram showing the steam and water circulation. The feedwater heater pressures are shown in atmospheres and the temperatures in degrees Centigrade.

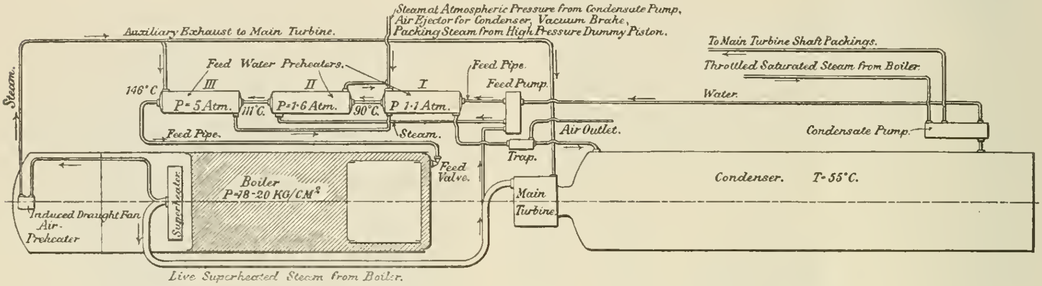
The Ljungstrom locomotive does not depend for its efficiency entirely upon the great heat drop utilized by the turbine. The employment of waste heat in the flue gases to heat the air for combustion with resulting increase in firebox temperature and furnace efficiency together with heating the feedwater to a high temperature by passing it through three heaters fed by exhaust steam at successively higher temperatures add materially to the efficiency of the locomotive as a whole. There is also an important gain in continued freedom from scale obtained by using pure condensate only for feedwater. The manner in which the latent heat of the fuel is disposed of is shown in the heat balance diagram. Of every 100 heat units contained in the coal, 18 are lost in gases passing out of the stack, unconsumed fuel in the ashes and by radiation. The boiler actually delivers more steam than would be represented by the remaining 82 units because of the 7 units returned to the boiler by the air preheated and the 14.1 units by the feedwater heaters. The losses due to gland leakage, radiation, etc., is 3.5 units. The condenser fan requires 3.3 units and 60.5 units are necessarily rejected to the condenser. This leaves 14.7 units which are transformed into the useful work of the locomotive. This result would be considered very creditable in a good stationary power plant and is almost double the highest known thermodynamic efficiency of any reciprocating engine locomotive.

Tests and Performance

Fuel economy is one of the strong claims for the Ljungstrom locomotive although low maintenance costs, large starting torque and evenness of turning effort also are advanced. The ordinary Swedish locomotive with about 145 lb. boiler pressure, steam superheated to 650 deg. F. and expanded down to an exhaust pressure of six pounds above atmosphere, will convert about 200 B.t.u. into useful work for every pound of steam used. The Ljungstrom locomotive with its higher pressure and steam expanded down to 2.1 lb. absolute converts about 400 B.t.u. into useful work. The fuel consumption is thus only 50 per cent as much as with an ordinary locomotive. In addition there are further economies resulting from preheating the air for combustion and from feedwater heating.

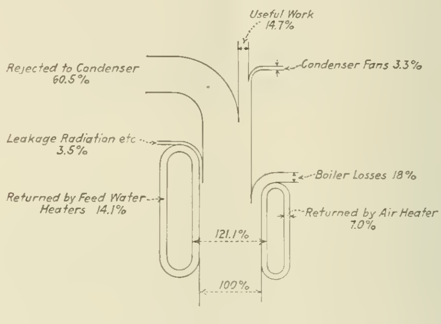
Before the locomotive was placed in service it was submitted to tests on a specially constructed dynamometer, which tests extended over several months and were carried on under the supervision of engineers from the Swedish State Railways.

Following these successful tests, it was turned over to the railroad and has since been used on numerous runs, hauling heavy trains and conforming to the operating conditions of other locomotives, the firing and running being performed by ordinary railway employees. In repeated instances a dynamometer car has been attached to the train and full records of performance thus obtained. The drawbar pull repeatedly has reached 30,000 lb. and the work performed has been in excess of 1,500 hp. These test records bear out the claims for fuel economy. For example, on one of the runs between Stockholm and Upsala the train consisted of 11 coaches and a dynamometer and weighed 596 short tons including the locomotive. The maximum speed was 51 m.p.h. and there were only a few stops. The coal consumption for the run averaged 37.4 lb. per 1,000 ton-miles. Under other conditions and where the stops have been frequent, the coal rate has been as high as 67 lb. A vacuum of 26 in. to 27 in. was easily maintained with an air temperature near the freezing point.



Steam and Water Circulation in Ljungstrom Turbine-Driven Locomotive

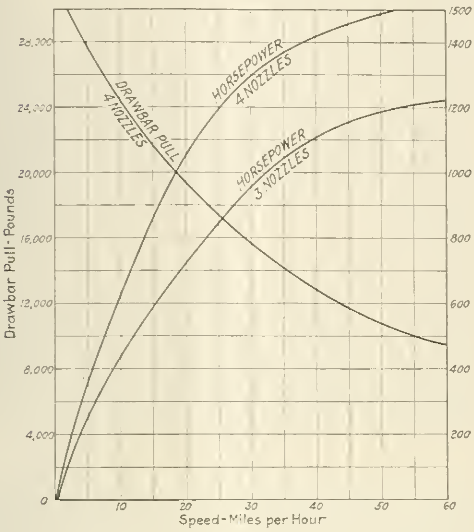
The drawbar and horsepower characteristics of the locomotive are shown in the diagram giving the output at different speeds. These curves were plotted from the results of tests. The maximum drawbar pull shown is in excess of 30,000 lb., but this can be utilized only with the best track conditions, about 27,000 lb. being the maximum that can be used ordinarily without slipping the wheels. It will be noted that the drawbar pull curve drops rather rapidly, particu-



Heat Balance Diagram

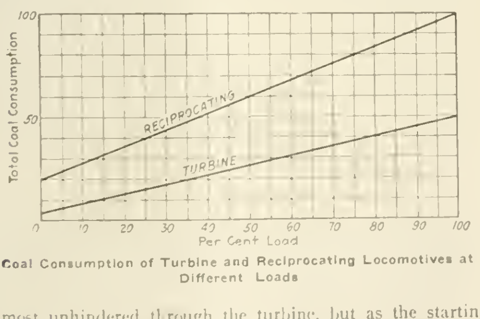
larly at low speeds. This characteristic tends to decrease the danger of slipping the wheels and still leaves a large power for heavy pulls on grades.

Two curves have been drawn to show the relative coal consumption of the turbine locomotive and a reciprocating locomotive of equal power under different conditions. One is plotted for different loads and the other for different speeds, the assumption being made that the fuel consumption of the turbine locomotive at full load would be one-half



Output of the Locomotive at Different Speeds

that of a reciprocating locomotive. The straight line diagram shows that the relative savings at light loads is proportionately even greater than at heavy loads. This is partly due to the small friction losses of the turbine and to the higher vacuum obtained with light loads. The curve plotted on a speed basis shows that at starting the turbine engine is not as economical as the reciprocating engine. When the nozzles are opened in starting, the steam at first can flow



Coal Consumption of Turbine and Reciprocating Locomotives at Different Loads

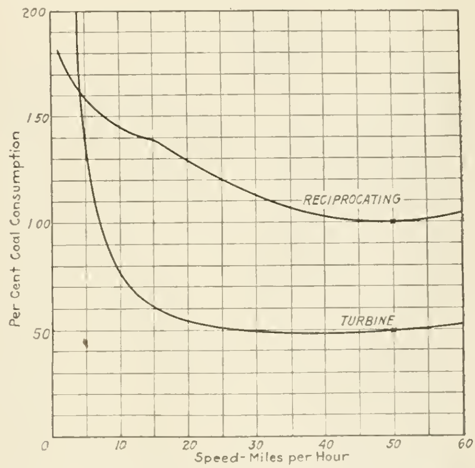
almost unhindered through the turbine, but as the starting torque is higher than for a reciprocating locomotive, the acceleration is rapid and at speeds of over five miles per hour the advantage is strongly in favor of the turbine locomotive. The greatest difference is at a speed of about 15 m.p.h., where the ratio is as 60 to 140, from which point it decreases to 2 to 1 at 50 m.p.h.

In operation, the locomotive has shown a better starting torque and quicker acceleration than standard locomotives. It is easily controlled and runs with unusual smoothness at all speeds. Coal consumption has been reduced 50 per cent and as there is very little loss of water, the supply lasts for a considerable time before replenishing is necessary. The continued performance of this remarkable locomotive will be watched with the greatest interest.

In the drawings included with the general description, all dimensions were given in millimeters. The accompanying data sheet shows dimensions and weights in both metric and English measures and also includes considerable general information not otherwise given.

Locomotive Data Sheet

Builder	Aktiebolaget Ljungstroms Angturbin	
Railroad	Swedish State	
Service	Passenger	
Track gage	4 ft. 8½ in.	
Wheel arrangement, boiler unit	4-6-0	
Wheel arrangement, condenser unit	0-6-2	
Weights in working order:	Metric	English
Boiler unit	62 tons	138,880 lb.
Condenser unit	64 tons	143,360 lb.
Locomotive complete	126 tons	282,240 lb.
On drivers	48 tons	107,520 lb.



Coal Consumption of Turbine and Reciprocating Locomotives at Full Load and Different Speeds

General dimensions:		
Length over buffers	21,915 mm.	71 ft. 11
Rail to top of stack	4,[illegible]80 mm.	14 ft. 0½ in.
Width over all	3,100 mm.	10 ft. 2 in.
Wheel bases:		
Leading truck	2,[illegible] mm.	7 ft. 2⅝ in.
Rigid, boiler unit	2,700 mm.	8 ft. 10[illegible] in.
Driving wheels	[illegible],050 mm.	10 ft. 0 in.
Total for both units	17,525 mm.	57 ft. 6 in.
Wheels, diameter outside tires:		
Boiler unit, truck and rigid	[illegible] mm.	[illegible] in.
Driving	[illegible] mm.	56[illegible] in.
Trailing truck	[illegible] mm.	43[illegible] in.
Turbine, type	[illegible] non reversing	
Nozzles	[illegible]	
Speed, maximum	[illegible] r. p. m.	
Rated capacity	[illegible] h. p.	
Reduction gear, type	[illegible], reversing	
Reduction ratio	[illegible] to 1 approx.	
Boiler type	[illegible]	
Steam pressure	[illegible] lb. per sq. in.	
Fuel	[illegible] coal 11,900 B. t. u.	
Diameter, outside	1,6[illegible] mm.	66 in. approx.
Firebox, length and width	[illegible] mm. x [illegible] mm.	63 in. x 63 in. approx.
Tubes, number and diameter	160-7[illegible] mm.	3 in.
Tubes, length	3,000 mm.	9 ft. 10[illegible] in.
Grate area	[illegible].6 sq. m.	28 sq. ft.

Heating surfaces:		
Firebox	10 sq. m.	108 sq. ft.
Tubes	105 sq. m.	1,130 sq. ft.
Total evaporative	115 sq. m.	1.238 sq. ft.
Superheating	80 sq. m.	861 sq. ft.
Comb. evaporative and super-Sheathing	195 sq. m.	2,099 sq. ft.
Coal capacity	Saddle bunkers 7 tons	
Special equipment:		
Condenser, type	Air cooled	
Condenser surface	1,000 sq. m.	10,764 sq. ft.
Condenser vacuum	24.25 in. nominal.	26 to 27 in. test
Condenser fans	3 of variable speed	
Air heater	166 sq. m.	1,786 sq. ft.
Induced draft fan	Turbine, 10,000 r. p. m., 40 hp.	
Superheater	Fire tube units in all tubes	
Tube soot blower	Operated from cab	
Feedwater heater	3 units in series	
Condensate pump	Turbine, direct driven, 3 impellers	
Boiler feed pump	Turbine, geared, single impeller	
Air ejector	2 jets	
Data and proportions:		
Draw bar pull, maximum	13.5 tons	30,240 lb.
Normal speed	70 km. p. h.	43.5 m.p.h.
Maximum speed	110 km. p. h.	68.3 m.p.h.
Maximum legal speed in Sweden	90 km. p. h	55.9 m.p.h.
Total weight per horsepower	156.7 lb.	

Educational Work for Fuel Economy*

By D. C. Buell
Director, Railway Educational Bureau

Education on a railroad is so intimately bound up with supervision that the two are almost synonymous. One of the present indications of the realization of the importance of educational work is the endeavor being made on many railroads to relieve their supervising officers of office work and keep them out on the road mingling with the men as much as possible. In the past few years the greatest advance in educational work on our American railroads has been due to the practice, which has become almost universal, of holding frequent staff meetings at which matters of vital importance to the operation of the property are discussed by the officers and the men together. These staff meetings started first as an outgrowth of the safety movement and later developed into general meetings with splendid results.

In spite of the universal mental unrest of officers and men of our railroads during and following the period of federal control, there has been a willingness on the part of railroad men to take advantage of educational opportunities of a practical nature which have been presented. This willingness is growing month by month and the prediction is made that during the next ten years railroad men will not be willing just to get by with their job, but will welcome and take advantage of any practical opportunities offered them to increase their knowledge and become more proficient in their work.

From the very nature of the case the greatest economy in the use of fuel on railroads is directly in the hands of the locomotive fireman. In the old days, a man was not allowed to fire a locomotive until he had served his apprenticeship in the roundhouse or on the ash pit, or in some capacity where he became somewhat familiar with firing practice, but the present method is merely to hire the most likely looking man applying and put him right to work as a fireman without previous training or experience other than a couple of road trips for the purpose of breaking him in to his new work.

It is believed that the growing realization of the importance of educational work on our railroads will result in certain definite methods of procedure in the not too distant future, as follows:

The establishment at large railroad centers of schools for the training of new firemen. At these schools, men selected for the position of fireman will be given thorough instruction on fuel and its use. Dummy fire boxes will be set up where men can be given actual practice in shoveling coal and be taught the proper handling of a scoop, and the proper placing of coal in the fire box. At these schools men also will be taught the principles of various types of stokers and stoker operation, as well as the flagging rules, the giving and interpreting of hand, lamp, and other signal indications, the principles of the injector, etc. A week or ten days' intensive instruction along these lines will mean much during the following years that the applicant holds the position of locomotive fireman.

Supervising officers will be relieved more and more of clerical work, attendance at meetings, and other duties which reduce the amount of time they spend on the work with the men in actual supervisional and instructional work.

Moving pictures will be used to a much greater extent than at present and with regularity to instruct men in fuel economy as well as in the other phases of railroading that they must learn as they progress as firemen. These moving pictures will interest and improve the service of older firemen and engineers.

Supervising officers will encourage their men to take advantage of other educational opportunities which may be offered from time to time and will work with the men to help them take advantage of such educational opportunities.

There is a possibility that, as this educational problem assumes more importance, the railroads will select from among their employees those who are best informed to act as instructors and will perhaps find it economical when the right kind of man is available to use such a man as an instructor on the division on which he is employed.

Discussion

In presenting his paper Mr. Buell said that about ten per cent of the men in railroad service are studying to better themselves through personal ambition, while 90 per cent must be induced to study by some outside means. This necessary inducement can be brought into effect by the local fuel organization, by some form of bonus, by competition through the natural satisfaction which all individuals feel in the knowledge of a good job well done and by progressive examination. He expressed the opinion that compulsory educational work is not likely to be highly successful.

That the most difficult task is not that of educating the men, but educating the higher officers to the requirements of fuel economy, was expressed by a number of those who took part in the discussion. This was illustrated by the experience of the Southern Pacific in its campaign for fuel economy in stationary plants. For a year or two emphasis was laid on the education of the men operating the plants, but with very meagre results. The matter was then taken up with the division superintendents, the performance of the plants on each division being rated competitively, with the result that last year the co-operation of the superintendents was obtained and a marked improvement effected.

*Abstract of a paper presented at the International Fuel Association convention, Chicago, May, 1922.

The Tyrone Division of the Pennsylvania Railroad reports having passed through the shopmen's strike without the loss of a single man. This division connects with the Main Line at Tyrone, Pa. Its lines aggregate 279 miles in length, and it employs 1,720 men. General Manager C. S. Krick has sent congratulations to the superintendent on "the wonderful loyalty displayed by the men in remaining at work during the trying days of the strike, particularly when men on the adjacent division left their work in considerable numbers and exerted every effort to induce the employees of the Tyrone division to join them. You and your subordinates evidently have created and maintained among your employees that old-time feeling of loyalty and affection for the company and its interests that has done so much to make the Pennsylvania Railroad what it is today."

New Shop Agreements Have Novel Features

Union Pacific, Burlington and Lehigh Valley Wage Rates Recognize Varying Degrees of Skill Within the Crafts

AMONG the railroads which have recently negotiated agreements with newly organized associations of their shop employees, the agreements of the Union Pacific System and the Chicago, Burlington & Quincy are of particular interest because of the extent to which they depart from the practice established by Labor Board decisions, both as to working conditions and rates of pay. The new wage rates established by both of these agreements are similar in that the various craft classifications have been subjected to a considerable subdivision based on the degree of skill required in the performance of the work, and each subdivision carries its own wage rate. Generally speaking, these wage rates range from 15 cents above to from 7 to 13 cents below the mechanics' rates established by the last wage reduction of the Labor Board.

Union Pacific Agreement

The minimum rate for work ordinarily assigned to fully qualified mechanics is two cents an hour above that established by the Labor Board. The work of specialists or handy men is paid for at rates lower than the mechanics' rates established by the Labor Board but above the rates for helpers.

Rates for Locomotive Crafts—The mechanics in each craft are divided into two groups: (1) those doing work requiring fully qualified mechanics, and (2) those doing work not requiring such skill.

In the machinists' rules there are 28 classifications of fully qualified mechanics. The first eight classes each receive a rate of 85 cents an hour and include specialists (who determine the time and methods required for the performance of all operations), layers out, tool makers, die makers, valve setters, large vertical turret lathe operators, special milling machine operators and axle and crank pin lathe men. The next five classes receive 80 cents an hour and include operators of frame and cylinder planers and frame slotters, air brake specialists, valve gear repair men and inspectors required to sign affidavits under the federal locomotive inspection rules. The next four classes receive 76 cents an hour and include air brake repairmen, machinists assigned to such work as power plant machinery and roadway equipment, autogenous welders and operators of horizontal boring and milling machines. The last 11 classes receive 72 cents an hour. The work in these classes includes that of first-class machinists, locomotive inspectors not required to make affidavits, machine operators not specified in other groups and steam pipe and superheater men.

In the second or less skilled group of mechanics there are 26 classifications. The highest rate in this group is 68 cents an hour and applies to the first 10 classifications. These include operators of semi-automatic machines, lathes, shapers of driving wheel lathes, radial drills and ordinary drill presses on work not specified under any superior classification. Boiler stud men and men laying out and squaring up engine trucks and trailer frames and fitting up truck brasses are also included in this group. The next nine classes receive 64 cents an hour and include men repairing trucks and putting up shoes and wedges, car wheel lathe operators, tire setters, men on valve and cock work, spring and brake rigging men, second-class boring mill operators and operators of truck axle lathes. The next two classes include operators of rough grinders and tool grinders, and receive 60 cents. Men repairing tender trucks, and applying and removing couplers, metal bumpers, metal pilots and engine and tender drawbars, are rated at 60 cents if of over one year's experience and 57 cents if of less than one year's experience. Gas and electric cutters and men doing machinists' work on metal cabs, running boards, stack saddles, brackets, etc., receive 57 cents an hour.

Helpers with over one year's experience are rated at 49 cents an hour and those with less than one year's experience receive 47 cents.

Each of the other locomotive shop crafts is subdivided in a similar manner, although the number of classes from the nature of the work is not as large as in the case of the machinists. But throughout the agreement each classification is so specific as to leave little opportunity for misunderstanding.

With the exception of the blacksmiths, the first classification under each craft is that of the specialist competent to determine the time and the methods to be used in the performance of all operations in the craft, and rates for the various groups are 85 cents, 80 cents, 76 cents, and 72 cents an hour for men who are fully qualified mechanics. In the case of the blacksmiths, the heavy hammersmith working on material six inches or over receives 95 cents an hour.

For work not requiring the skill of fully qualified mechanics the rate groups in each of the locomotive shop crafts are 68 cents, 64 cents, 60 cents and 57 cents an hour respectively. The rates for ordinary helpers are the same in all crafts, but a rate of 54 cents is applied to certain special jobs such as helpers on hand flanging work and boiler washers in the boilermakers' craft, and first furnace heater helpers, hammersmith helpers, first and second fire helpers, and hammer operators in the blacksmith shop.

Carmen's Rates—Car repairmen are divided into two separate crafts: passenger car men and freight car men. Fully qualified passenger car mechanics receive the same rates as the locomotive crafts. The 85-cent rate applies to specialists, layers out and decorators. Letterers and stripers, pattern makers and first-class cabinet makers receive 80 cents; millwrights, electro-platers, and autogenous welders, 76 cents; burnishers, first-class painters, paint mixers, upholsterers, wood machine operators, second-class cabinet makers, first-class locomotive carpenters, and carmen working on passenger car bodies, 72 cents.

Of the less skilled mechanics, truck and platform men, air brake men and second-class locomotive carpenters receive 68 cents; passenger car inspectors, 65 cents; hand-car carpenters and rough painters, 64 cents; seamsters and seamstresses, 60 cents; gas and electric cutters, 57 cents, and paint removers, oilers and brassers, 54 cents. The same helpers' rates apply as in the locomotive crafts.

Starting at 38 cents an hour, coach cleaners receive up to 42 cents depending on the length of service.

Freight car repair men are classified as fully qualified mechanics and helpers. There are six rate groups among the mechanics, the highest of which receives 75 cents and the lowest 54 cents. The first group includes specialists, layers out, wrecking derrick engineers and autogenous welders. The second group, which receives 71 cents, includes air brake rack men and triple valve repairers. The third group receives 67 cents and covers car carpenters and flask makers. Car inspectors and men on ordinary car repair work, starting at 54 cents for less than one year's experience, and adding three cents an hour for each additional year's experience, receive a maximum of 63 cents. Stencilers, painters and gas and electric cutters receive 57 cents, while oilers and brassers are rated at 54 cents. The rates for helpers are the same as in the other crafts.

Differentials above the standard rates are provided for men employed at certain specified points, and in the case of coach cleaners employed at Los Angeles receive from four to six cents below the standard.

Seniority Groups—Compared with those of the Labor Board, the working rules provide considerably more subdivisions in the seniority group, particularly those for the car men, and where the requirements of the service justify, employees may be assigned to work within a spread of 12 hours with one interval of relief of not less than two hours' duration. A mechanic may be required to perform the work of more than one craft when a literal application of the craft classification would require the use of more men than are actually necessary to perform the work.

The agreement provides for 11 seniority groups of mechanics. These are machinists, boiler makers, blacksmiths, sheet metal workers, electricians, pattern makers, upholsterers, painters, mill men, car men (including locomotive carpenters) and coach cleaners.

Stabilizing Employment—One of the most significant features is the article providing for the increase or reduction of expenses with as little disturbance as possible to regularity of employment. Both the managements and the local employees' representatives are charged with the responsibility to so regulate the bulletined hours of assignment as to reduce to the minimum the necessity for increasing or decreasing the number of men employed. For this purpose variations in the bulletined hours may be made by agreement from a minimum of seven hours a day for five days a week, or 35 hours a week, to a maximum of 58 hours a week. The assignments are to be so regulated as to provide as nearly as possible an average of 8 hours a day.

Overtime rules conform to the requirements of this article and instead of applying to time after 8 hours, are made to apply after the normal bulletined hours, whatever they may be.

Stationary Engineers and Shop Laborers—The Union Pacific System has also negotiated a separate agreement with other shop, engine house and power plant workers, who are included in the Shop Employees' Association. This agreement, which is essentially the same as that applying to the mechanic, takes in the employees formerly associated with the International Brotherhood of Stationary Firemen and Oilers and the United Brotherhood of Maintenance of Way Employees and Railway Shop Laborers. The same system of detailed classification and varying rates of pay has been worked out for the employees within this group as that which applies to the mechanical trades.

Apprenticeship—"The number of apprentices will be governed by the necessity of educating the requisite number of mechanics for the service and by the existing facilities." Provision is made for the employment of technical apprentices without conflict with the provisions governing the employment of the regular apprentices. Apprentices start at 29 cents and receive an increase of 3 cents every six months up to the sixth period. The last two increases are 4 cents and 6 cents, respectively, making a final rate of 54 cents.

Helper apprentices start at 49 cents and are advanced 2 cents each six months, terminating their apprenticeship at the end of three years with a rate of 59 cents.

On completion of apprenticeship, if retained in the service, the seniority rights of an apprentice as a mechanic date from one year prior to the completion of apprenticeship.

Welding—The number of oxyacetylene, thermit and electric welders in each craft will be selected as nearly as possible in the same ratio to each other as the ratio between the volume of work generally recognized as belonging to each craft. Once selected, however, individuals or gangs are expected to weld any job, irrespective of the classification to which it belongs.

Overtime—A distinction is made between overtime in the shop and emergency work in yards or enginehouses. In the former case, employees receive a minimum of 2 hr. 40 min. at one and one-half time (equivalent to 4 hr. straight time), while in the latter they are allowed a minimum of 2 hrs. pay for 1 hr. 20 min. work.

In the case of wrecking service, men are allowed one and one-half time rates from the time called until the return to the home station. The Labor Board rules provide for one and one-half time for time in excess of the recognized straight time hours at the home station only.

Settling Grievances—An adjustment board is created consisting of an equal number of representatives from the Association and the Union Pacific System lines. All differences of opinion as to the meaning or application of the rule, or as to the innocence or guilt of any employees disciplined, which are not satisfactorily adjusted between the general manager or lower officers and the representatives of the employees are to be referred to the adjustment board, the decision of which is to be final and binding on both parties. Should a dispute arise involving the revision of the rules or rates of pay, the agreement provides that such disputes be referred to the United States Railroad Labor Board for settlement, the decision of the Labor Board to be final and binding on both parties.

Questions involving discipline are to be decided only as to guilt or innocence. If guilty there is to be no interference with the management in the application of discipline.

The agreement provides for the application of the so-called check-off system to the collection of association dues. Provision is made, however, that upon giving 90 days' written notice to the other, either party may withdraw from this arrangement.

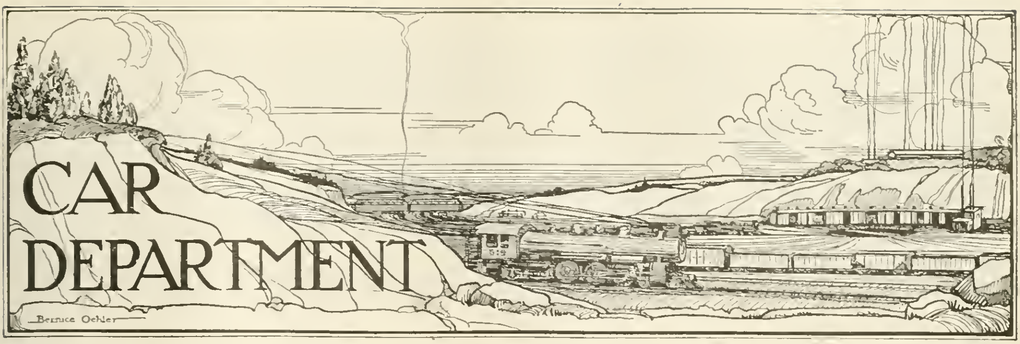
Chicago, Burlington & Quincy Agreement

This agreement is similar to that of the Union Pacific in general character. The wage rates established on the C. B. & Q. are practically the same on the U. P., but the classifications are somewhat less specific and fewer groups are included in the higher rates. The working rules are similar to those established by the Labor Board.

Provision has been made for a large number of seniority groups. Separate seniority lists are maintained for machinists in the machine and erecting shops and wherever forces are under separate supervision separate seniority lists are to be maintained. Sheet metal workers are arranged in two lists, divided between the tinners and copper smiths, and plumbers and pipe fitters. Electrical workers are sub-divided as electricians, power plant electricians, and electric crane operators (two classes). For the car men, separate seniority lists are maintained for pattern and cabinet makers, wood working machinists, upholsterers, silver-platers, coach builders, trimmers and repairers and locomotive carpenters; painters (letterers, etc.); painters (plain painting); car inspectors, and freight car builders and repairers. Wood and steel car repairers are carried on separate seniority lists.

Lehigh Valley Agreement

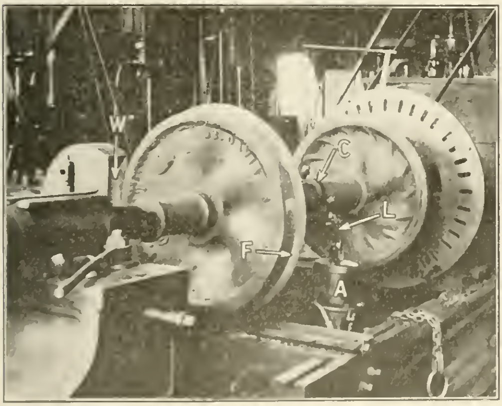
The Lehigh Valley agreement with the newly formed Association of Maintenance of Equipment Employees of the Lehigh Valley provides for three separate classifications, viz., craftsmen, promoted helpers and helpers. The rates of craftsmen vary from 72 cents to 80 cents per hour; of promoted helpers from 53 cents to 63 cents an hour; helpers receive 47 cents the first year and 49 cents thereafter. Passenger carmen, gang leaders on freight car repairs, etc., receive regular craftsmen's wages, but freight carmen and inspectors are rated from 63 cents to 65 cents an hour. Promoted helpers in the car department are rated at from 53 cents to 60 cents and car cleaners at 37 cents. Regular apprentices begin at 27 cents and helper apprentices at 47 cents.



Home Made Car Wheel Grinder

THE recently increased use of autogenous welding methods for building up flat spots in car wheels has focused attention on the need of some device or method for finishing the wheels to a smooth, true circumference after the welding operation. It is practically impossible to apply just enough welded material to the flat spots so as to leave a smooth contour the same as the original tread.

The way in which this problem has been met at one prominent Eastern railroad shop is shown in the illustration. The method consists of building up the flat spots in car wheels by welding and truing off excess metal by grinding. The grinding machine consists of a converted 48-in. Stover lathe in which the car wheels are mounted on their original axle centers. A 24-in. grinding wheel *W* with a 2 in. face is mounted on the tool post of the lathe and arranged to be driven by belt from an overhead drive shaft. The steam cylinder and center casting of a 9½-in. air compressor is mounted in an inverted position between the ways of the lathe bed as shown at *A*. By means of clamp *C*, solidly bolted to the center of the axle and intermediate lever *L*, pneumatic operation of the air compressor piston and piston rod gives the car wheels a partial revolution back and forth. The flat spots which have been built up pass and re-pass the grinding wheel and are ground down to the proper contour. A flat spot after being ground is shown at *F*.



An Effective Grinder for Truing Built-Up Flat Spots

The air compressor is applied with the operating head at the bottom, pneumatic power being supplied through a pipe of small diameter. Rapid movement of the car wheels and piston rod is undesirable so the compressor is throttled by means of the small pipe and does not use so much air. This grinder is obviously efficient for the purpose intended because there is no lost time. The flat spots reciprocate back and forth past the wheel and do not make a complete revolution. The grinding wheel can be adjusted readily across the tread of the wheel and radially towards the axle center by movement of the usual handles controlling a lathe tool post. This device has been in service four years with satisfactory results in the reclamation of chilled cast-iron car wheels with flat spots. While the time required to true a pair of wheels varies greatly with the extent of the flat spots and amount of excess material applied by the autogenous welding methods, 45 min. may be given as an average time.

Recent Decisions of the Arbitration Committee

(The Arbitration Committee of the A.R.A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Delivering Line Responsible for Carding Under Rule 32

Atchison, Topeka & Santa Fe box car No. 28,606 was delivered home with fire damage by the Kansas City Southern on November 2, 1920. The Santa Fe inspector, overlooking the external and visible damage, marked it O. K. for merchandise loading. Before the car was loaded it was discovered that the interior was extensively damaged and that the side door and the facia and siding on an end and one side clearly showed exterior damage. Following the discovery of the damage a request for protection was refused by the chief interchange inspector because the Santa Fe had made no record of the damage when the car was received. Investigation developed that the fire damage was first discovered at the elevator on the Kansas City Southern, when the car was unloaded before its return to the owner.

In its decision the Arbitration Committee points out that the first paragraph of Rule 2 states specifically that "Cars having defects for which delivering line is responsible must be properly carded when offered in interchange," and that this wording obligates the delivering line to assume responsibility by proper carding, and under Rule 32, section (k) it should issue a defect card to cover the damage.—*Case No. 1229, Atchison, Topeka & Santa Fe vs. Kansas City Southern.*

Handling Line Responsible for Damage Due to Cars Breaking Away While Switching

Pere Marquette car No. 30490 was damaged in switching by the A. T. & S. F. at Kansas City on August 13, 1920, to the extent of $956.48, estimated. The car was at the head end of a string of 14 cars being pushed by a switch engine when the six head cars broke loose because of a defective coupler and, after running from 14 to 16 car lengths, collided with the cars standing on the track. The speed was variously estimated at from 6 to 10 miles an hour. None of the cars were derailed. The Pere Marquette claims protection under Rule 32 (b), collision or impact other than that occurring in regular switching. The A. T. & S. F. claims that the action occurred in regular switching, that the speed of the cars was not excessive and that the fact that the foreman in charge of the crew was disciplined does not relieve the owner of responsibility for the damage.

The Arbitration Committee decided that the accident was caused by collision when the six cars broke away as the engineer applied the brakes while backing in on the siding, making the damages delivering line responsibility.—*Case No. 1231, Atchison, Topeka & Santa Fe vs. Pere Marquette.*

Work Done Under Rule 120 Not Limited to That Specified on Inspection Certificate

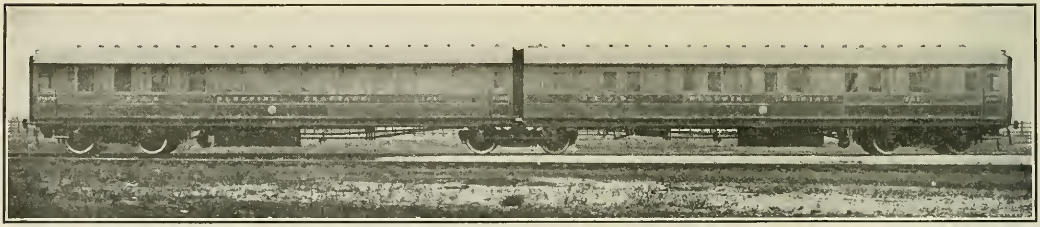
On February 16, 1921, the St. Louis Southwestern asked authority under Rule 120 to repair Chicago, St. Paul, Minneapolis & Omaha flat car No. 15023, submitting inspection certificate showing six sills broken in two, with an estimate of $139.20 material and $117.60 labor to complete the repairs. On receiving authority to proceed with the repairs the St. L. S. W. moved the car to its Pine Bluff shops. Instead of renewing the six sills one side sill was renewed and two draft sills and two intermediate sills were spliced, the total cost of the repairs amounting to $163.23. The car was returned to service on March 25, and on April 2 was again broken in two on the lines of the Terminal Railroad Association of St. Louis. The latter company, on April 11, again asked the owner for disposition under Rule 120, submitting an inspection certificate showing both side sills, two draft sill splices and two intermediate sill splices broken. One of the side sills was broken at both ends and both were reported old defects. Old defects were also reported at the B ends of the spliced sills, the former repairs having been reported at the A end. The St. Louis Southwestern contends that it was within its rights in splicing the sills, the work having been done strictly in accordance with the interchange rules. The authority from the owner did not specify the nature of the repairs, but the owner contends that without specific authority to the contrary, the St. Louis Southwestern was not justified in making the repairs other than as indicated in the request for authority.

The Arbitration Committee decided that it is evident that the St. Louis Southwestern made such repairs as in its judgment were necessary and inasmuch as the car owner did not request application of full length sills the position of the St. Louis Southwestern was sustained.—*Case No. 1230, St. Louis Southwestern vs. Chicago, St. Paul, Minneapolis & Omaha.*

Repairing Line Held Responsible for Reapplication of Non-Standard Triple Valve

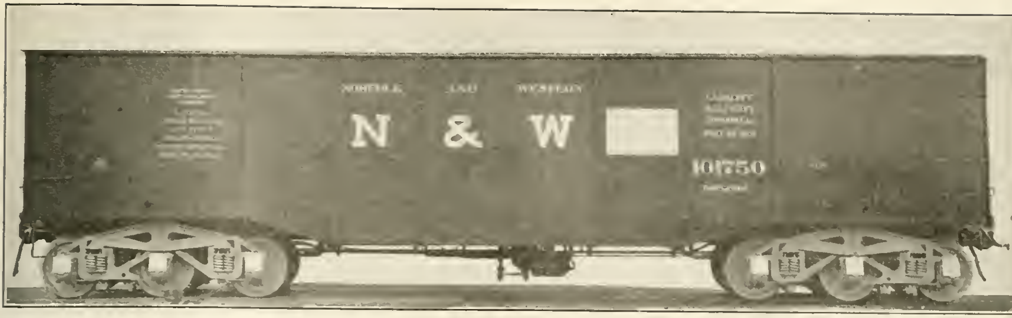
On April 17, 1920, the A. T. & S. F. cleaned, oiled, tested and assembled the brake cylinder and triple valve under L. & N. box car No. 4546, charges for which were included in a system bill against the L. & N. When the car arrived home the L. & N. found that it carried a New York H-1 triple valve instead of the Westinghouse K-2 triple valve which was standard for the car, the car being so stenciled. A joint evidence card was properly executed, the wrong repairs corrected and billing repair card and joint evidence card submitted to the A. T. & S. F. The latter road declined to furnish its defect card on the grounds that it was not responsible for the wrong repair inasmuch as no material was applied on its line, the same triple valve having been removed, cleaned, oiled and replaced. The Santa Fe contended that the old cleaning date showing that the last cleaning had been done on the Wabash (this information having been shown on the Santa Fe billing repair card), should have led the L. & N. to take the matter up with that road, as the triple valve was either applied by the Wabash or prior to the receipt of the car on its line. The L. & N. contends that the removal for oiling, cleaning and testing and the replacement of the non-standard triple valve constitutes the perpetuation of wrong repairs.

The Arbitration Committee's decision is to the effect that the application of a New York H-1 triple valve in place of the New York H-1 triple valve removed, when the car is stenciled "Westinghouse K-2 Triple" constituted perpetuation of wrong repairs, and that the A. T. & S. F. must issue its defect card on receipt of a properly executed request from the owner.—*Case No. 1232, Louisville & Nashville vs. Atchison, Topeka & Santa Fe.*



Twin Sleeping Car for the Great Northern Railway of England

An articulated sleeping car has been built recently at the Doncaster Works of the Great Northern according to designs of H. N. Gresley, locomotive engineer. The overall length of the double car is 115 ft. 6 in. and the weight 138,550 lb. The car is carried on three four-wheel trucks spaced on 47 ft. centers. Each body contains 10 compartments with a single berth and lavatory. Communicating doors permit eight of these to be combined into double compartments. An attendant's compartment and a toilet are also provided. The equipment is quite complete and includes a gas heated circulating boiler for the hot water supply. Windows are of novel construction and fitted with frameless lights, raised and lowered by turning a small handle.



100-*Ton Gondola Car, Designed to Combine Lightness with Strength*

Car Operation and Design from Various Viewpoints*

Effect of Dead Weight on Cost of Operation—Importance of Limiting Speed at Impact in Switching

By John A. Pilcher
Mechanical Engineer, Norfolk & Western

THE importance of the proper design of modern freight car equipment to the car owners, as well as the economic interests of the country at large, cannot be overestimated. It is only within a little over 20 years that steel cars have come into general use. This development has been hastened by the increase in the price of lumber, the decrease in the price of steel and the demand for cars of greatly increased capacity. The use of steel makes it possible to build a car of any desired capacity, so far as the structure itself is concerned, the limitations upon size being only such as are placed by the clearances and strength of the roadway and other physical conditions surrounding operation.

The car constructed of wood, with the draft timber attached to the bottom of the center sills, equipped with the single-spring draft gears and the cast-iron link-and-pin drawbar, is a very resilient structure. This resilience was demonstrated by the fact that it was possible for so many years successfully to use the cast-iron drawhead. We cannot imagine the use of a cast-iron drawhead in a modern steel freight car with any expectation of having it moved any distance. This resilience of the old car was, in a measure, a protection to the lading in the car.

Steel Equipment Introduces New Condition

The introduction of steel into car construction, while it allowed of any capacity and any strength necessary, developed a rigidity in the car construction which reflected itself in local damage to the car itself, as well as the lading, and made necessary the development of the modern shock absorbers, known as friction draft gears, so that one of the greatest problems we now have in car design and upkeep is to get and maintain sufficient and proper shock absorbers and coupler attachments.

When we look about us and see the large variety of steel car designs that have been developed we can appreciate that there are many points from which the important features of the design can be viewed. The primary feature to every design is, of course, the production of a vehicle to haul the freight and produce revenue for the owner and user, but there are also various other features that have to be considered, and they present themselves in as many different phases as there are different minds working on the problem. It is my desire to point out some of the many important features that need be given consideration in the design of a steel car.

Stresses Due to Impact Complicate Problem of Design

If a railway car were subject to no other stresses than those of carrying the load the problem would be a simple one, and could be worked out on the same basis as bridges where the conditions are more or less fixed. There would then be no reasons for not reaching a proper strength of construction for the definite loading. The fact, however, is that the car has to be started, moved and stopped without there being any definite speeds of acceleration and retardation or without there being any certainty as to the character of the roadway over which it is to pass.

The design of the car needs to be studied from many points of view. Among these I will mention the following:

The Owner and User.—This involves the weight of the car itself, cost, maintenance and the possible earning capacity, based upon the cost of the investment and the cost of repairs.

The Transportation or Operating Department.—Its idea is a strong car so as to relieve it of all the burden of the supervision of yard switching crews. In this way it can cut down to a minimum the cost of switching service, which is a very large item in the cost of transportation.

The Claim Department.—It desires a car built in such a way that it will protect the lading from all possible weather conditions and be so resilient of itself that whatever is put in the car will never be damaged by any hurry-up movement in the yards.

The Car Builders.—The car builder desires a car that is very easy to build, one that can be put through the shop with the least amount of supervision; one that will allow the maximum of output in shop production. He is willing to sacrifice a great deal to these considerations.

The Manufacturers and Sellers of Specialties.—These look upon the car as a structure upon which they can hang something that they have to sell. A large duplication of cars of

*From a paper presented before the Railway Club of Pittsburgh, September 28, 1922.

the same type offers a wonderful field for exploitation for the specialty man.

Car Design from the Standpoint of the Owner and User

For the owner and user the car must be constructed primarily to carry the most freight with the least deadweight, so as to bring up the revenue load and enable the car to earn the largest amount of revenue during its life. This feature can hardly be given too much prominence. Of course, like all good things, it is possible to carry it too far.

Lightness of structure does not necessarily mean weakness of structure. The car should, of course, be designed so that it will last through a reasonable period of years, or so it will not be everlastingly on the repair tracks, as a car on the repair tracks is a charge against interest and depreciation during that period without any corresponding income.

So far as the load-carrying capacity of the car is concerned, it is not a difficult matter to fix definite limits of stresses for its proper design. If the designer were given fixed definite limits of speed of acceleration and retardation of the car in its movement and definite conditions of the track over which it is to be moved, it would not be a hard matter to fix the definite requisite strength of the car in every other way. It is at this point where different interests in railroad operation clash. It is the man in charge of moving the cars who is responsible for the speeds at which the cars are brought in contact in the classification yards. His idea is that he can save in the cost of classification by rushing the car movement. He should not fail to remember that every car he damages in this way costs him money in switching charges in that he has to take the car to the repair tracks and bring it back. In addition it also costs the company the loss of the time of the car and the cost of repairs, all charges coming from the same treasury.

It is possible to construct a car and make it strong enough to stand any kind of service to which it is liable, even without having the limits fixed for this service, but if a car should be made strong enough to stand any possible yard service it would be so heavy and so costly as to be of little value to the owner.

Impact Speeds in Switching Should Be Limited

You will readily agree that every car should be made strong enough to stand any accelerating and retarding force that can happen to it while in train service or any type of brake application, but we do not believe it should be made strong enough to stand any kind of service that can be given to it in classification yards. Certain definite limits should be placed upon the rate of acceleration and retardation in the classification yards, or rather a definite maximum speed limit at the time of contact should be set and a large amount of supervision given in the education of the men to see that these provisions are carried out.

A great many of the car details have already been standardized. Through the instrumentality of the Master Car Builder's Association and the Mechanical Section of the American Railway Association, such items as wheels, axles, brasses, boxes, brake beams, brakes, couplers and parts, etc., have been definitely agreed upon. Certain other fundamental features of the car construction affected by impact have also been agreed upon, such as the standard cross-section of center sills, the minimum size and quality of draft yokes, and other features in connection with the draft gear, as well as definite dimensions affecting the fundamentals of the design. Studies are now being made as to the standard method of assuming the loading on the car and of the maximum allowable fibre stresses under such assumptions which will be allowed in the car framing itself, as well as the truck side frames, bolsters and other parts. This will be a wonderful step forward in unifying the art of car construction. It cannot, however, result in any permanent good unless there are some limitations put upon the usage of the car in the classification yard service. We can hardly conceive of anything that cannot be damaged or destroyed if handled sufficiently roughly.

The strength of the cars has been gradually built up in its power to resist end shocks, due to over-speed impact, from the old resilient wooden car through a series of modifications of the composite cars with various strengths of metal center and draft sills until we have reached the full steel car with a minimum of 24 sq. in. cross-section of center sills, which until the recent increase to 30 sq. in. was the maximum.

Center Sills Now Stronger Than Couplers

A recent examination shows that cars constructed with the old limit of 24 sq. in. of center sills (which had been in use for several years) are sufficiently strong between the back stops to furnish reaction against which the shanks of the most modern 6 in. by 8 in. coupler can be upset. It is interesting to note that an examination of a group of such cars, 16 cars being taken just as they were reached, showed three coupler shanks upset 1 in.; two 7/8 in.; three 3/4 in.; four 1/2 in. and the rest of the group from 1/4 in. to 1/2 in. A later examination checking up these same cars indicated that one of these coupler shanks was upset as much as 1 1/4 in. From this we draw the deduction that no cars should be brought together at a speed exceeding that which will bring the draft gear solid, as any excess of such speed is nearly always liable to damage the cars, draft gears and couplers.

The old wooden cars with the wooden draft sills were all fitted up with dead-blocks of some form. Through these the final shock on the car came directly on the end of the wooden end sills to the center sills and they were resilient enough to sustain these shocks for a long time. Doing away with the dead-blocks brings the final shocks on the couplers, and with a clearance between the coupler horn and the striking face of the end sills these forces act directly upon the couplers, upsetting the shanks and driving the coupler heads back into the car and damaging the draft gears.

The damaging of the draft gears and the upsetting of the couplers, which allows the coupler head to be driven back into the car body, has made heavy repairs around the ends of the cars necessary, even though the sills are not damaged between the back stops. The general development of trouble at the end of the car has of late brought into evidence many efforts to overcome this damage by building on to the end of the sills very heavy steel striking castings against which the coupler horn and head will land without going back into the car. If these castings are made sufficiently strong they will, of course, protect the shank of the coupler and, in a measure, the draft gear, at least to the extent of not allowing them to be compressed more than the slack between the horn of the coupler and the striking plate, but it will necessarily be at the expense of the coupler head containing the movable parts.

If there is no limitation placed upon the speed of the cars at the time of impact, these heavy striking plates will simply be anvils against which the coupler heads will, in a short while, be destroyed. Already the coupler horns have suffered.

Suggested Change in Coupler Design

If the dead-block, which was used in the days of the link-and-pin coupler and for a long time afterwards, is to be considered entirely a thing of the past, even though the danger from its use is also largely passed, because no one is allowed to go between the cars in making the coupling, would it not be a good thing if the coupler head were made with a rim all around to come against the heavy cast-wheel striking faces on the ends of the sills, rather than depending upon the horn of the coupler alone?

I am offering in this a method of distributing these heavy loads to all parts of the coupler head rather than to concentrating them on the striking horn of the present couplers, which never was originally intended to be a striking part, but simply a projection through which the lift-hook lever protrudes.

Even if we should replace the dead-blocks which, with resilient material behind them, would, in their shock absorbing capacity for heavy shocks, be equivalent to an additional draft gear, would we not still have to place some limitation on the speed at the time of impact? Protecting the cars from destruction would not protect the lading enclosed within a rigid car from serious damage.

The continual adding of material to the car adds to both the cost and weight. These very seriously reflect in the dividend of the owning and operating corporation.

Comparative Costs of Heavy and Light Cars

I wish to illustrate just what this means by making a comparison of three groups of cars, built at the same time, coming under our observation not many years back. One group of these cars was built with the idea of increasing the revenue load to the maximum which, of course, meant keeping the deadweight to the minimum and correspondingly decreasing the cost. In connection with the design of these cars, a reasonable strength was not neglected, as they were made sufficiently strong to upset the couplers previously mentioned, and up to the present time have not developed any defects that call for extensive repairs that would in any way attract attention. The other two groups of cars are very much heavier, due to the character of the design and to the additional equipment with which they were loaded.

Considering a train of different groups of cars of 5,500 tons gross, including the cars and lading, the lighter cars have $759.10 more revenue in the train in the case of one group and $516.49 more revenue in the train in the case of the other group. Taking the cost of the train into consideration, the lighter cars cost $95,833.88 less than the one group and $74,212.50 less than the other group. If we allow interest and depreciation on the additional cost of 10 per cent and allow 20 round trips per year with the equipment, it means that the lighter cars had an interest and depreciation charge of $479.17 less, per trip, than one group and $371.56 less, per trip, than the other group. If we add together the difference due to the interest and depreciation and the difference in revenue per train we have a difference in one group of $1,238.77, which is 12.32 per cent of the gross revenue of the train, and in the other a difference of $888.03, or 8.62 per cent of the gross revenue of the train.

These figures are startling and show clearly that great saving to the railroads can be made by so regulating the handling of cars in classification yards that the adding on of extra material in the hope of preventing break-downs, due to over-speed impact, will not be needed. The fact that the lighter car in question was sufficiently strong between back stops to upset the shank of the latest A.R.A. coupler and strong enough to furnish the anvil against which the draft gears are being damaged, shows that the car is sufficiently strong in its present state, unless the couplers and draft gears are to be further strengthened.

Damage in Yards Responsible for Failures on Road

Is it not a fact that this over-speed impact in yards, which is upsetting the shanks of couplers and damaging the draft gears and creating in the trains a large amount of unresisted slack is the primary cause of the damage to trains in transit from the emergency brake application and the passage of long trains over humps and through dips?

It is my belief that trains of heavy cars properly equipped with modern draft gears, that have not been damaged and put out of commission or partially put out of commission by improper handling in classification yards, cannot be handled in ordinary train service in such a way as to bring about a sufficient differential in speed between the parts of the train at the time of impact to do any damage to either the equipment or the lading. I have recently been on very long, heavy special trains of new equipment, when the draft gears and attachments are in good condition, and have been impressed with the absence of these internal collisions. While these trains were equipped with special brake appliances which were being tested, I personally give credit for this admirable feature of operation to the condition of the couplers and draft gears and the absence of any great amount of unresisted slack.

This statement may lead to some difference of opinion and may open a way for considerable discussion, but I believe that practically all of the break-in-twos of trains in service when the cars are equipped with modern draft gears and connections is entirely due to damage previously done in classification yards, either to the couplers, knuckles and pins themselves, or else in the fact that the compression of the coupler shanks and damage to draft gears has developed sufficient unresisted slack so there is opportunity for a considerable internal collision in the trains during movement.

Little Gained by Further Increasing Strength of Cars

To show how little can be gained by increasing the strength of cars, we have considered the impact test made by the United States Railroad Administration on the cars on the test track at Rochester, N. Y. At this time they not only tested various types of friction draft gears, but also made impact tests of cars without any draft gears. Drawing an analogy from these to show how little can be gained by increasing the strength of the cars, I call your attention to the following:

1—Assuming a 40-ton car weighing gross 132,000 lb., with a center sill of 24 sq. in. cross-section, fitted with a draft gear that will go solid at an impact speed of four miles per hour, we find the reaction between the cars just as they go solid will be 1.6 times the weight of the car, or 211,000 lb.

2—If we consider the cars going together at 4.4 miles per hour, the force will be 3½ times the weight of the car, or 462,000 lb. With 24 sq. in. cross-section, considering only direct stresses, this will give us 19,250 lb. per sq. in. If the sill of this car were increased to 30 sq. in., and using the same fibre stress, the force of reaction would have to be 580,000 lb., which is 4.4 times the weight of the car and lading. This will represent an impact speed of 4.55 miles per hour for the same car. We could, therefore, by increasing the sill of this car from 24 to 30 sq. in., or 25 per cent, increase the impact speed of the two cars from 4.4 to 4.55 miles per hour, or .15 miles per hour, which is 3.4 per cent. These figures are given that you may see how little increased speed at time of impact is gained by a very large increase in the cross-section of sills. This gives a proportionate increase in strength and unfortunately a proportionate increase in weight. It also gives an increase in interest and depreciation charge, and a proportionate decrease in earning capacity, and nothing like a proportionate increase in impact speed. It has only a very minor effect in the decrease in the cost of car repairs.

In recent years great efforts have been made to reduce the cost of transportation by large increases in the tonnage of the trains, primarily to increase the revenue per train. To do this very large locomotives have been built. This has been largely brought about by those in charge of transportation, who also have control over the equipment in the classification yards where, according to my belief, 97 per cent of the damage to both equipment and lading is done. With more care in the handling of cars in the classification yards the expense and upkeep of equipment can be very materially decreased and the expense of the claim department materially reduced.

How far do you suppose the transportation officer would be willing to go in his efforts in the reduction of the cost of hauling freight if he could bring about a saving equivalent to as much as 10 per cent of the gross revenue of the railway company he is serving? I should think he would be willing to undertake most anything. I have shown in a previous statement as between two groups of cars—one heavy and expensive and the other lighter and correspondingly less expensive, that there is a difference amounting to as much as 12.32 per cent of the gross revenue of the train.

Protecting Against Corrosion

One of the serious features in connection with steel cars, and particularly open top steel freight cars, is corrosion. While the outside of the car can, in a measure, be protected by the use of coatings, the inside portion of the open top car is subject to the corrosive influence of the contents of the car. The dumping and handling of the loads prevent the use of protective coatings on the inside. After the car has been designed so as to carry the load and withstand the shocks of impact, it would last indefinitely, but for this corrosion.

Its final destruction can only be retarded by adding thickness to the material at certain points where corrosion is liable to be excessive, and at certain points where corrosion will weaken the structure, particularly as for instance, in the framing. It is very hard to determine just how much the designer is justified in adding at these points, because any amount added decreases the hauling capacity of the car.

It is very desirable in the construction of large open top cars for use on dumpers to use inside stakes. When the stakes are placed inside they are subject to the extra corrosion which must be allowed for in fixing their size. Shapes should be used offering the least surface for corrosion.

During recent years there has been considerable experiment made as to the value of copper-bearing steel for the purpose of retarding corrosion, using steel of approximately .20 per cent copper. The special tests that have been conducted and observations that have been made of former steel structures built of copper-bearing metal indicate that we may have a very considerable lengthening of the life of the car by the use of copper-bearing steel.

Every car must be looked upon as a package in which merchandise is being shipped. Any increase in the cost of the package, whether it is a car or a separate package going into the car, is a charge against the transportation of that particular article. Every additional expense to the cost of these packages is an additional burden on the transportation of the article and may, in some cases, prevent its being moved at all by the railways. It is just on account of such additional charges in order to protect freight that the automobiles on highways are cutting so deeply into the revenue of the railways, alongside of which they operate. The high cost of cars and the high cost of packages can kill transportation just as easily as high freight rates, because all three go together to make up the cost of transportation.

The designer, above all things, wishes to produce a car that has a large margin over its light weight for lading and for earning revenue, but to get this there must be some limitation put on the speed at which cars are brought together, and this should not be in excess of that which will bring the draft gears solid.

The Transportation Point of View

I have already touched upon this point of view in the preceding paragraphs. The transportation man always wishes a car designed so strong that it does not have to be repaired and one that can be handled without undue care. The transportation people are responsible for keeping down the cost of handling, but it is also their method of handling that, to a large extent, brings about the necessity for repairs. If any compromise is to be arrived at as between the cost of handling and the cost incident to indifferent handling, and the cost of interest and depreciation and loss of revenue in the train due to heavy construction, some definite limitation of speed at the time of impact will have to be fixed, otherwise the designer has nothing definite to which to work and will continue to build cars, making each one stronger than the other. This tendency to make the parts that break a little bit stronger has resulted in each new design being built coming out a little stronger and having power to inflict damage upon the older cars. Such new cars only await their turn to be smashed up by cars of a still heavier design and less carrying capacity coming out later. It is to be hoped that a campaign of education will be brought about to prevent any cars being put together at a greater speed than that which will bring the draft gears solid. Unfortunately there are a great many cars equipped only with twin-spring draft gears, which on the 40-ton loaded car would go solid with an impact speed just a little less than two miles an hour. There are a large number of such cars in use which must be considered in any study of this important phase of the problem.

It would be a good study for the transportation man to find out what percentage of switching movement he would save in his yards if he did not have to set aside damaged cars. Would he not be very much like the telephone operator who is in such a hurry that she gives the wrong number two out of five times, and as a consequence, gets so many calls that she cannot reduce her speed and so continues to make errors that are not only a source of annoyance to her but more so to her patrons? I cannot help thinking that if more time is taken in the handling of cars in switching there will be so much less time given to cutting out damaged cars that there would be little or no increase in the cost of the service.

Point of View of the Claim Department

The stronger and stiffer the car is designed and the heavier, the more liable it is to go solid on the draft gears, and the more liable it is to bring about damage claims due to the rigidity of the car itself. Damage claims, while very small in proportion to the cost of the car repairs, bring about a great deal of friction with outside patrons and develop dissatisfaction which is often of greater moment than the actual cost. The real cure for this is the educational campaign against over-speed impact.

The Car Builder's Point of View

The car builder, of course, desires a car so designed that it is easy to build. This is a consideration every designer should have in mind, since the simplicity in construction reflects itself in the price of the car to the owner and user, and in the cost of transportation, in that it reduces the interest and depreciation charge against the equipment. Too much study cannot be put in the design in order to increase the facilities for building along with decreased weight.

I recently had my attention called to two cars of the same weights and approximately the same number of rivets to drive, and was told by one builder that with the same working force, 25 cars of one design could be delivered from the shop a day as against 20 of the other design. This is mentioned to show the value of giving attention to this feature of the design. Particularly should attention be given to the possibilities of using machine as against hand-driven rivets, not only to save in the cost of rivet driving, but in getting better driven rivets.

The Specialty Man's Point of View

These men who have felt themselves called upon to develop and sell specialties for railway cars have taken a great part in the constructive development of the car-building industry of the country. They are to be highly commended for their efforts. The car building industry, on account of the large duplication of the same design, is a wonderful field for the efforts of such men. There are a great number of these specialties which are exceedingly useful and they should be used, because they are helps in reducing the weight, reducing the cost and reducing the maintenance of the cars. Great care, however, must be taken in selecting them, to be sure that the designer is not being muddled by having the advantages of the specialty overstressed to the neglect of its final value as an economic device, in comparison with others, when the cost is taken into consideration. It requires a large amount of careful analysis not to fool one's self as to the real value of these devices when they are presented, as they often are, in such a pleasing and convincing manner.

In general I do not believe it is possible to go to too much expense in the preparation of the design for steel freight equipment where there is such a large duplication from the same design. This is true for an individual company purchasing any large number of cars for their own use. It is true in a much larger proportion for the railways of this country, as a whole, when they can standardize cars for use on all railways. I have always felt that the American Railway Association, Mechanical Section, could not do better than to organize an engineering department for this purpose.

Every car for which a design is to be prepared should not have simply one design furnished and passed upon, but a dozen or more qualified designers should each work up a design following his own bent or views of construction, each along different lines, each bringing his design to completion, making all of the necessary diagrams, showing methods of loading, weights, details of construction, estimated costs, and then these designers should themselves select either the best two or three to be finally passed upon, or the best types of construction that can be put together, considering weight, cost of construction, relative strength, ease of construction and other pertinent features, and in this way get the advantage of the very best that it is possible to produce to be presented to the country at large. The engineering cost of such a method would be insignificant compared to the advantages to be gained.

The final results will be that the car builders themselves will not find it necessary to maintain such large engineering forces, the cost of which enters into their overhead, which naturally has finally to be passed on to the purchaser and user of the cars.

Continuous Brakes in France

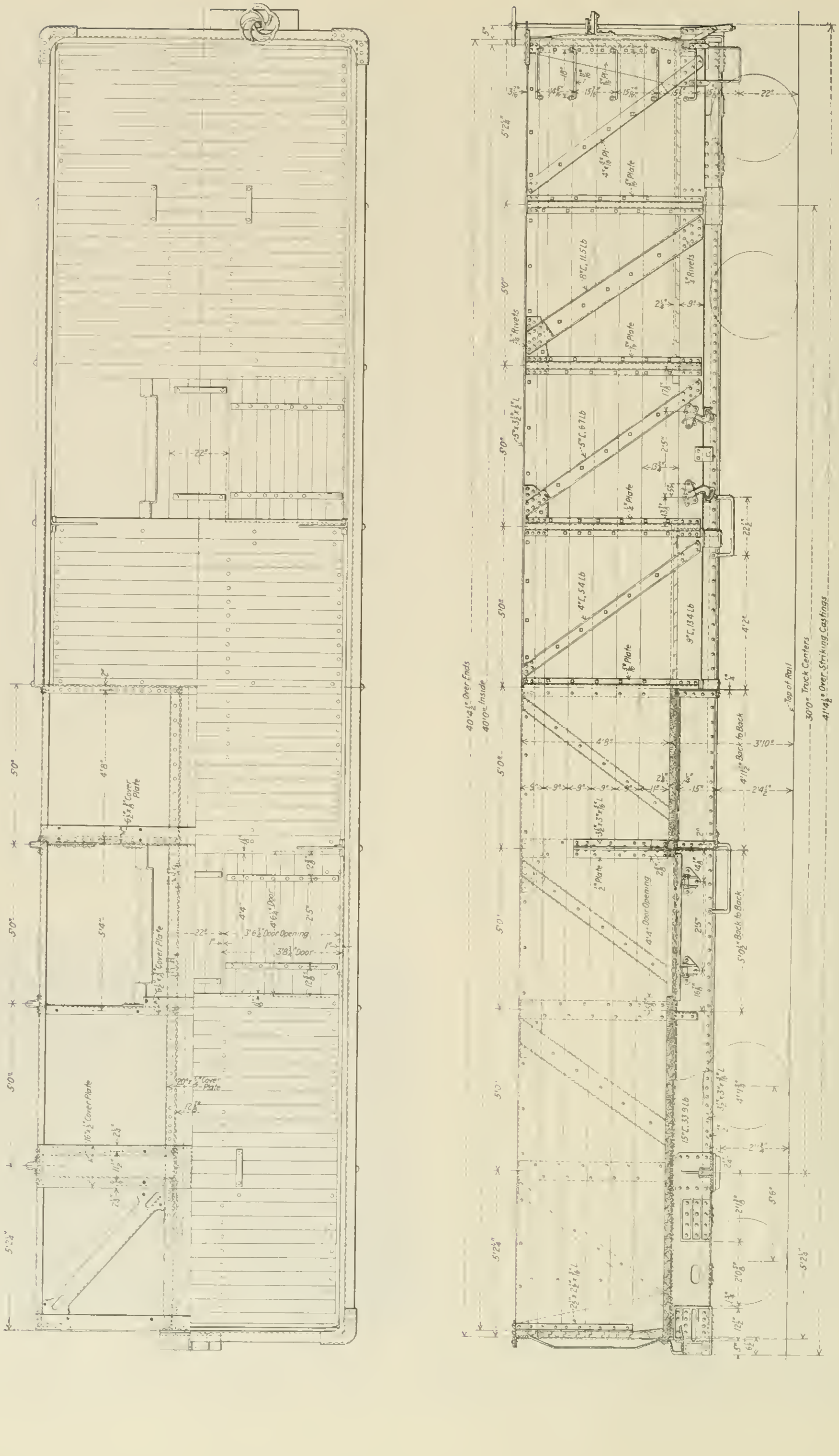
SOME months ago a series of trials was carried out in France with continuous brakes on goods trains, the tests being made on different sections of line with varying gradients. The trains were fitted with three systems of brakes—the Clayton-Hardy, Westinghouse and Lipkowski. The Engineer (London) states that the Technical Commission pursued its task with so much secrecy that a great deal of misleading information has been published from time to time concerning the results obtained with one or the other system, and it is only September 26 that a report has been issued giving a unanimous preference to the Westinghouse brake. The Clayton-Hardy vacuum brake was found to give the best results on long and steep down gradients, but the two other brakes were sufficiently satisfactory, the Westinghouse being adapted for long and severe braking effort by means of separate stop valves that could be put in action as required, while the Lipkowski obtained the same result with a stop valve and a control valve. On the level all three brought the trains to a standstill within approximately the same distance with a slight advantage in favor of the vacuum brake. The Westinghouse system, however, had a decided superiority over the others in smoothness of braking, and appealed to the commission on the ground that its satisfactory working in the United States eliminated any risk of unforeseen difficulties. The Clayton-Hardy was rejected because it would be a very costly operation to replace the compressed air system now used on passenger trains and on a large number of goods trains by vacuum brakes, and as the system adopted would have to be employed on all the rolling stock, the substitution would take a much longer time than could be allowed. Moreover, the weight and size of the Clayton-Hardy were regarded as an objection which could only be overcome by its showing a considerable superiority over the other systems. The Lipkowski brake was ruled out on the ground that it was frequently modified during the trials and was obviously still more or less in an experimental stage.

The commission thereupon decided unanimously to give a preference to the Westinghouse triple valve compressed air brake fitted with a coupling which permits of a stop valve being connected up when heavy goods trains have to descend specially steep gradients. Nevertheless, the adoption of the Westinghouse brake does not necessarily imply that it will be employed exclusively, and it is suggested in the report that some other compressed air system may be used in the future on condition of its being interchangeable with the Westinghouse in a certain proportion. The commission has obviously in view a possible extension of the Kunze-Knorr compressed air brake, which is already used in Germany and Austria, and is being tentatively adopted in Italy and other countries, and as the Berne convention provides for the interchangeability of rolling stock equipment on the continental railways, it is hoped that the Westinghouse brake will at least be employed in conjunction with the German device, should the latter continue to be used on some of the railway systems. The struggle for preference for international use will therefore take place between the Westinghouse and the Kunze-Knorr brakes.

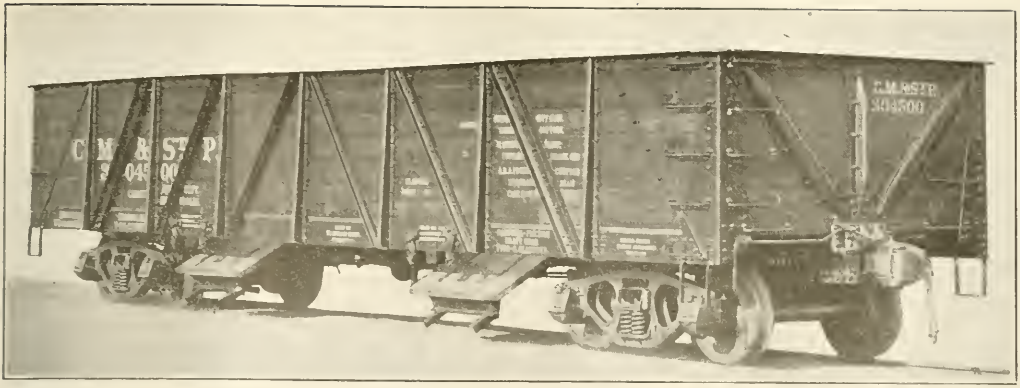
The report of the commission is simply a recommendation for the approval of the Conseil Superieur des Chemins de Fer, which can only come to a decision after investigating the conditions of manufacture in France and the cost of equipment. In the event of a favorable decision, the French government will be invited to propose formally the adoption of the Westinghouse brake on goods trains by the countries which signed the Berne Convention of 1907.

Photo by International

A Washout Near Lyons, N. Y.



Plan and Side Elevation of Chicago, Milwaukee & St. Paul Gondola Car



Method Used in Designing C. M. & St. P. Gondola Car

Analysis of Factors of Design and Loading and Calculation of Stresses in Underframe and Body

In making its recent purchase of 2,500 gondola cars, the Chicago, Milwaukee & St. Paul adopted a new policy by preparing an engineering specification in addition to the general specification. The engineering specification is in effect a summary of the methods of design and includes an analysis of the car framing and the stresses in the individual members. The methods used are so logical and thorough that the specification is of unusual interest; in fact, it is probably the best treatise on the design of cars of that type which has been prepared up to this time.

The type of car was decided on as a 40-ft. gondola of 100,000 lb. capacity with two hoppers. The object which the designers sought was to build the most efficient car of this type that could be devised for hauling coal and for general service, giving equal consideration to economy in construction and in maintenance and to obtaining high serviceability. A consistent endeavor was made to select logical sections and to obtain a disposition of metal proportionate with the static and dynamic stresses to be resisted. Due regard was given to all connections, ample rivets being provided but none that are unnecessary.

Factors of Design

There are four general factors to be considered in the design of a car: (1) the static load from the combined weight of car and lading; (2) the buffing shocks, to which the car will be subjected in the yards and on the road; (3) the torsional strains produced by the weaving and swaying of the car body under traffic; (4) the fatigue of metal from the constant and repeated change of stress intensity under the varying conditions of traffic. Each should be carefully studied independently and later all correlated in the final assembly.

The first factor is comparatively simple of analysis and may be provided for with definiteness. Care should be taken that all possible loadings and disposition of loads have been considered, that the most severe conditions may be provided for.

The buffing shocks to a car are received through the couplers and draft gear and transmitted to the center sill. The design of car must be such that the shock received through the center sill will be distributed throughout the car structure, or as in the case of a car brought to a sudden stop, the connections of the car structure throughout down to the center sill must be such that the center sill may receive and transmit the inertia of the car and lading as a whole.

Provision against the supplementary shocks from shifting of loads is also to be handled under this study. This is provided against by special end reinforcement.

The third factor, that of torsional strains, is probably the most indefinite as to analysis. Reversals of stress and greatly augmented strains frequently result from this action.

Metal fatigue is usually a factor of the maintenance. Weaknesses do not, as a rule, develop immediately, but appear after several months of service. Sections amply strong to the analysis of static load may later fail or weaken from the repeated application under traffic of unexpected strains.

The final design should present a car of such construction that each structural element will not only function properly in its individual capacity, but will blend itself into the whole structure and make the entire assembly into one large composite structure.

The primary function of the center sill is to receive and transmit buffing shocks. It may or may not be called upon to carry the weight of the car. The present tendency in design, for other than flat cars, is to carry the load from bolster to bolster by trussed side frame construction, with the center sill suspended between side frames and performing only its primary function. In order that such a condition may be fully realized, the center sill must be positively and securely supported by cross bearers, and particularly at the middle of the car.

The non-weight carrying center sill is usually of shallow section, seldom over 15 in. deep, and would, therefore, be subject to serious deflection if not properly supported throughout its length. The center point between bolsters being the point of maximum deflection, is, of course, the logical point for support. One cross-bearer at the center is insufficient, because of the shallow depth of the cross-bearer construction, and further, the very nature of the cross-bearer construction, which at the center sill is not a continuous member, does not give a positive bearing or support for the center sill, and the result would be, after repeated loadings and oscillations under traffic, a permanent sag. To guard against such a situation, not only should there be a cross bearer at the center point, but also at the adjacent panel points on either side of the center.

In case an odd number of panels be selected, there would not be a support at the center of the car; then two cross-bearers of rugged construction should be used, one on either side of the center. This latter condition will exist in box car construction, and the cross-bearers must be designed with this object in mind.

Structurally, the center sill is a compression strut under heavy stress produced by buffing shocks, and as such, must be well supported laterally to keep it in line and avoid buckling. The only point along the center sill where the condition of positive lateral support is approached is at the body bolster. It is only approximately so at the cross-bearer points, as the rigidity at this point is a function of the stiffness in the construction in that zone. Therefore, it is apparent that if proper lateral support is to be obtained for the center sill, it is necessary that rigid construction be developed in a zone approximating the middle third of that portion of the underframe between truck centers.

The side frame stiffness is also a function of the rigidity of the underframe. The top chord member of the side frame truss plays a double part; it carries the stress derived from the static load on the truss and also acts as a beam supporting the pressure of the lading against the side of the car. The primary support for this condition is provided by the inside gussets, but further support is contributed by the truss verticals or stakes. The maximum lateral deflection occurring at the center of the car necessitates provision for stiffness at this point, which is obtained by the use of cross-bearers to give good anchorage at the base of the stakes.

Under the weaving of traffic torsional strains will be set up in the car body and underframe. As before, these will be greatest through the middle portion of the car. Therefore, it is quite evident that every effort should be made toward obtaining rigidity and rugged construction in the middle zone.

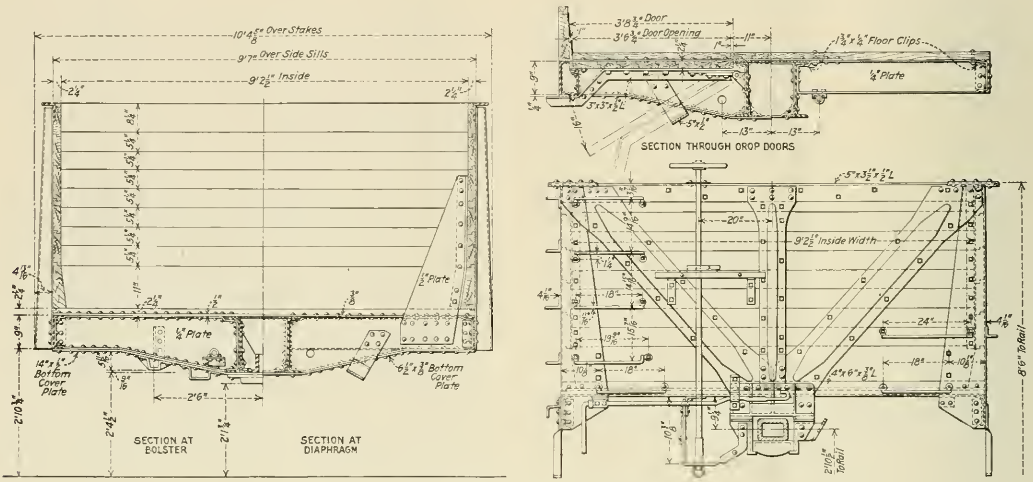
General Construction

In this car the side framing or truss is designed to carry the full load with the center sill considered floating and suspended by the cross-bearers. Lateral deflection in the top chord members is overcome by the insertion of gusset braces as indicated in the drawings. The side pressure is resisted by the top chord acting as a continuous beam supported at each end and at the two panel points where gussets are provided. The vertical truss members also support the side laterally, which gives an added factor of safety.

The general dimensions of the car are as follows:

Length inside	40 ft. 0 in.
Length over buffer striking castings	41 ft. 4½ in.
Width inside side lining	9 ft. 2½ in.
Width over side angle gussets	10 ft. 1 in.
Height from top of floor to top of sides	4 ft. 8 in.
Height from top of rail to top of floor	3 ft. 10 in.
Height from top of rail to top of car body	8 ft. 6 in.
Truck centers	30 ft. 0 in.

The body is built with steel posts and braces, with side and top chord members of angles, channels and pressed sections and reinforced composite end construction. The side lining is 2¼ in. by 8½ in. ship-lapped, and the floor 2¼ in. by 5¼ in. ship-lapped Douglas fir. Two drop doors are provided on each side of the car.



Sections Through Body and End Elevation

For purposes of design the total weight of the car was estimated at 44,000 lb., of which 15,000 lb. would be in the trucks and 29,000 lb. in the body. The weight of coal which the car can carry when loaded to capacity is 120,000 lb., making the total weight of body and lading 149,000 lb. This is not strictly a static load and 20 per cent is therefore added for oscillation, making the loading on which stress calculations are based, 178,800 lb. The area over the sills is 396 sq. ft., making the load per square foot of floor 452 lb. Having determined these values, the calculations for the body stresses can be made.

Center Sill

As previously stated, the center sill is to be supported at several points between the bolsters, and the sections between supports will be so short that they cannot act as a long column; that is, they will fail by compression and not by buckling. The center sill section, therefore, needs to be analyzed only for direct compressive stresses and for stresses due to eccentric loading.

The recommended practice of the American Railway Association, Mechanical Division, calls for a minimum cross-sectional area of 24 sq. in. and a ratio of unit stress to end load less than 0.06.

In this case it was decided to make the principal center sill members two 15 in., 33 lb. channels. The cover plate selected for these chanels was 20 in. by ¼ in. To give a corresponding increase in strength at the bottom flanges, the channels were reinforced with 3½ in. by 3 in. by ⅜ in.

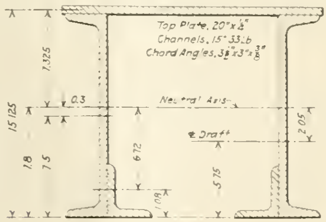


Fig. 1

angles, riveted inside the channels with the shorter leg horizontal. This built-up center sill, shown in Fig. 1, is analyzed to determine whether it meets the requirements for strength.

Let the properties of each element of the sill be represented by symbols:

A = cross-sectional area.
x = distance from base (bottom of sill) to center of gravity of each section.
d = distance from center of gravity of each section to neutral axis of sill.
Iz = moment of inertia of each section about a horizontal line through its neutral axis.
S_b = section modulus of part of sill above neutral axis.
S_t = section modulus of part of sill below neutral axis.
$\frac{US}{ES}$ = ratio of unit stress to end load.
Ee = distance from center line of draft to neutral axis.

Then the calculations for the center sill are as follows:

	A	x	xA	d	Ad²	Iz
Top plate	5.0	15.125	75.61	7.325	268.2	.026
Channels	19.8	7.5	148.5	.3	17.8	625.2
Angles	4.6	1.08	4.98	6.72	207.9	5.44
Combined section..	29.4		229.09	7.8	493.9	630.666
						493.9
						1124.566

$$S_t = \frac{1124.566}{7.45} = 151$$

$$S_t = \frac{1124.566}{7.8} = 144$$

$$\text{Ratio } \frac{US}{ES} = \frac{1}{A} + \frac{Ec}{Sb} = \frac{1}{49.4} + \frac{2.05}{144} = .034 + .014 = .048$$

For the benefit of those who do not habitually deal with similar problems in mechanics, it may be well to explain the steps in the method. The first three values, A, x and xA, are computed to find the distance of the center of gravity from the base. This is obtained by dividing the sums of the values of Ax by the sum of the values of A, which gives 7.8 in. The moment of inertia of the section about the neutral axis is found by taking the sum of the moment of inertia of each part about its own neutral axis (Iz) and adding the sum of the area of each section multiplied by the square of the distance from the center of gravity to the neutral axis of the sill (Ad²). This gives the moment of the entire sill section as 1124.566. The section modulus is equal to the moment of inertia divided by the distance from the neutral axis to the most remote fibre. The value of the modulus in this case is 151 for the top section and 144 for the bottom section.

The maximum ratio of stress to end load in this sill will occur in the bottom section where the bending moment due to eccentric loading produces compression in addition to the direct stress. The resulting value in this case is 0.048.

Checking Stiffness of Bottom Flange of Center Sill

Although the center sill is supported so that it cannot buckle as a whole, there is a possibility of local buckling in the bottom flange. To determine whether this has sufficient strength, the bottom half of one channel with its reinforcing angle is considered as acting alone. This forms a column of the section shown in Fig. 2, which is to be investi-

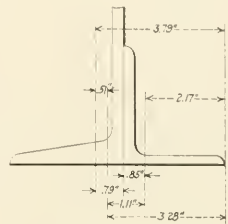


Fig. 2

gated for buckling sideways. The supports are to be 5 ft. apart; in other words, the length of the column, l, = 5 ft. 0 in., or 60 in.

The moment of inertia of the half channel about its vertical neutral axis is 4.115 and its area is 4.95. The moment of inertia of the angle is 1.85 and its area 2.3. The properties of the combined section are found as in the case of the complete sill, as shown below, the symbols being the same as in the previous tabulation.

	A	x	Ax	d	Ad²	Iz	I
Channel	4.95	3.79	18.75	.51	1.29	4.115	
Angle	2.3	2.17	5.00	1.11	2.83	1.85	
Combined section..	7.25		23.75	3.28	4.12	5.965	10.085

The allowable stress is determined by the A. R. E. A. formula for columns.

$$P = 16,000 - 70 \frac{l}{r}$$

where P = allowable stress in lb. per sq. in.
l = length of column.
r = radius of gyration.

In this case $l = 60$, $r = 1.18$ and $\frac{l}{r} = 50.8$. The allowable stress is therefore 12,450 lb. per sq. in. The maximum

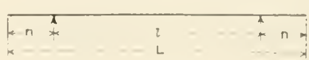


Fig. 3

actual stress from buffing, due to direct compression and bending from eccentric loading with a force of 250,000 lb., is

$$\frac{250,000}{29.4} + \frac{25,000 \times 2.05}{144} = 8,500 + 3,560 = 12,060 \text{ lb. per sq. in.}$$

Since the transverse members will deflect somewhat under load, part of the weight of the lading may come on the center sill and the stresses are therefore checked, assuming that the sill carries one third of the load. The loading diagram is shown in Fig. 3, the stresses being computed as shown below:

$L = 41$ ft. $3\frac{1}{2}$ in. $n = 5$ ft. $7\frac{3}{4}$ in. $l = 30$ ft. 0 in.
$W = \frac{1}{3} \times 178{,}800 = 59{,}600$
f_t = maximum fibre stress at top of sill
f_b = maximum fibre stress at bottom of sill

$$f_t = \frac{W(l - 2n) \times 12}{8 \times S_t} \qquad f_b = \frac{W(l - 2n) \times 12}{8 \times S_b}$$

$$\frac{59{,}600 \times 18 \text{ ft. } 8\frac{1}{2} \text{ in.} \times 12}{8} = 1{,}675{,}000$$

$$f_t = \frac{1{,}675{,}000}{172.5} = 9{,}740 \text{ lb. per sq. in. compression } (+)$$

Unit stress from buffing = 5,530 (+)
Combined 15,270 (+)

$$f_b = \frac{1{,}675{,}000}{165} = 10{,}150 \text{ lb. per sq. in. tension } (-)$$

Unit stress from buffing = 12,060 (+)
Combined 1,910 (+)

In the final design of the car 3½ in. by 3 in. by 5/16 in. chord angles were used, but this would make only minor changes in the calculations given above.

Body Bolster

The body bolster is made up of two pressed steel pans with top and bottom coverplates. The tentative section selected for the coverplates was ½ in. by 16 in.

In figuring the distribution of load to the side trusses, it is assumed that the weight of the lading in the adjoining

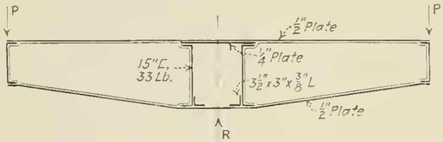


Fig. 4

panel (see Fig. 8) is taken directly on the bolster. The load, P, (Fig. 4) on the end of the bolster is, therefore, $30{,}260 + \frac{14{,}010}{2} = 37{,}265$ lb. The reaction, R, of these forces at the center plate would be $37{,}265 \times 2 = 74{,}530$ lb. The sections through the center sill are analyzed as follows:

Section through center line of car: The bending movement at the center $= \frac{1}{4} \times 74{,}530 \times 109\frac{3}{4} = 2{,}040{,}000$ in. lb. The stress in the plates $= \frac{2{,}040{,}000}{15.75} = 133{,}000$ lb. At 16,000 lb. per sq. in. 8.3 sq. in. of metal would be required in the

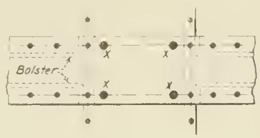


Fig. 5

top and bottom cover plates, or ½ in. plate, 16.6 in. wide. Adding the width of two 3/16 in. rivet holes would make the total width of plate required 18.225 in. A ½ in. by 16 in. plate would have a cross section of 8 sq. in., or, deducting two 13/16 in. rivet holes, a net area of 7.1875 sq. in. The stress in the plate would be $\frac{133{,}000}{7.1875} = 18{,}500$ lb. per sq. in. By adding the rivets shown at xx in Fig 5, the cover plate of the center sill can be used to relieve the high stress at this point. If a 16-in. bolster cover plate is used with two ¾-in. rivet holes, the net width of the cover plate would be 14.375 in. The combined thickness of the bolster and center sill cover plate is ¾ in., giving a cross section of 10.782 sq. in. The unit stress for this section would be $\frac{133{,}000}{10.782}$, or 12,350 lb. per sq. in.

Section 12 in. from center line of car: The bending mo-

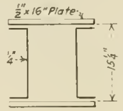


Fig. 6

ment at this section would be (P × 5 ft. 6⅞ in. × 12) — (R × 12), or 1,600,000 in. lb. The modulus of the section is as follows:

Iz of plates = 1/12 × 16 × ⅛ = 0.167 × 2 = 0.334
Iz of flanges = 1/12 × 3 × 1/64 = 0.0039 × 4 = 0.016
Iz of webs = 1/12 × ¼ × 14.75² = 67.00 × 2 = 134.000
134.350

Ad² of plates, 8 in. × 7.875² × 2 = 993.0
Ad² of flanges, 0.75 × 7.5² × 4 = 42.2
Ad² of webs, 0.0
1035.2

Iz total = 1169.54

$$S_m = \frac{1{,}169.54}{8.125} = 143.8$$

$$\text{Unit stress} = \frac{1{,}600{,}000}{143.8} = 11{,}000 \text{ lb. per sq. in.}$$

At the end of the bolster the bending moment becomes zero and the total load acts as a shearing stress of 37,265 lb. At 12,000 lb. per sq. in., this would require an area of 3.1 sq. in. The web area is $2 \times \frac{1}{4} \times 9 = 4.5$ sq. in., making the unit shear $\frac{37{,}265}{4.5}$, or 8,280 lb. per sq. in.

The force transmitted by the side truss through the bolster is 30,260 lb. These parts are to be joined with ¾-in. rivets

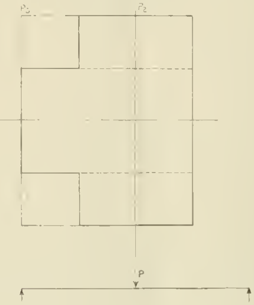


Fig. 7

having ¼-in. bearing, giving a bearing value of 4,690 lb.; $\frac{30{,}260}{4{,}690} = 6.5$, which indicates that a minimum of seven ¾-in. rivets would be required at this point.

Cross-Bearers

The cross-bearers are of the same general contour as the body bolsters except that they have but one pressed web plate instead of two. The load which is considered as carried by the cross-bearers, is shown in Fig. 7. The most unfavorable condition would occur when the load was concentrated at the center and this loading is assumed in calculations for the cross-bearer. Then $P = 2 \times 3/5 \times p_2$ (see Fig. 8) $= 6 \times \frac{13,550}{5} = 16,250$ lb. The moment at the center line of the car $= \frac{1}{4} \times 16,250 \times 9$ ft. $1\frac{3}{4}$ in. $\times 12 = 445,000$ in. lb. The stress in the plate would be $\frac{445,000}{15.75} = 28,250$ lb. This would make the area required to give a stress of 16,000 lb., 1.76 sq. in. This would be equivalent to 4.7 net width of ⅜-in. plate, or 5.38 in., allowing for one 11/16-in. hole.

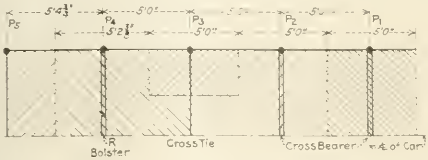


Fig. 8

The cover plate is actually made ⅜ in. thick and 6½ in. wide, the net area being 2.18 sq. in., giving a unit stress of 12,950 lb. per sq. in.

Side Truss

The load distribution for the body is shown in the following table and in Fig. 8.

Truss Loading

$p_1 = 5 \times 4$ ft. 9½ in. $\times 452$		= 10,840
$p_2 = 1\frac{1}{4} \times p_1$		= 13,550
$p_3 = \frac{1}{2} \times p_1$		= 5,420
$p_4 = 5$ ft. 2⅜ in. $\times 4$ ft. 9½ in. $\times 452 + (\frac{1}{4} + p_1)$		= 14,010 (Not on truss)
$p_5 = 2$ ft. 8⅜ in. $\times 4$ ft. 9½ in. $\times 452$		= 5,870
R = 5,420	Check	
13,550	30,260 + p_4 (14,010) = 44,270	
5,420		
5,870	178,800 ÷ 4 = 44,700	
30,260		

The loads are considered concentrated at the vertical members, as shown in Fig. 9. Knowing these forces, the stresses in the members of the side truss are most readily determined by the graphical method shown in Fig. 10. Starting at the point x, the known forces, p_1 or x0, p_2 or 0n, etc., are laid out. The force R or ml acts upward and is laid out in tending to p_5 and the line la is drawn parallel to the bottom chord. Then the stress in the diagonal can be scaled off from the line xa and the stress in the bottom chord from the line la. In a similar manner xb and ab are drawn, then bc and cm, xd and cd, de and ne, xf and ef and fg and og, in the order mentioned.

The sizes of the truss members are then determined as

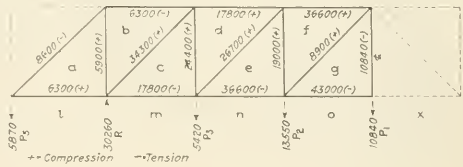


Fig. 9

follows: The maximum stress in the bottom chord is 43,000 lb. For this member a 9-in., 13½-lb. channel is used, which has a cross-sectional area of 3.89 sq. in. Deducting the cross-sectional area of two ⅝-in. holes in the flange and two in the web, leaves a net section of 2.93 sq. in., which gives a unit stress of 14,650 lb. per sq. in. The diagonal, ax, with

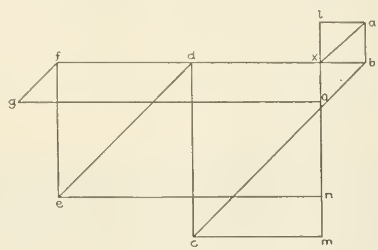


Fig. 10

a maximum stress of 8,600 lb., would require an area of only 0.54 sq. in., or say ⅜ in. by 1.44 in. section. Adding the width of one 13/16-in. hole would increase the size

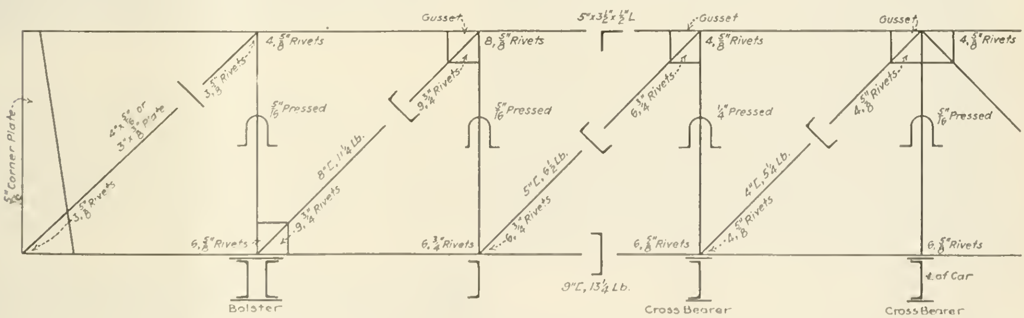


Diagram Showing Size of Members and Riveting in Side Truss

that direction. The last load, p_5, brings the force line back to the starting point, x.

To find the other forces acting at any points in the truss through the diagonals or top or bottom chords, the triangle of forces is drawn. For example, having lx proportional to the force p_5, xa is drawn from x parallel to the diagonal ex- to 2.25 in., but to get satisfactory arrangement of rivets, a ⅜-in. by 3-in. bar is used.

The diagonals, dc, de and fg, are in compression and act as columns. The stresses are checked by the A. R. E. A. formula, but inasmuch as the diagonals are stiffened by bolting to the side sheathing, possible buckling is disregarded, and wherever the unit stress is less than 14,000 lb. per sq. in. the section is considered safe. The stresses in these members and the properties of the sections are as follows:

BC. maximum stress = 34,300 lb. compression

8 in. 11¼ lb. channel A = 3.35 r = 0.63 $\frac{r}{l} = \frac{86}{.63} = 136$

$\frac{70\,l}{r} = 9{,}550$

$16{,}000 - 70\frac{l}{r} = 6{,}450$ lb. per sq. in.

Actual stress $= \frac{34{,}300}{3.35} = 10{,}250$ lb. per sq. in.

DE. maximum stress = 26,700 lb. compression

5 in., 6½ lb. channel A = 1.95 r = 0.498 $\frac{l}{r} = \frac{86}{.498} = 172$

$16{,}000 - 70\frac{l}{r} = 3{,}900$ lb. per sq. in.

Actual stress $= \frac{26{,}700}{1.95} = 13{,}700$ lb. per sq. in.

FG. maximum stress = 8,900 lb. compression.
4 in., 5¼ lb. channel Allowable stress = 3,000 lb. per sq. in.
Actual = 5,750 lb. per sq. in.

Rivets required $\frac{8{,}900}{2.810} = 3.2$ or 4 min.

The post CD has a maximum stress of 24,400 lb. compression. A steel pressing of the form shown in Fig. 11 is used for this member, the calculations being as follows:

Depth A varies from 4 13/16 in. to 2½ in.
Take average section — 3.65625
I For each part

1. Semi-circle

$I_z = .1098\,(R^4 - r^4) - \frac{.283\,R^2r^2\,(R - r)}{R + r} = .374$

$x = \frac{4}{3\pi} \times \frac{R^2 + Rr + r^2}{R + r} = 1.025$

$a = \frac{1}{2} \times .785\,(d_1^2 - d_2^2) = .361$

2. Vertical Section

$I_z = 1/12 \times \frac{5}{8} \times 2.094^3 = .48$

a = 1.308

x = 1.047

3. Base

$I_z = 1/12 \times 4.25 \times \frac{5}{16}^3 = .011$

a = 1.328

x = .1625

A	x	Ax	d	Ad²	Iz	
.361	3.431	1.24	2.356	1.915	.374	
1.308	1.359	1.775	.284	.106	.48	
1.328	.156	.208	.919	1.121	.011	I
2.997		3.223		3.142	.865 = 4.007	

$r = \sqrt{\frac{I}{A}} = 1.158'' \quad \frac{l}{r} = \frac{.61}{1.158} = 52.7$

$16{,}000 - 70\frac{l}{r} = 12{,}310$ lb. per sq. in.

Actual $= \frac{24{,}400}{2.997} = 8{,}150$ lb. per sq. in.

The top chord carries a maximum stress of 36,600 lb. compression and is also subjected to bending stresses due to the outward pressure of the lading. The maximum moment from a load of sand is found to be 31,300 in. lb. A 5-in. by 3½-in. by ½-in. angle, with the short leg extending outward, is used for this member, the calculations being as follows:

A = 4.0 r = 1.01 l = 180 in. $\frac{l}{r} = 178$ $S_m = 1.56$

Allowable stress $= 16{,}000 - 70\frac{l}{r} = 3{,}540$ lb. per sq. in.

Actual compression stress $= \frac{36{,}600}{4} = 9{,}150$ lb. per sq. in.

Bending stress $= \frac{31{,}300}{1.56} = 20{,}000$ lb. per sq. in.

Total 29,150 lb. per sq. in.

The stresses in this member considered alone are excessive, but the angle is attached to the top section of the wood side lining, which is 8½ in. high and 2⅜ in. wide. The stress from bulging is reduced by the wood reinforcing to 7,630 lb. per sq. in., making the total from compression and bulging 16,780 lb. per sq. in.

Load Distribution Between Center Sill and Side Truss

Assuming the transverse members of the body to be perfectly rigid, the ratio of load distribution between the center

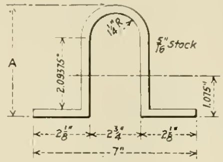


Fig. 11

sill and the side truss of the body would vary as the ratio of deflection of these members. The deflection is directly proportional to the moment of inertia, and to determine this relation the moment for the side truss is found, as shown in Fig. 12, and the following calculation:

I for frame

	A	Iz	x	xa	d
Channels	= 3.89	47.3	65.59	255.145	30.97
Angles	= 4.00	9.99	4.5	18.000	30.12
Combined section		57.29		273.145	34.62

	Ad²
Channels	3,731.05
Angles	3,628.86
Combined section	7,359.91

I for section = 7,359.91 + 57.29 = 7,417.20

The moment of inertia for the center sill is 1,124.566.

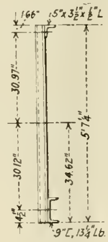


Fig. 12

Therefore, the proportion of the load as taken by the center sill would be $\frac{1{,}124.566}{2 \times 7{,}417.20}$, or 7.6 per cent. The side trusses would carry the remainder, or 92.4 per cent. This would decrease the stresses in the side trusses in the same proportion, but no allowance has been made for this in the selection of truss section, it being utilized merely to provide an additional factor of safety.

Central Control of automotive traffic has now become imperative, in the view of J. M. Glenn, secretary of the Illinois Manufacturers' Association. So much business has been diverted from the railroads to the automobile, and transportation by gasoline has become such an important factor, coupled with the inability of the public highway to meet the demands, that it is imperative that the Interstate Commerce Commission and the various State utility commissions assume control of motor truck and auto passenger traffic, says Mr. Glenn. The railroads are trying to meet the competition by introducing gasoline cars, but experts doubt if they will be successful. The state furnishes the automobile carrier a road maintained at public expense, and yet it is plainly inadequate.

Rotary Surface Grinder Effectively Used on Air Brake Parts

A ROTARY surface grinder, with a work table consisting of a rotating magnetic chuck, the abrasive wheel on a horizontal spindle traversing back and forth across the work, is shown in Fig. 1. This machine, made by the Heald Machine Company, Worcester, Mass., has been installed for a considerable time in the air brake room of the Michigan Central at Jackson, Mich., having conclusively demonstrated its value for grinding air brake parts and, in fact, any surface grinding operation within the capacity of the machine. Any flat surface under 18 in. in diameter can be ground and blocks up to 6 in. thick can be accommodated between the work table in its lowest position and the grinding wheel.

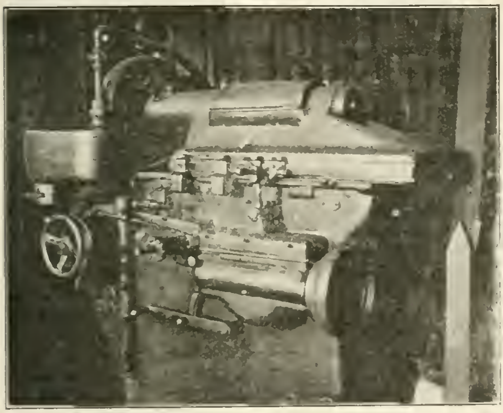


Fig. 1—View of Heald Rotary Surface Grinder from Operating Side of the Machine

One of the principal operations performed on this machine is grinding the sides of air compressor piston rings before application to the pistons. Fig. 2 shows an operator in the act of inspecting a ring just after being ground. The fit of these rings in the piston grooves is of prime importance if compressor capacity and efficiency are to be maintained. The piston grooves are accurately machined, usually on some type of boring mill, and with smooth rings accurately ground to fit these grooves, there is little chance of air leakage by the piston, and consequent loss of compressor efficiency. The particular advantage of the grinding machine for this operation is that the two sides of the ring are finished smooth and exactly parallel. The accurate control of the amount of metal removed by grinding also enables an unusually close fit in the piston groove to be obtained. (As small an amount as .001 in. of metal can be removed at a time.) Another advantage of grinding the sides of piston rings is that the rings may be cut off more rapidly from the packing pot when first being made, using a heavier feed. The grinder finishes these comparatively rough sides smooth, whereas without the grinder, it would be necessary to use the smallest cutting-off feed available with a specially ground tool.

Approximately 50 per cent of the air compressor rings used on the Michigan Central are made in the Jackson shops and ground on the sides on this machine, as shown in Fig. 3. The rings are made 1/32 in. heavier than standard and ground to fit the piston grooves, about 1/64 in. being removed from each side. On an average about 20 rings of the larger size can be ground an hour. It is possible to grind two rings simultaneously as shown in Fig. 3, but there is little advantage in this practice owing to the ease with which rings can be released from, or secured to, the magnetic chuck. The ring is simply placed in the desired position, being held there by the magnetic chuck as soon as the switch is thrown. Reversal of the switch releases the ring.

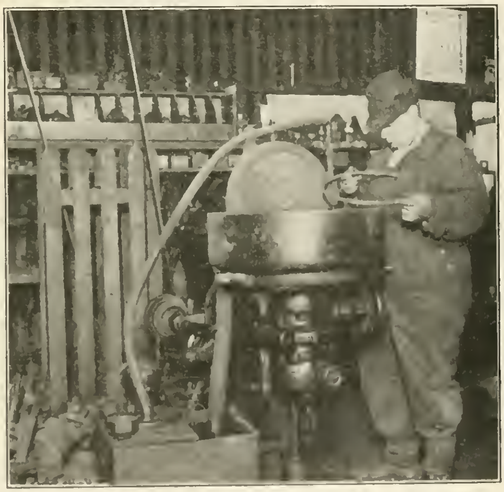


Fig. 2—Inspecting An Air Compressor Ring After Being Ground

Another job of a similar type done on this machine consists of grinding the sides of the smaller main valve rings in the top heads of air compressors. Twenty-five of these rings can be placed on the magnetic chuck, at the same time, being finished accurately, rapidly and smoothly. For the reasons mentioned the grinder is better adapted to perform this operation than any other tool, and the accuracy of finish in this particular case is extremely important since the compressor will not reverse properly unless these rings are an accurate fit in the main valve piston grooves.

In addition to this work, many surface grinding jobs are brought to this machine from other departments of the shop

Fig. 3—8½-In. and 14½-In. Rings Ready for Grinding

and from division points not equipped with grinding machines. Many dies are received from the tool room for grinding. For example, a guide liner die just being developed at Jackson is shown in Fig. 4. This is an effective labor-saving device since these liners are made standard and in quantities as against the old method of cutting them out one at a time with a hammer and chisel and consequent loss of time. This guide liner die was ground on both sides in about 30 min., 1/64 in. of metal being removed from each side. The die was

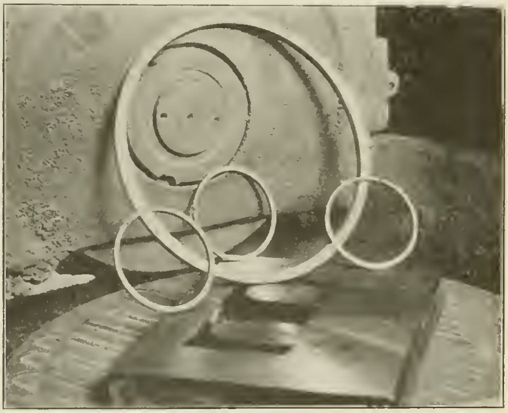


Fig. 4—Close-Up of Packing Rings and Guide Liner Die, Ground on Heald Machine

first ground dry and then finished wet. Fig. 4 shows a combination of the three most important types of jobs now done on this rotary surface grinder.

The machine has also been adapted for lapping-in rotary valves and valve seats as found in the common type of engineers' brake valve. In this case, an auxiliary lapping plate on which abrasive is applied, is held in an eccentric position on the magnetic chuck table. One or more rotary valves, or valve seats are thereupon traversed back and forth across the lapping plate as it revolves, being loosely guided by means of a sheet metal plate provided with the necessary holes and bolted to the grinding wheel head. It has been found necessary to do a little hand lapping after this operation, but most of the work is eliminated.

Preheating Cast-Iron Thermit Welds

In order to compensate for the lower melting point of cast-iron as compared with steel, the Metal & Thermit Corporation, New York, recommends that in preheating cast-iron sections preparatory to Thermit welding them, these sections be heated only a little more than necessary to show color, such as a dull red heat. If this advice is followed, a quieter pour will be obtained and the fusion will be just as perfect. This practice has now been tried successfully in numerous cases, the most important case being a Thermit weld on a large cast-iron press head which required 1,100 lb. of Thermit. The weld was successful with good fusion to the extreme of the edge of the collar, although the cast-iron section was heated only to a dull red heat.

It is believed that this point is important to bear in mind and that operators will find it overcomes possible difficulties which they may be experiencing in cast-iron welding. As the cast-iron of the parts being welded is not quite so fully expanded at this lower temperature, a slightly greater tendency for hair-line cracks to appear in the Thermit steel collar perpendicular to the line of break might be expected. In actual practice, however, this has not been found to be the case, probably because of the fact that the expansion curve is much greater up to a red heat than it is from the red heat to the white heat. The sections are practically fully expanded at this dull red heat. Thermit steel at first heats and expands the sections with which it comes in contact and, therefore, the slight difference in preheating is negligible.

Experimental Tests of Molybdenum Steel

The work on molybdenum as an alloying element in steel, conducted at the Ithaca, N. Y., field office of the United States Bureau of Mines in co-operation with the Vanadium Corporation of America, will be continued in the present fiscal year as a Bureau of Mines problem. The object of this work is to add to the technical information on the value of molybdenum, one of the few elements entering into true alloy steels, of which the United States possesses an abundance of high-grade ore, readily mined and handled. Though there are limitations to its use, it is plainly of great value in steel that is to be heat treated to produce superior qualities. Molybdenum is slowly taking rank along with nickel, chromium, and vanadium as an alloying element for high-grade steel.

Besides the more common physical tests, single-blow impact and repeated impact tests have been made by the Bureau ot Mines on the molybdenum and on comparison alloy steels in co-operation with the Wyman-Gordon Company.

Chief attention has been given endurance tests. This work has been expedited by conclusions drawn from the recently reported work on endurance testing at the University of Illinois and at the Naval Experiment Station. As the alloy steels are of much value when heat treated to give high tensile strength and hardness, and as the investigators above mentioned have worked mainly with plain carbon steels or with alloy steels not heat treated to great hardness, especial attention was paid to molybdenum and other alloy steels so treated as to give great strength. The making of the steels and the heat-treatment and preparation of test bars have been completed. Actual endurance testing remains to be done before complete conclusions can be drawn. Further study is also to be made on the relationship of the rise-of-temperature method of endurance testing, and the regular method of actually testing the steels to destruction by long-time tests.

Steel Treaters and Drop Forgers Meet at Detroit

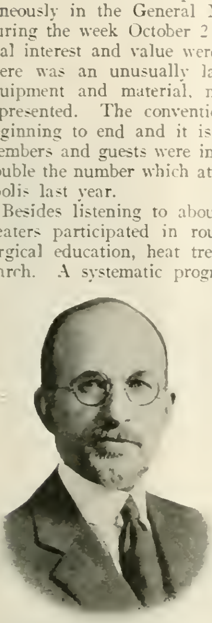
Conventions Featured by Technical Papers, Round Table Discussions, Plant Visitations and a Live Exhibit

THE fourth annual convention of the American Society for Steel Treating and the first annual convention of the American Drop Forging Institute were held simultaneously in the General Motors building, Detroit, Mich., during the week October 2 to 7. Technical papers of mutual interest and value were presented at joint sessions and there was an unusually large exhibition of heat treating equipment and material, nearly 100 manufacturers being represented. The convention was a decided success from beginning to end and it is officially estimated that 18,000 members and guests were in attendance. This is practically double the number which attended the convention at Indianapolis last year.

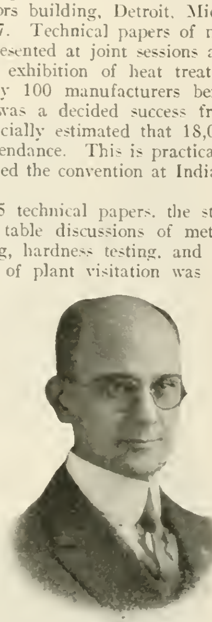
Besides listening to about 25 technical papers, the steel treaters participated in round table discussions of metallurgical education, heat treating, hardness testing, and research. A systematic program of plant visitation was arranged, enabling members and guests to benefit by seeing the many modern heat treating and drop forging plants in Detroit in operation. The annual banquet was held in the ball room of the Hotel Statler, and practically 700 members and guests arose to greet the officers and directors of the two societies as well as the principal speakers as they filed in to take their places at the speakers' table. F. P. Gilligan, chairman of the evening and retiring president of the American Society for Steel Treating, introduced C. T. Bragg, president of the Michigan Valve & Foundry Company, Detroit, as toastmaster. The opening address was made by James Couzens, mayor of Detroit. F. H. Alfred, president of the Pere Marquette, emphasized the need of freeing the railroads from politics, stating that the present system of public control imposes useless and extravagant regulatory laws which would absolutely dwarf the development of any industry so regulated. Mr. Alfred was followed by M. L. Burton, president of the University of Michigan, who presented a masterly address on "That Mind of Yours."

New officers elected for the following year include T. D. Lynch, Westinghouse Electric Company, Pittsburgh, president; W. S. Bidle, of the W. S. Bidle Company, Cleveland, second vice-president; W. H. Eisenman, Cleveland, secretary and S. M. Havens, Wyman-Gordon Company, Harvey, Ill., director. The president's term is for one year and the others are elected for two years each.

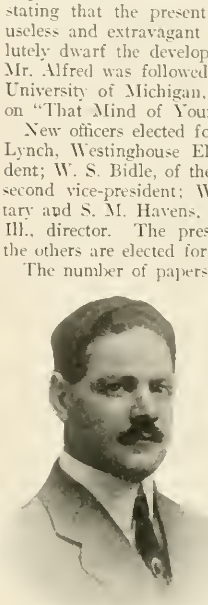
The number of papers presented this year was limited so that practically no simultaneous sessions were held. There was a good attendance at all the sessions and many of the most interesting points were brought out in discussions. Many of the papers were available in printed form in the societies' journal, Transactions, which was distributed before the meetings and greatly assisted in following the reading of the papers. Abstracts of some of the articles presented at the convention and of interest to railroad men are given below and others will be published in the December or subsequent issues.



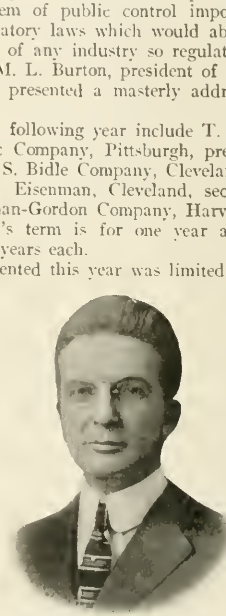
T. D. Lynch
President



W. S. Bidle
Second Vice-President



W. H. Eisenman
Secretary



S. M. Havens
Director

Newly Elected Officers of the American Society for Steel Treating

Lathe Breakdown Tests of Modern High Speed Tool Steels

By H. J. French* and Jerome Strauss†

UNLIKE structural steels, which are generally sold within definite limits of chemical composition, most carbon and practically all alloy tool steels are supplied as brands or under trade names. There are some advantages to this system, both from the standpoint of manufacturer and purchaser, but it has seriously retarded general dissemination of knowledge concerning different types and in many instances has been responsible for erroneous impressions regarding their properties and applications. This applies generally to tool steels but in particular to that important class termed "rapid" or "high speed" steels with which the authors are alone concerned in this report.

It has long been recognized that high grade raw materials, good melting practice and great care in fabrication, all based on an intimate knowledge of the product, are necessary in the manufacture of high speed tool steels and that variations in the many operations involved, which are closely related to tool performance, may readily overshadow the effects of small differences in chemical composition. However, this condition has frequently been misrepresented with the result that the importance of chemical requirements has been largely disregarded by purchasers.

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In quite a few instances large consumers have selected brands on the basis of performance in so-called "breakdown tests" in which the endurance of tools is measured under fixed working conditions though the selling price and power consumption of the various steels may be introduced in any comparisons which are made. In recent years tests of this type have also been used in comparing the performance of special steels or in determining the effects of variations in heat treatment, despite the fact that Taylor[1] specifically recommended determining the cutting speed which would produce failure in 20 minutes under otherwise fixed working conditions and described at great length the reasons for following such a procedure. Comparison of the breakdown and Taylor tests is not within the scope of this report. The former is accepted because it has found commercial application and a portion of the work described in subsequent paragraphs may be characterized as a critical survey of this method of test. The cutting speeds, feed, depth of cut and general test conditions approximated those used in a number of cases for the purchase of large quantities of steel.

In studying the results first obtained, marked superiority in performance of certain types of steel was observed so that these alloys are first grouped according to chemical composition and the resulting classification is used in discussion of results of the lathe cutting tests. It is based upon the analysis of about 65 lots representing nearly 40 brands produced throughout the period 1919-1922[2].

Five sets of breakdown tests are described. The first three, which were carried out at high speed with heavy cut and feed, cover comparisons of about 25 brands and are presented to show some of the limitations in test methods which have been used in the purchase of high speed tool steels. Test Series 4 was carried out with reduced feed in order to ascertain whether the superior endurance observed for certain groups in the first three sets of tests was maintained under more moderate working conditions in which lower frictional temperatures were produced.

The expense of large tool tests, time, labor and special equipment required, made it desirable to carry out test Series 5 to determine whether comparable results could be obtained with small tools. Results of fracture tests, microscopic examination and secondary hardness determinations are also included to throw light upon the quality of metal tested or the characteristics of the various steels under heat treatment.

Classification of Modern High Speed Tool Steels

While the essential alloying elements in high speed tool steels are chromium and tungsten practically all brands now produced in this country for roughing tools contain between 0.5 to 2.25 per cent vanadium. The term *modern* high speed tool steels therefore refers to chromium-tungsten-vanadium steels (which may or may not contain additional special elements) and little or no attention will be paid to the very few brands still manufactured without the intentional addition of vanadium, particularly as they are inferior in performance to the former types.

The modern steels may be grouped under 5 headings, as follows:

1. Low tungsten steels
2. Medium tungsten steels
3. High tungsten-low vanadium steels
4. Cobalt steels
5. Steels containing one or more special elements such as molybdenum or uranium and called "special steels"

Their relative importance from the standpoint of number of brands within each group are indicated in Table I.

Description of Severe Breakdown Tests

Three series of cutting tests were made with 1 by ½-in. lathe tools prepared from about 25 brands and these are grouped according to the type compositions previously described. The first two were carried out in different shops with slightly different tool angles and cutting speeds as shown in Table II but with tools made from the same bars of any single brand. Heat treatments used in both series were carried out at one time with the same equipment and operators under the instructions of the manufacturers' representatives.

The third set of tests consisted of some of the tools in the first series after they had been thoroughly annealed, retreated and ground, together with tools from different lots of the same brands or types not originally represented. Annealing was carried out by heating to 1550 deg. F. and slowly cooling in a furnace to room temperature while the final heat treatments were not necessarily those recommended by the manufacturer but were chosen with the idea of obtaining the best tool performance for each type. These treatments were carried out by different operators in two shops which had

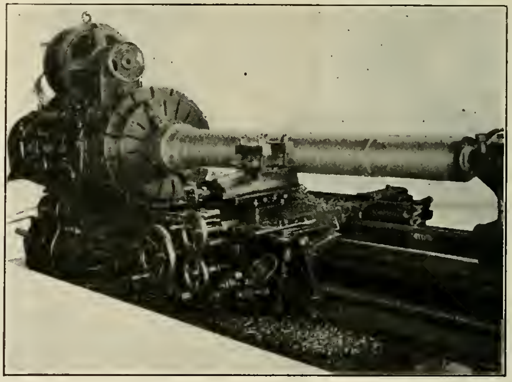

Fig. 1—Lathe and Tool Holder Used in the Cutting Tests

[1] F. W. Taylor: On the Art of Cutting Metals. *Trans.* A. S. M. E., 1906.

[2] Approximately one-third of all analyses was made by H. Bright, Assoc. Chemist, Bureau of Standards, one-third by chemists associated witb one of the authors, and the remainder collected from various other sources.

TABLE I—SUMMARY OF COMPOSITION OF 39 BRANDS OF MODERN HIGH SPEED TOOL STEELS BASED ON ANALYSIS OF 66 LOTS

Type of High Speed Tool Steel	No. of lots analyzed	No. of brands found in specified type	Carbon, per cent			Chromium, per cent			Tungsten, per cent			Vanadium, per cent			Cobalt, per cent			Mo, Per cent	U, Per cent
			Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.		
1. Low tungsten—high vanadium	10	6	.56	.74	.65	2.21	4.45	3.69	11.10	14.00	13.07	.50	2.15	1.47	....	....	....	....	..
2. Medium tungsten	4	2	.62	.71	.66	3.01	4.67	3.93	14.08	15.79	14.92	.69	2.07	1.54	....	....	....	....	..
3. High tungsten—low vanadium	36	22	.45	.85	.66	2.26	4.70	3.54	16.13	19.65	17.90	.48	1.24	.88	....	....	....	....	..
4. Cobalt	8	7	.58	.88	.69	2.78	4.31	3.70	13.07	18.79	16.38	.91	1.63	1.21	1.86	4.73	3.28	....	..
5. Special	8	7	...	...	...	....					(Typical Compositions)								
(a) Molybdenum steels	..	..	...	...	.69	....	....	3.52	.....	.....	12.88	...	....	1.97	....	....	....	.71	..
	..	..	...	...	.64	....	....	3.58	.....	.....	16.65	...	....	1.10	....	....	....	.71	..
	..	..	...	...	.60	....	....	4.00	.....	.....	15.50	...	....	1.20	....	....	....	.50	..
(b) Cobalt-molybdenum steels	..	..	...	...	.65	....	....	4.25	.....	.....	17.70	...	....	1.00	....	....	4.88	1.07	..
(c) Uranium steels	..	..	...	...	.66	....	....	3.94	.....	.....	13.80	...	....	1.45	....	....	....	....	.23
	..	..	...	...	.58	....	....	3.85	.....	.....	13.64	...	....	1.36	....	....	....	....	.19
	..	..	...	...	.64	....	....	3.21	.....	.....	17.03	...	....	.86	....	....	....	....	.26
	..	..	...	...	.80	....	....	3.63	.....	.....	19.80	...	....	.80	....	....	....	....	.21
Totals	66	44	...	...	...	....	....	....	.....	.....	.....	...	....	....	....	....	....	....	..

not participated in tests Series 1 and 2. Thus the three sets of tests should furnish a definite idea regarding the possibility of reproducing results in a severe breakdown test with roughing tools, particularly with respect to brand or type comparisons.

The form of tool selected for all tests was that known as Sellers No. 30 and is commonly employed for heavy duty roughing work. Its angles are 6-deg. clearance, 8-deg. back slope and 14-deg. side slope, while the radius of the nose was made 3/16 in. The edge of the tool between this arc and its full width was straight and met the surface of the bar about 1 in. from the end. This form was adhered to in tests Series 2 and 3 but in test Series 1 the angles were accidentally modified to 6-deg. clearance, 7½-deg. back slope and 12-deg. side slope.

Fig. 2—Roughing Lathe Tools which Failed in Breakdown Tests

Test Procedure

Heavy duty motor-driven engine lathes, of a capacity somewhat in excess of that actually required for the work to be performed, were used in all tests. That employed in tests Series 1 and 3 is shown in Fig. 1. Speed control of the motor was such as to permit obtaining the desired surface speed of the test log within about +5 and —0 per cent and all tests were run dry.

Table II—Conditions Under Which 1 by ½-In. Lathe Tools Were Tested

Test Series	1	2	3
Desired cutting speed, ft. per min. at bottom of cut..	67	61	60
Feed, in. per rev.	.045	.045	.045
Depth of cut, in.	3/16	3/16	3/16
Tool angles—			
Clearance	6	6	6
Back slope	7½	8	8
Side slope	12	14	14
Nose, radius in in.	3/16	3/16	3/16
Test logs used	I and II	III	II

The tools varied in length from 8 to 11 in. and the holder in which they were used was 15 inches long. This consisted of 2 carefully machined U-shaped sections with the bottom of the groove square, 17/32 in. wide and ⅜ in. deep; one section was placed above and the other below the tool and both were held in alignment by two dowel pins at each end. The holder with the tool in place was clamped in the four-bolt tool post shown in Fig. 1.

Cutting was done on test logs of about 15 in. diameter and 8 ft. long, of forged and heat treated 3 per cent nickel steel such as is in wide commercial use for heavy forgings. One to two inches was removed from the diameter after heat treatment and testing was stopped when the log had been cut down to 8 inches.

The test logs used in the three series of tests are quite similar and uniform throughout, as far as may be judged by the tensile properties and hardness. Without doubt, however, variations in machinability exist, so that one tool of each brand was tested before the second tools were used. The latter were then tested in order before the third tool of each brand was tried. Cutting speeds and feeds are shown in Table II. After adjusting the speed of the lathe to give the desired surface speed to the log, the tool was fed in by hand (having previously been adjusted to proper depth) until it took a full cut; the automatic feed was then thrown in and the time observed. Breakdown was sharp in all cases and left no doubt as to the time of any run. A summary of the results of the three series of tests are given in Table III.

Table III—Performance of Various Types of High Speed Tool Steels in Three Series of Lathe Tests

	Performance, as per cent of best type				
Group or steel	1st series	2nd series	3rd series	Total	Average
Low tungsten steels	100	94.1	100	294.1	98
Cobalt steels	67.8	100	97.3	265.1	88
High tungsten steels	56.3	55.3	64.2	175.8	59
Special steels (Mo or U added)	54.6	69.0	(uranium) 51.7	175.3	58
Medium tungsten steels	54.1	55.8	62.4	172.3	57
Special cobalt-molybdenum steel	....	....	84	.....	..
Tungsten-less steel	44.4	....	17.7	62.1	31

Comprehensive tables showing the test details are included at this point; also, a discussion of brand and group comparison, and a table showing average energy consumption.

Character of Chips Produced and Failure of the Tools

From a long "ribbon" of steel progressive decrease in length of chips is undoubtedly, largely caused by a gradual change in the most effective portion of the top surface of the tool resulting from abrasive action of the metal being cut. A groove or "gutter" is worn near the nose and forces the chip to curl more and more sharply as the wear increases and because the chip is highly stressed the ribbon breaks into small sections instead of passing freely over the tool at approximately its original top angles. The wear on the entering side near the nose is also an important contributing factor particularly near the end of the cut and both effects are shown in Fig. 2.

Breakdown is concomitant with the production of a "glaze" on the test log shown in Fig. 3. At the moment of failure

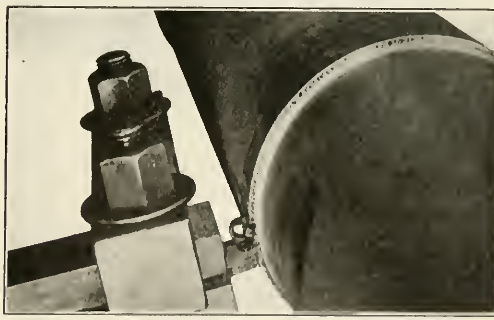

Fig. 3—Lathe Tool Just After Failure; Illustration Shows "Glaze" Produced On the Test Log

which generally occurs suddenly, the dimensions of the chip decrease both in direction of the feed and depth of cut. This is probably caused by "springing" of the tool in the holder and is due to greatly increased pressure in all directions resulting from the "dulling" or rubbing away of the nose. If the tool is withdrawn from the test log at the first signs of failure the last thin chip produced will often "freeze" to the nose, as shown in Fig. 4, thus giving concrete qualitative evidence of the high pressure and temperature existing at the moment.

Test Series 4 showed that the relatively poor endurance of the high-tungsten, low-vanadium steels in the severe tests is not observed under more moderate test conditions. Test Series 5 showed that when small tool tests are carefully carried out, the results are a measure of what would be obtained with larger tools. An interesting feature in comparing the large and small tool tests was observed in that the small tools removed more metal than the large ones before failure. Owing to variables in the two sets of tests, detailed comparisons are of doubtful value and the authors offered no explanation of the apparent better showing of the small tools. Miscellaneous tests were also carried out to determine secondary hardness, character of fracture, etc.

Summary and Conclusions

Important features developed or conclusions drawn from the described tests may be summarized as follows:

1. Breakdown tests, in which endurance of tools is determined under definite working conditions, are not satisfactory as the basis of purchase for high speed tool steels.

2. While competitive comparisons of brands of nearly similar performance are not justified, owing to the qualitative nature of this type of test, relatively large differences may be ascertained with certainty providing sufficient tools are tested and averages of at least 2 grinds are used in interpretation of results.

3. In certain severe breakdown tests with roughing tools on 3 per cent nickel steel forgings, in which high frictional temperatures were produced, it was found that the performance of commercial low tungsten-high vanadium and cobalt steels was superior to that of the high tungsten-low vanadium type and special steels containing about ¼ per cent uranium

Fig. 4—"Freezing" of the Last Thin Chip to the Nose of the Tool

or ¾ per cent molybdenum. The average power consumption in all cases was practically the same so that this factor need not be introduced in comparisons which may be made on the basis of endurance of the tools.

4. Modification in test conditions including small changes in tool angles but principally changes in cutting speed more markedly affected the performance of steels containing cobalt or special elements such as uranium or molybdenum than that of the basic types (plain chromium-tungsten-vanadium steels).

5. The relatively poor endurance of the high tungsten steels under severe working conditions was not observed in more moderate tests, made on the same test log with equal cutting speed and depth of cut but with reduced feed, in which the frictional temperatures produced were not so high. Also in these latter tests the performance of the cobalt steels was better than either the low or high tungsten steels.

6. Hardness determinations and examination of fractures indicate that the various types of commercial high speed steel show differences in behavior under heat treatment and in physical properties which probably are of importance under moderate working conditions, and might counterbalance slight advantages in performance.

Heat Treating in Lead

By R. B. Schenck*

THE lead pot furnace has, in recent years, been applied to volume production in steel treating with considerable success. While molten lead is far from being an ideal heating medium, it is the only metal which can be successfully employed for this purpose, and in comparison with the salts in commercial use as bath materials, it has the advantage of a much wider range of working temperature and a much higher heat conductivity. These two properties permit the use of lead in units of very large capacity for temperatures of 650 to 1,700 deg. F., thus covering the hardening and tempering ranges of nearly all commercial steels.

The selection of pot materials, the design of the pots and brickwork, and the method of firing are points of prime importance and must receive considerable attention if efficient operation is to be obtained. The unit should be built for the job it is intended to handle, bearing in mind at the same time the desirability of standardization.

While some parts cannot be treated efficiently in lead, there are many which can be handled very successfully. Axle shafts, transmission gears and many smaller parts are now being hardened from lead pots, and a greater number are being tempered in lead. The lead furnace has its greatest range of usefulness for tempering operations, and many parts can be tempered in lead which cannot be efficiently quenched from this type of furnace.

Comparing the lead pot with the oven furnace from the standpoint of operation cost, a great deal depends on the nature of the work handled, but in general, it can be stated that for hardening, the oven furnace is the cheaper of the two, and for tempering, the costs are slightly in favor of the lead pot.

Taking everything into consideration, the greatest argument for the lead pot furnace is the high quality of the treated product resulting from uniform and accurate temperatures. It is very difficult, if not impossible, with an oven furnace to obtain the degree of uniformity which exists throughout a lead pot. Experience covering a period of years has proven, at least to the author's satisfaction, that where conditions permit of its use, the lead pot can produce consistently better work than any other form of heating unit.

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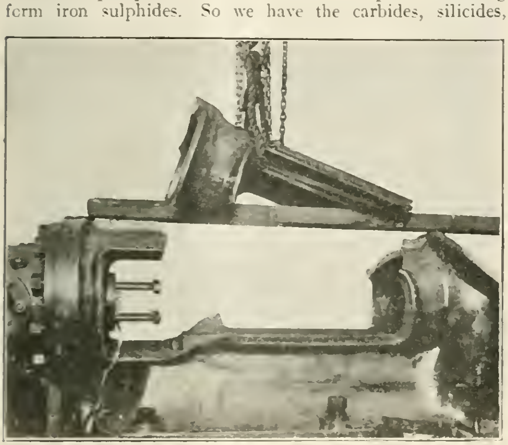
General View of P. & L. E. Blacksmith Shop at McKees Rocks

Principles of Oxyacetylene Fusion Welding
Part 7—Welding Cast Iron, Continued

By Alfred S. Kinsey*

TO the welder who has a discerning eye and who takes a lively interest in the changing characteristics of the metal he is welding, the segregation of cast iron will explain some of the peculiar conditions he has met when welding this metal.

By *segregation* is meant the gathering in separate groups of the different chemical elements of the metal. The pure iron and the carbon combine and form iron carbide. Iron and silicon form iron silicide. The manganese is peculiar in that it combines with the iron and the carbon and forms iron-manganese carbide, and also mixing with the sulphur it forms manganese sulphide. The iron and phosphorus make iron phosphides, and the iron and sulphur combining form iron sulphides. So we have the carbides, silicides,



Broken Compressor Casting

phosphides and sulphides. And as they all have different freezing points they form groups by segregation.

Now the welder may notice sometime when he has his cast iron job in the molten condition that it has a tendency to chill in spots and form little pools of frozen metal. This is the iron *carbide*, sometimes called combined carbon, in action. It will be noticed more in the white irons.

Again manganese *sulphide* will show itself in a cast iron weld as a peculiar film or scum on the surface of the molten metal, and the welder will soon learn that it looks quite different from the ordinary molten slag.

The segregation of the *silicides* shows itself in molten cast iron in the form of small lumps which do not want to melt. This is the silicon encasing a small amount of iron and forming a globule which is pasty and slow to melt.

The *phosphides* sometimes cause the interior of a casting to be spongy and difficult to weld. The welder will notice that the metal is of a weak spongy nature, and that the weld when cold has small gas pockets.

The first indication the welder would have of the *sulphides* in the cast iron would be the flying sparks popping out of the molten metal. Then he would notice that the metal did not flow smoothly. The segregation of the sulphides is more likely to occur about a quarter of the way down from the surface of the metal.

Of course it is not expected that a welder is going to make a special study of every cast iron welding job he performs, but many welders are becoming so thoroughly interested in their work that they are asking to have explained the causes of certain peculiar conditions they meet in melting cast iron with the oxyacetylene torch, and this brief description is intended to encourage the desires of such men.

Hardness and Strength of Cast Iron

It will be remembered that the hardness of cast iron depends largely on the quantity of combined carbon present. This combined carbon is not all alike; some of it is as hard as the hardening carbon in a steel tool and is called austenite carbon, while the remainder of the combined carbon is called cementite carbon. Now let us be sure of these carbons. First, cast iron has carbon in two forms, the graphitic (soft) and the combined (hard) carbon. Then the combined carbon is in two forms, austenite (the hardest) and cementite (softer, but not as soft as graphitic).

The welder who has studied his jobs will have noticed that a cast iron weld sometimes will be filed hard in one place, rather hard in another, and the remainder soft and filable. The different natures of the carbon explains this. The reason usually is to be found in too quick and uneven cooling from the molten to the solid condition.

Now it is to be remembered that the strength of a cast iron weld often is an important characteristic of the metal even though we may think the job would be made of steel if it had to be strong.

Compression—The most valuable characteristic of cast iron is its ability to withstand compressive loads. This may go as high as 200,000 lb. per sq. in., but the average would be about 100,000 lb. An interesting thing about this strength is that it varies with the thickness of the metal, as for example, an iron casting having a compressive strength of say 125,000 lb. per sq. in. on its surface would show only a strength of about 50,000 lb. down four inches from the surface. This is due very likely to the uneven cooling of the casting when it was made, and it serves as a good illustration of the effect of the speed of cooling on the compressive strength.

Tension—While the pulling strength of cast iron is not considered as an indicator of the value of the metal as it would be in steel, it is not to be disregarded. One can easily find iron castings with quite heavy loads hanging to them, and this demands tensile strength. A good average figure for this is about 20,000 lb. per sq. in.

Transverse—The resistance of cast iron to a cross-wise load is important, as the metal is brittle and does not bend like soft steel. The part of the casting receiving this kind of strain is therefore made of liberal size. The average transverse strength of cast iron would be about 2,800 lb. on a special test bar.

Now a welder should keep in mind that when he melts cast iron to make a weld he has these three strength factors of the metal under his control. An ideal cast iron weld would be the one having the same compressive, tensile and transverse strengths and of equal machinability with the rest of the casting, called the base metal, and this is possible with the oxyacetylene torch in the hands of a welder who

* Professor of shop practice, [illegible] Institute of Technology, advisory service engineer, Air Reduction [illegible]

has learned the characteristics of the metal and works in harmony with them.

Crystallization—The crystallization of iron is a fascinating study, and while it may lead to the most involved metallurgy, there are parts of the subject which are not difficult to comprehend by those who may be interested.

First let us think of a piece of pure iron as a network of grains each having at least four flat sides, sometimes five, six, seven or eight sides. In the natural state these grains are carefully arranged with their sides in close contact. Now if we could look through a microscope we would see that each of the grains of iron is composed of a group of crystals like fern leaves or small trees in design. In most cases the crystals are arranged closely together, side by side, and are then known as twin crystals. The strength of the metal largely depends on these crystals being undisturbed in their formation.

After a certain number of crystal groups have been formed into a bigger combination, they separate themselves from any other crystals and thus form a crystal grain of metal, usually just called a grain. Therefore when we hear that a piece of iron is crystallized it is intended to mean that the crystals no longer lie in orderly arrangement but have become so mixed and disordered that the grain they form has become enlarged and, the same thing occurring in the other grains makes the whole piece of metal have a coarse granular appearance.

The grains of iron are supposed to be held together by the law of attraction, although a newer theory states that there is a sort of metallic cement which forms between the grains and holds them together.

The lines between the grains are called grain boundaries, and the lines between the crystals are known as crystalline planes. When the crystals twin, as they should, the line between them is the twin plane. We will see the value of these as we go along.

Slip Bands—Strains produce an interesting effect on iron. Suppose we have a bar of iron 1 in. square by 12 in. long. A pull or tensile strain on the bar would finally break it. Then an examination of the fracture would very likely show a number of vertical cracks through the thickness of the metal, and it will be found that the pieces of metal between these cracks have slid down on one another so that the surface of the bar has become stepped. We might illustrate by using a row of dominoes stood on end. Pressed together they might represent the solid bar of iron. Then by giving them a slight push forward without letting them fall, they will lean against each other slanting a little off the vertical, so that their faces will have slid on each other, leaving the tops out of level.

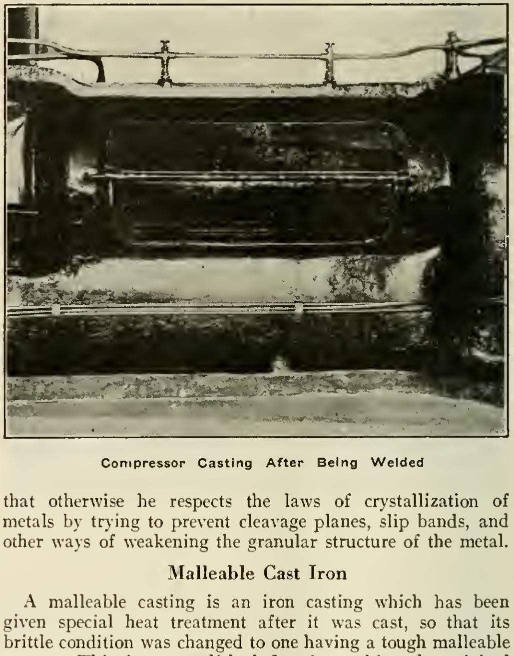
The vertical cracks thus formed are called slip bands. They really are not cracks, but rather are lines between the groups of crystals which have slipped on one another. Sometimes these slips occur between the grains, that is at their boundaries, and at other times the slips may fracture the grains and pass through them.

These slip bands are caused not only by the strains due to actually pulling on the metal, but they also may be produced by too rapid or unequal cooling of the iron. Sometimes a weld is allowed to cool quickly enough to set up undue strains and slip bands may be seen. Again some welding rods may not be of the proper chemical composition and the weld will be full of miniature cracks which are slip bands. Nickel steel may do this if the percentage of nickel is too low, as for example in some nickel steel welding rods, which would be ideal for some welds if the nickel in them was from 3.00 per cent to 3.75 per cent, the nickel content may be only about 1.50 per cent, and this would spoil the weld by causing it to be full of slip bands. And once these slips occur they cannot be hammered closed or filled with molten metal by sweeping the torch over them.

Cast iron is liable to these slip bands, especially if the corners of the casting are sharp. This is due to the following law of crystallization: That the crystals of iron arrange themselves with their ends pointing toward an outside surface.

To illustrate let us think of the crystals in, say, the spokes of a cast iron pulley. If the junction where the spokes and the hub meet were a sharp corner the crystals would have no surface to lie against and they would therefore be separated from the neighboring crystals and thus form a cleavage plane between the crystals running from the sharp corner of the spoke and hub on down through the hub to the hole in its center. Here is the line of greatest weakness and it will develop slip bands. On the other hand if the sharp corner were rounded, called filleting, which of course would have to be done on the wooden pattern of the casting, the crystals would have a surface to lie against and no cleavage plane would be formed.

The meaning of all this to the welder is that he should see that he does not make welds having sharp corners, and that otherwise he respects the laws of crystallization of metals by trying to prevent cleavage planes, slip bands, and other ways of weakening the granular structure of the metal.



Compressor Casting After Being Welded

Malleable Cast Iron

A malleable casting is an iron casting which has been given special heat treatment after it was cast, so that its brittle condition was changed to one having a tough malleable nature. This is accomplished first by making the original casting of white cast iron. It will be remembered that there are five grades of cast iron running from No. 1, a soft gray iron, through the other gray irons to No. 5, which is a white iron, hard and brittle. Such a white iron casting contains about 3 per cent of carbon which is in what is known as the combined, or cementite condition. The problem therefore is to change the cementite carbon of the iron to graphitic carbon, which will make the casting tough and malleable.

The white iron casting is packed in an iron box and surrounded by a special powdered iron ore, or mill scale which is the scale dropping from iron bars when being rolled in a steel mill, or some other material, all of which are iron oxides. The packed casting is then heated red hot and allowed to cool very slowly, thereby transforming the carbon and malleabilizing the casting. This is usually referred to as annealing the casting, and the changed carbon is known as temper carbon.

The malleability of cast iron is therefore accomplished by two things: (1) The transformation of cementite to graphitic carbon; (2) the reduction of the amount of carbon by its absorption by the iron oxides surrounding the casting. There are two kinds of malleable iron castings, the White Heart Castings, and the Black Heart Castings.

White Heart Malleable Castings

These are made by using the iron oxide packing to remove the carbon from the castings, and by annealing them at a temperature of from 1,470 to 1,650 deg. F. for a period of four or five days. This changes the color of the iron from a dark to a silvery white from the outside through to the center, and gives the metal a coarse grain. This method of malleabilizing iron is so slow that it only is used on small castings.

Black Heart Malleable Castings

In this kind of casting the malleabilizing is accomplished by changing the cementite to graphitic carbon, and not so much by taking the carbon out by an oxide packing, as with the white heart iron. Black heart castings are packed in oxides, however, to give them greater strength, and this packing burns out some of the carbon near the surface and gives it a white rim while the core is quite dark. This gives these castings the name of Black Heart. They need to be heated for annealing at a temperature of from 1,290 to 1,470 deg. F., and require only about 2½ days at such a temperature to be converted.

Black heart malleable castings are the ones in greatest use for all sizes. An oxyacetylene welder may easily identify such a casting if it is broken, by its rim of white pure iron over a dark core of graphitic carbon iron, while a white heart casting could readily be recognized by its uniform silvery grain from surface to center. Of course a welder would know any kind of malleable casting from the ordinary iron casting by the finer grain and tougher nature of the former and the coarser gray grain of the latter.

Welding Malleable Iron

From the foregoing it may be seen that the chemical difference between an ordinary iron casting and a malleable iron casting is chiefly that of the carbon. That is, an ordinary iron casting has its carbon in two forms, mostly of graphitic and a little of combined, while the carbon in a malleable iron casting is first practically all in the combined (sometimes called cementite carbon) form, and then it is changed by heat treatment to graphitic carbon. But this graphitic carbon is not the same as the graphitic carbon of an ordinary casting. It is in the shape of fine particles scattered throughout the metal and is called temper carbon, while the other graphitic carbon lies between the grains in good-sized flakes. The ordinary graphitic flake carbon weakens cast iron, while the malleable temper carbon makes it tough and strong.

Now let us see how this affects the oxyacetylene welder. When a malleable iron casting is heated to the molten state for welding and then allowed to get cold its uncombined temper carbon of fine particles is absorbed by the pure iron and it then becomes the combined carbon of the malleable iron before it was annealed, leaving the metal a hard brittle white iron.

There is no practical way to overcome this. About the only thing that can be done when making a malleable iron weld is to use for the welding rod a metal which will remain soft and tough after cooling, and for this purpose tobin bronze has been found quite serviceable. It fuses well with the malleable iron and is stronger in tensile strength. Of course the tobin bronze weld will not match the iron in color.

In welding malleable iron care should be taken with how it is melted. The bronze rod and the iron should be run together with the metal in the dull condition, that is, while it is still thick and sluggish, and not as liquid as in ordinary welding. This will retain some of the temper carbon in the iron at the edges of the weld and prevent it from becoming too brittle.

There is a time, however, when malleable iron can be successfully welded, and that is at the malleable iron foundry after the white iron casting has been made and before it is packed in iron oxides to be annealed. Then if it contains blow-holes or other defects they may be satisfactorily welded by the usual oxyacetylene method of welding cast iron with cast iron welding rod. The annealing or malleabilizing which would follow would then have the same effect on the weld as on the rest of the casting.

An Interesting Economizer Installation

The L Street Station of the Boston Edison Company has an economizer installation, shown in the diagram, of interest to power plant engineers because a considerable saving is made by using a low pressure economizer in a high pressure station. In addition to a lower first cost, there is also a decrease in maintenance and upkeep.

The economizers are located on the third floor of the station and the water is pumped to them by turbine-driven,

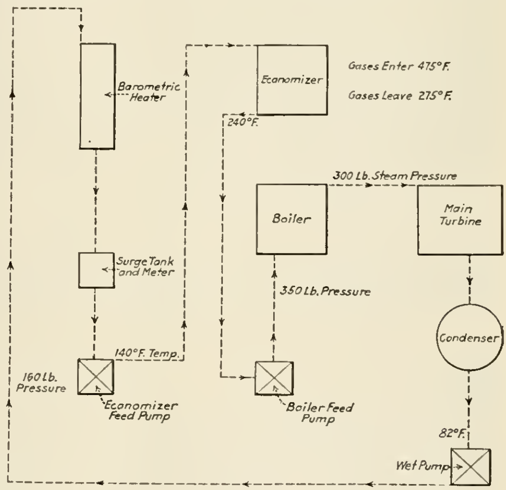


Diagram of L Street Station Economizer Installation

staged pumps located on the floor of the generator room. After leaving the barometric heater, the feed water passes through a meter and surge tank and drops down to the economizer feed pump at 140 deg. temperature. It is pumped through the economizer at an initial pressure of 160 lb. The water then drops down to a second pump and is pumped into the boilers at 350 lb. pressure and approximately 240 deg. temperature, representing 100 deg. rise through the economizer.

A condition is shown on the sketch where the boilers are at low rating and naturally the values would be higher for higher ratings at the station. The interesting part of this equipment is the fact that two pumps are used, one before the economizer and one between the economizer and the boilers. This naturally brings up the questions of proper control.

The boilers are equipped with automatic regulators of the Copes type. When water is fed too rapidly to the boilers, this regulator acts and shuts down the supply. As the pressure builds up, the pump regulator works through a Mason control on the pump turbines, cutting down the supply of steam and decreasing the speed. This builds up a pressure on the economizers that is communicated to the pump control on the economizer feed pump, similar to the boiler feed pump control. This, in its turn, slows down to the proper amount. There is no surging or hunting and no irregularities in this feed pump system. The control follows the load accurately and this station has had no trouble with the economizer equipment since its installation.

As the idea was new, it was thought best to provide the high-pressure type of economizer, in case the pumping system did not work out as well as expected by the engineers. Sturtevant economizers were furnished and tested to 500 lb. pressure but experience indicated that this system can be successfully applied using a standard low pressure type of economizer at a much lower initial cost.

This system could be applied to stations, having low pressure type economizers, where it was desirable to increase the steam pressure. Again, it can be applied where the economizers have been in for a considerable period of years and the life extended three or four years by cutting down the pressure as boiler pressures are reduced from time to time.

TABLE I.—UNIVERSAL PIECE WORK EARNINGS APPORTIONMENT TABLE.

Hours of 40 per cent operative (B)	Hours of 60 Per Cent Operative (A).																	
	1.	1.25	1.5	1.75	2.	2.25	2.5	2.75	3.	3.25	3.5	3.75	4.	4.25	4.5	4.75	5.	5.25	5.5
1.	.60	.6522	.69	.7242	.75	.7714	.79	.8049	.82	.83	.84	.85	.86	.864	.87	.877	.88	.887	.89
1.25	.5454	.50	.6428	.6772	.7058	.7296	.756	.7674	.7826	.7958	.8076	.8182	.8276	.836	.8437	.8507	.857	.863	.8684
1.5	.50	.5556	.60	.6364	.67	.6923	.714	.7333	.75	.7647	.78	.7895	.80	.8095	.82	.8261	.83	.84	.85
1.75	.4615	.5173	.5625	.60	.6316	.6585	.6818	.7022	.72	.7359	.75	.7627	.7742	.7846	.7841	.8028	.8108	.8182	.825
2.	.43	.4839	.53	.5675	.60	.6279	.65	.6735	.69	.709	.73	.7377	.75	.7612	.77	.7808	.79	.7974	.805
2.25	.40	.4545	.50	.5385	.5713	.60	.625	.6471	.6667	.6842	.70	.7142	.7273	.7392	.75	.76	.7692	.7778	.7857
2.5	.38	.4286	.47	.5122	.55	.5745	.60	.6226	.64	.661	.68	.6923	.70	.7183	.73	.7403	.75	.759	.77
2.75	.3529	.4054	.45	.4884	.5216	.551	.5769	.60	.6207	.6393	.6562	.6716	.6857	.6986	.7105	.7215	.7317	.7412	.75
3.	.33	.3846	.43	.4667	.50	.5394	.56	.5789	.60	.6191	.63	.6522	.67	.68	.69	.7037	.71	.7241	.733
3.25	.3158	.3658	.4091	.4468	.48	.5094	.5357	.5593	.5806	.60	.6176	.6338	.6486	.6623	.675	.6867	.6977	.7078	.7174
3.5	.30	.3488	.39	.4286	.46	.4909	.52	.5409	.56	.582	.60	.6164	.63	.6456	.66	.6706	.68	.6723	.70
3.75	.286	.3333	.375	.4117	.4444	.4737	.50	.5238	.5454	.5652	.5833	.60	.6154	.6296	.6428	.6552	.6667	.6774	.6875
4.	.27	.3191	.36	.3962	.43	.4576	.48	.5077	.53	.5493	.57	.5844	.60	.6144	.63	.6404	.65	.6631	.67
4.25	.26	.3061	.3461	.3818	.4138	.4426	.4687	.4925	.5143	.5342	.5526	.5596	.5854	.60	.6136	.6264	.6382	.6495	.66
4.5	.25	.2941	.3333	.3684	.40	.4285	.45	.4782	.50	.52	.54	.5556	.57	.5862	.60	.6129	.62	.6364	.64
4.75	.24	.283	.3214	.356	.387	.4154	.4412	.4648	.4865	.5065	.525	.5422	.5581	.573	.587	.60	.6122	.6237	.6346
5.	.23	.2727	.31	.3443	.38	.403	.42	.452	.47	.4936	.51	.5294	.55	.5604	.57	.5876	.60	.6117	.62
5.25	.222	.2631	.30	.3333	.3636	.391	.417	.44	.4615	.4814	.50	.5172	.5333	.5484	.5625	.5757	.5882	.600	.6111
5.5	.21	.2542	.29	.3231	.35	.3803	.41	.4286	.45	.47	.49	.5056	.52	.5368	.55	.5643	.58	.5887	.60
5.75	.207	.2459	.281	.3134	.3428	.3697	.3947	.4177	.439	.4588	.4773	.4945	.5106	.5257	.54	.5534	.566	.578	.5893
6.	.20	.2381	.27	.3043	.33	.36	.38	.4074	.43	.4482	.47	.4838	.50	.5152	.53	.5428	.56	.5675	.579
6.25	.1935	.2307	.2646	.2958	.3243	.3506	.375	.3976	.4186	.4382	.4565	.4737	.4898	.505	.5192	.5327	.5454	.5575	.569
6.5	.19	.2239	.26	.2877	.32	.3417	.37	.3882	.41	.4286	.45	.4639	.48	.4951	.51	.53	.54	.5478	.56
6.75	.182	.2174	.25	.28	.3077	.3333	.3571	.3793	.40	.4193	.4375	.4545	.4705	.4857	.50	.5135	.5262	.5384	.55
7.	.176	.2112	24	.2727	.30	.3253	.35	.3707	.39	.4105	.43	.4455	.46	.4766	.49	.5041	.52	.5293	.54
7.25	.171	.2055	.2368	.2658	.2927	.3176	.341	.3626	.383	.402	.42	.4369	.453	.4678	.4821	.4956	.5084	.5206	.5323
7.5	.167	.20	.23	.2592	.29	.3103	.33	.3548	.37	.394	.41	.4276	.44	.4636	.47	.487	.50	.5122	.52
7.75	.162	.195	.225	.253	.279	.3043	.326	.3473	.3673	.386	.404	.4205	.436	.451	.4655	.479	.492	.504	.5156
8.	.16	.19	.22	.247	.27	.2967	.32	.3402	.36	.3786	.40	.4128	.43	.4434	.46	.471	.48	.496	.51
8.25	.154	.185	.214	.241	.267	.2903	.3125	.3333	.353	.3714	.389	.4053	.421	.4356	.45	.4634	.476	.488	.50
8.5	.15	.181	.21	.236	.26	.2842	.31	.3267	.35	.3644	.38	.3962	.41	.4285	.44	.456	.47	.491	.49
8.75	.146	.1764	.205	.231	.255	.2783	.30	.3204	.34	.3578	.375	.3913	.407	.4215	.4355	.4489	.4615	.4736	.485
9.	.143	.1723	20	.226	.25	.2727	.294	.3143	.33	.3514	.37	.3846	.40	.4146	.43	.4418	.45	.4667	.48
9.25	.14	.1685	.196	.2?1	.245	.2673	.288	.3084	.327	.3451	.363	.3781	.394	.408	.4218	.4351	.4478	.46	.4714
9.5	.136	.1648	.194	.216	.24	.2621	.28	.3027	.3266	.34	.36	.3719	.39	.3871	.42	.4285	.44	.4532	.46
9.75	.133	.1613	.187	.212	.235	.2571	.278	.2973	.316	.3333	.35	.3658	.381	.395	.41	.4222	.435	.4468	.4583
10.	.13	.1578	.18	.208	.23	.2523	.27	.292	.31	.3277	.34	.36	.37	.389	.403	.416	.43	.441	.45

UNIVERSAL PIECE WORK EARNINGS APPORTIONMENT TABLE (*Continued.*)

Hours of 40 per cent operative (B)	Hours of 60 Per Cent Operative (A).																		Hours of 40 per cent operative (B)
	5.75	6.	6.25	6.5	6.75	7.	7.25	7.5	7.75	8.	8.25	8.5	8.75	9.	9.25	9.5	9.75	10.	
1.	.896	.90	.904	.908	.91	.913	.916	.918	.9207	.923	.925	.927	.929	.931	.933	.934	.936	.94	1.
1.25	.873	.878	.882	.8864	.89	.8936	.897	.90	.903	.9057	.9083	.9107	.913	.9152	.9173	.9193	.9213	.923	1.25
1.5	.8519	.86	.8621	.87	.8709	.87	.8708	.88	.8857	.89	.8919	.89	.8974	.90	.9025	.9048	.9069	.91	1.5
1.75	.8313	.8373	.8427	.8478	.8526	.8571	.8614	.8654	.8691	.8727	.8761	.8793	.8823	.8853	.888	.8906	.8931	.8955	1.75
2.	.8117	.82	.824	.83	.835	.84	.8446	.85	.8532	.86	.8608	.864	.8677	.87	.874	.8768	.8796	.88	2.
2.25	.7931	.80	.8064	.8125	.8182	.8235	.8286	.8334	.8378	.8421	.8461	.85	.8537	.8571	.8605	.8636	.8667	.87	2.25
2.5	.7753	.78	.7895	.796	.8019	.8077	.8131	.8181	.8231	.8276	.8319	.8361	.84	.8437	.8473	.85	.854	.86	2.5
2.75	.7582	.7659	.7732	.78	7864	.7924	.7982	.8035	.8087	.8136	.8182	.8223	.8268	.8308	.8346	.8382	.8417	.845	2.75
3.	.7419	.75	.7576	.76	.7714	.78	.7838	.7894	.7948	.80	8048	.809	.814	.8181	.8222	.826	.8297	.833	3.
3.25	.7263	.7347	.7425	.75	.7569	.7636	.77	.7758	.7814	.7869	.792	.7968	.8015	.8059	.8102	.8142	.8181	.822	3.25
3.5	.7118	.72	.7301	.74	.7431	.75	.7565	.76	.7685	.7741	.7795	.785	.7894	.794	.7985	.8028	.8068	.81	3.5
3.75	.6969	.7058	.7143	.7222	.7297	.7368	.7436	.75	.7561	.7619	.7674	.7727	.7778	.7853	.7872	.7916	.7959	.80	3.75
4.	.6831	.69	.70	.71	.7168	.724	.731	.737	.744	.75	.7557	.76	.7664	.77	.7762	.78	.7851	.79	4.
4.25	.67	.6792	.688	.6964	.7043	.7118	.7189	.7258	.7323	.7384	.7443	.75	.7553	.7605	.7655	.7703	.7748	.78	4.25
4.5	.6571	.67	.6757	.68	.6923	.70	.7073	.714	.721	.727	.7333	.74	.7446	.75	.755	.76	.7646	.77	4.5
4.75	.6448	.6545	.6637	.6724	.6806	.6885	.696	.7031	.71	.7164	.7226	.7285	.7342	.7396	.745	.75	.7548	.76	4.75
5.	.633	.64	.6522	.66	.67	.68	.685	.69	.70	.71	.7122	.72	.7241	.73	.735	.74	.745	.75	5.
5.25	.6216	.6315	.641	.65	.6585	.6667	.6744	.6818	.689	.6956	.7021	.7082	.7142	.72	.7255	.73	.7358	.74	5.25
5.5	.6106	.62	.6302	.64	.648	.66	.6641	.67	.6788	.69	.6923	.70	.7046	.71	.7161	.72	.7267	.73	5.5
5.75	.60	.61	.6198	.629	.6378	.646	.6541	.6617	.669	.676	.6827	.6892	.6954	.7013	.7069	.7125	.7177	.723	5.75
6.	.589	.60	.6097	.61	.6279	.64	.6444	.65	.6595	.67	.6734	.68	.6863	.69	.698	.70	.709	.714	6.
6.25	.5798	.59	.60	.6093	.6183	.6268	.635	.6428	.6503	.6575	.6644	.671	.6774	.6835	.6894	.6951	.70	.706	6.25
6.5	.57	.58	.59	.60	.61	.62	.6259	.63	.6414	.65	.6556	.66	.6687	.675	.681	.69	.6922	.697	6.5
6.75	.561	.5714	.5814	.59	.60	.609	.617	.62	.6326	.64	.647	.654	.66	.6667	.6727	.6785	.6841	.689	6.75
7.	.552	.56	.5725	.58	.59	.60	.6084	.616	.6241	.63	.6387	.65	.6521	.66	.6646	.67	.6762	.682	7.
7.25	.543	.554	.5638	.5735	.583	.59	.60	.608	.6159	.6234	.6305	.6375	.6441	.65	.6568	.663	.6685	.674	7.25
7.5	.5348	.55	.5555	.57	.5744	.58	.5918	.60	.6077	.62	.6226	.63	.6363	.64	.649	.65	.661	.67	7.5
7.75	.5267	.5373	.5474	.5571	.5664	.575	.5837	.592	.60	.6035	.6149	.622	.6287	.635	.6416	.6476	.6536	.659	7.75
8.	.5187	.53	.5395	.55	.5586	.57	.576	.58	.5923	.60	6073	.61	.6212	.63	.6342	.64	.6464	.65	8.
8.25	.511	.522	.5319	.542	.551	.56	.5686	.577	.5848	.5925	.60	.607	.614	.62	.627	.6333	.6393	.645	8.25
8.5	.5036	.51	.5245	5343	.5436	.55	.5613	.57	.5776	.59	.5928	.60	.607	.61	.62	.63	.6324	.638	8.5
8.75	.4964	.507	5172	.527	5364	.546	.5541	.5625	.57	.5783	.5858	.593	.60	.607	.6132	.62	.6256	.63	8.75
9.	.4893	.50	.51	.52	.5294	.54	.547	.56	.5636	.57	.5789	.59	.5932	.60	.6065	.613	.619	.625	9.
9.25	.4825	.493	.5033	.513	.5225	.532	.54	.5487	.5568	.5647	.5722	.579	.5865	.594	.60	.6064	.6125	.618	9.25
9.5	.4758	.49	.4967	.506	.516	.525	.534	.54	.55	.558	.5657	.57	.58	59	.594	.60	.6062	.61	9.5
9.75	.4694	.48	.4902	.50	.509	.5185	.527	.5357	.5438	.552	.56	.567	.5737	.58	.587	.594	.60	.606	9.75
10.	.464	.47	.4838	.49	.503	.51	.5204	.53	.538	.55	553	.36	.568	.574	.581	.587	.594	.60	10.

Universal Piece-Work Apportionment Table

A Labor-Saving Method of Calculating the Apportionment of Total Gang Earnings to Each Operative When Efficiency Rating and Elapsed Hours Are Unequal

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ALL railroad repair shops and many industrial plants which pay on the piece-work basis employ many men who work in gangs of two or more, and because of their varying experience or proficiency, one man is allowed 60 per cent of the total piece-work earnings on each job and the other 40 per cent; or two men are allowed 60 per cent, the other 40 per cent. Very often the percentages are 55 and 45, 70 and 30, etc.

When the hours spent by all men in a gang are equal, the determination of each man's apportionment is simply the product of the total earnings and his assigned percentage. But when the hours expended by the 60 per cent operative differ from those of the 40 per cent workman, as is generally the case on any assembly job, the piece-work inspector or clerk must calculate the apportionment due each workman by multiplying the hours of each by his 60 per cent or 40 per cent efficiency rating to obtain both ratios; the sum of the ratios is then divided into the total piece-work earnings, and the resulting quotient is then multiplied by each ratio.

The time and energy expenditure incidental to such calculations is three times as great as under the method evolved by the writer from ordinary reciprocal tables and it is felt that the scheme will be gratefully received in shop and auditing office throughout the country which are confronted with such problems.

Solution of General Problem

Example 1—A receives 60 per cent of partnership piece-work earnings, and works 6.5 hours; B receives 40 per cent of partnership earnings, and works 8.5 hours. Their joint earnings total $9.60. What should each receive?

Usual Solution

.60 × 6.5 = 3.900 A
.40 × 8.5 = 3.400 B
7 3

$1.3151
7.3 / 9.600
7 3
2 3 0
2 1 9
1 1 0
7 3
3 7 0
3 6 5
5 0

A
$1 315[illegible]
3.9
11[illegible]
[illegible]9453
$5 12889
Called $5.13

B
$[illegible]1[illegible]
3.4
52604
3945[illegible]
$4.471[illegible]
Called $4.47

Solution Table I (p. 654)

A
.5343*
$9.60
320580
48087
$5.129280

B
$9.60
5.13
$4.47

* See intersection of 6.5 hours (A) and 8.5 hours (B).

If the hours worked by either operative are in excess of ten (10), mentally divide the hours of each operative by the same number to bring the time within the scope of the table and proceed as shown above.

Stated briefly, the apportionment due each workman using the table system explained and illustrated above, is simply the product of the total piece-work earnings of the gang, and the figure which is shown at the intersection of the indicated hours.

The universal piece-work earnings apportionment table (see page 654) is applicable when any number of hours are consumed by any men working on an unequal percentage basis on a project aggregating any amount under piece-work schedules. The calculations in the table cover piece-work operatives on the 60 and 40 per cent basis, but are adaptable to 55-45 per cent, 70-30 per cent operatives, etc., by multiplying the 60 per cent result reached, as explained below, by 55/60, or .9167, or by 70/60, or 1.167.

The ratios shown in the table are for the 60 per cent operatives. The 40 per cent man receives the balance. All decimal ratios shown at intersections of the lines and columns are calculated for piece-work earnings of $1 on any project. When piece-work earnings constitute multiples of $1, the figure at the intersection should be multiplied by such earnings to obtain the earnings of the 60 per cent operator on the given job.

A Few Specific Examples

Example 2—A works 36 hours; B 24 hours. Total earnings $38.

Solution—A, 36 hours divided by 6 equals 6 hours. B, 24 hours divided by 6 equals 4 hours. Intersection of 6 and 4 equals .69 × $38 equals $26.22 equals A's earnings; $38 — $26.22 equals $11.78 equals B's earnings.

Example 3—A works 13 hours; B works 9 hours.

Solution—A, 13 hours divided by 2 equals 6½ hours; B, 9 hours divided by 2 equals 4½ hours. Use intersection of 6½ and 4½, which is .68, and proceed as in Example 2.

Example 4—A works 135 hours; B works 115 hours.

Solution—A, 135 hours divided by 10 equals 13.5 hours and divided again by 2 equals 6.75 hours. B, 115 hours divided by 10 equals 11.5 hours and divided again by 2 equals 5.75 hours. Use intersection of 6.75 and 5.75 hours, which is .6378, and proceed as in Example 2.

All the foregoing clearly shows the adaptability of the 60-40 per cent table for rapidly calculating the earnings due the 60 and 40 per cent operatives, working any number of hours on a piece-work job aggregating any amount.

If there are two men of 60 per cent ability and one of 40 per cent ability in partnership on any job, simply add the hours of each 60 per cent man and give each of them his pro rata hourly apportionment.

Example 5—A receives 60 per cent of piece-work earnings, totaling $25, and works 12 hours; A_1 receives 60 per cent of piece-work earnings, totaling $25, and works 8 hours; B receives 40 per cent earnings, totaling $25, and works 6 hours.

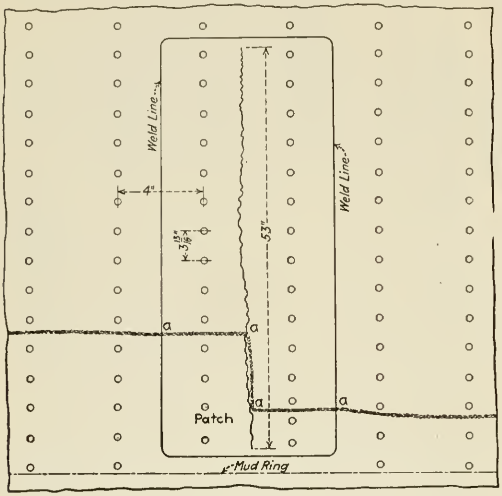
Solution—A and A_1 equals 20 hours, divided by 2 equals 10 hours. B equals 6 hours, divided by 2 equals 3 hours. Intersection of 10 and 3 equals .833 × $25 equals $20.83. A receives $20.83 divided by 20, or $1.041 per hour × 12 hours, or $12.49. A_1 receives $20.83 divided by 20, or $1.041 per hour × 8 hours, or $8.33. B receives $25—$20.82, or $4.18.

Comments on Autogenous Boiler Welding

By C. W. Carter, Jr.

MANY boilermakers do not have much faith in autogenous welding but experience has shown that welds, properly made under the correct conditions prove satisfactory and effect great savings in the construction and repair of pressure vessels. It is essential in getting good results to have welders who thoroughly understand the limitations of autogenous welding and are extremely careful to see that the materials properly fuse together. Welders must also see that the sheets are clean; that the proper distance between plates is allowed; and that the material is of the best quality in order to secure satisfactory results.

Numerous boiler patches that have come under my observation gave good results, but I have also seen patches which should have been condemned. The New York state code and rules of the A. S. M. E. Boiler Code Committee specifically state that any surface welded on boilers must be supported, or in case the boiler is repaired by patching, stays must project through a patch before it can be welded. The satisfactory welding of patches may be obtained by cutting out the patched portion, beveling the edge to 45 deg. and also the edge of the new patch to be applied. The patch is put in place, its size being such that a distance of 5/32 in. is provided between the sheet and the patch. Also, the rows of staybolts adjoining the patch are cut out to aid in expansion and to prevent leaky bolts which would occur after the patch was welded in place. Unless this precaution is taken, new



Method of Repairing Boiler With Long Vertical Crack Due to Freezing

cracks are almost sure to develop owing to the lack of provision for expansion and contraction.

A locomotive was recently sent to a repair shop for light running repairs, and after standing outside the shop for four days was finally brought in for repairs. It was then discovered that the water had not been drained from the boiler but had frozen. The gang foreman ordered steam turned into the boiler after the dome cap and hand hole plates were removed as far as possible. As the boilermaker who was cutting flues at the time heard a loud snap he investigated and found the right side sheet had developed a crack 53 in. long. This crack extended vertically from a place just above the mud ring upwards nearly to the crown sheet flange as shown in the drawing. The stays were 7/8 in. and 1 in. in diameter and had a pitch of 3 13/16 in. Repairs were made by cutting out the cracked portion including two rows of bolts and a section of an old weld as illustrated. The edges of the sheets were beveled to form an angle of 45 deg. and the new patch fitted, its edges also being beveled to 45 deg. All joints were electric welded and up-to-date; the patch has proved entirely satisfactory.

Reclaiming Coil Springs at McKees Rocks

ONE of the most important and interesting parts of the work done in the McKees Rocks blacksmith shop of the Pittsburgh & Lake Erie consists of the reclamation of used coil springs which have developed a permanent set. The equiment for handling this work is illustrated in Fig. 1, consisting of a furnace, one end of which is shown at *F*, gage *G*, oil bath *B* and testing machine *T*.

Fig. 1—Spring Tester and Gage with Furnace and Oil Bath In the Background

In reclaiming coil springs the first operation is to heat them to a temperature of about 1600 deg. F. in the furnace, after which each spring is opened up to the M. C. B. standard length in gage *G*, better shown in Fig. 2. This gage is adjustable for different sized springs as indicated, and is also adjusted to allow for spring shrinkage in cooling. The method of operation is simply to roll the red hot spring into the gage and open up each coil by means of spreader tongs until the coils are equally spaced and the spring is straight. This operation takes but a few seconds when the spring is immersed in oil tank *B* for about two minutes, more or less depending upon the size of the spring. The oil bath is not allowed to reach a temperature higher than 210 deg. F.

After withdrawal from the oil bath the springs are tested in a testing machine, the essential part of which is 36-in. cylinder *T*, operated by means of compressed air. It will be noted that a heavy guard plate *P* (Fig. 1) has been arranged to cover the coil spring while it is being compressed, which eliminates danger to the operators in case the spring should fly out of the machine. The pressure to which the spring is subjected is proportionate to the reading of gage *O* on the testing machine. Reference to Fig. 3 will show the actual pressure on the spring in pounds corresponding to each gage reading.

In testing, the springs are first closed solid. They are then tested for the load limit in accordance with M. C. B. specifications. For example, a class *C* bolster spring intended for use on cars of 80,000 lb. capacity is required to have a free height of 8¼ in. When pressed solid it measures 6 9/16 in. and under a load of 7,400 lb. on the testing machine, its height

Fig. 2—Adjustable Gage Used in Opening Springs to Standard Length

should be 7¼ in. Springs not standing the test are rejected. This practice has now been followed for a considerable period on the Pittsburgh & Lake Erie with successful results. A pile of completed springs is shown in Fig. 4, ready for shipment to the stores department or outside points as needed. The cylinder of the air tester is 36 in. in diameter and this

Gage Pressure in Pounds	Load in Pounds	Gage Pressure in Pounds	Load in Pounds	Gage Pressure in Pounds	Load in Pounds	Gage Pressure in Pounds	Load in Pounds
1	712	26	18531	54	38489	80	57020
2	1425	28	19957	55	39201	82	58446
4	2851	30	21382	56	39914	84	59871
5	3563	32	22808	58	41340	85	60534
6	4276	34	24233	60	42765	86	61297
8	5702	35	24946	62	44191	88	62722
10	7127	36	25659	64	45616	90	64148
12	8553	38	27084	66	46329	92	65573
14	9978	40	28510	66	47042	94	66999
15	10691	42	29935	68	48467	95	67712
16	11404	44	31361	70	49893	96	68424
18	12829	45	32074	72	51318	98	69850
20	14255	46	32786	74	52744	100	71276
22	15680	48	34212	75	53457		
24	17106	50	35638	76	54169		
25	17819	52	37063	78	55595		

Fig. 3—Test Pressures on Coil Springs Corresponding to Indicated Gage Pressures

machine is also used for many other operations in the blacksmith shop, such as drawing out or upsetting drawbars, rods and so forth.

It is obvious that when putting through a large number of springs the oil in the cooling tank will soon become too

REPORT SHOWING COILED SPRINGS RECLAIMED AT McKEES ROCKS DURING SEPTEMBER, 1922

Material Reclaimed	Cost New	Labor and Overhead	Scrap Value	Reclaim Cost	Amount Saved
2,720 coiled spring, weight 60,783 lb. ...	$2,127.40	$319.08	$395.08	$714.16	$1,413.24

Details of the Report

Class	Number of Pieces	Weight Lb.	Amount	Cost Per 100 Lb.	Weight of Each Spring Lb.
Inside coil, spring "G".	799	11,985	$62.32	$.52	15
Outside coil, spring "G"	790	31,600	94.80	.30	40
Inside coil, spring "C".	236	1,534	13.96	.91	6½
Outside coil, spring "C"	295	6,785	27.14	.40	23
Inside coil, spring "W".	227	1,419	12.91	.91	6¼
Outside coil spring "W"	373	7,460	34.32	.46	20
Totals	2,720	60,783	$245.45	Average $.35	Average 17½

hot for use. The present arrangement is to have two tanks which are used alternately or together as may be needed. It is proposed to increase the capacity for this work by installing an automatic cooling system for the tank *B*, Fig. 1. In fact a cooling tank for the new system has already been installed as shown in *C* (Fig. 1). This tank is made of cast-iron with copper cooling coils on the inside through which water constantly flows. A 10-in. water pump will be installed to force oil from the top of the oil tank *B* up through the cooling tank *C* and thence back to the bottom of tank *B*. This arrangement will prove effective in increasing the capacity to handle spring work, also enabling a more even temperature to be maintained in the oil tank. The extent to which this reclamation of coil springs is carried on at McKees Rocks is evident by a study of the preceding table showing savings effected. The total amount saved in September, which may be considered a representative month, is given as $1,415.24, 2,720 coil springs having been reclaimed. The cost of these

Fig. 4—A Pile of Reclaimed Coiled Springs Ready for Shipment

springs new would have been $2,127.40, whereas the total reclamation cost, including $395.08 scrap value and $319.08 for labor and overhead, was only $714.16. Details of the springs reclaimed are also given in the table.

Two Boiler Shop Devices

By C. E. Lester

A COMBINATION beading tool and finished bead gage that may be dimensioned in accordance with the standard practice on each individual road is shown in Fig. 1. This gage is valuable for use in the manufacture of beading tools,

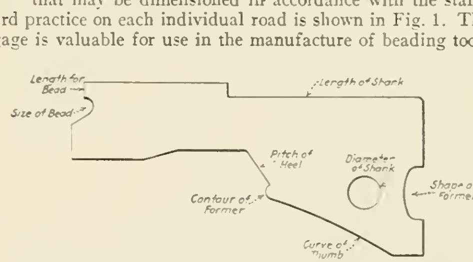


Fig. 1—Combination Gage for Beading Tools and Beads

setting flues to the proper length and testing the finished contour of the beads.

It is more or less impractical to attempt the design of one standard beading tool that will fulfil all the requirements in various localities and under varying conditions as well as to satisfy the pronounced ideas that many boiler makers have on the subject. However, there are but three prime factors in the construction of a beading tool that will form a perfect bead. These are: first, a predetermined fixed length of flue outside the sheet to form a bead; second, a standard gage thickness of flue that runs true to gage; third, a forming recess in the beading tool that is of the exact size to form a perfect bead, taking into account the amount that the flue will upset in working.

Auxiliary to these prime factors, there are needed in the making of a correctly designed beading tool (a) a forming recess in the tool parallel to the axis of the tool; (b) a former narrow enough to conform its movement to the small diameter of the flue without marking or cutting the bead; (c) a former with two convex surfaces for the same reasons.

Narrow Working Surface Needed

In the rotary movement of the air hammer necessary to turn the bead without making a burr inside the flue, it will be found that the working surface of the former, as illustrated, must be very narrow, otherwise the tool is handled with difficulty and puts rough ridges in the beads. The curve of the thumb is purely a matter of personal preference. For those who desire the flue beaded straight down without flaring, a comparatively straight thumb will suffice. For those who first flare the flue, the thumb may vary from nearly straight to one curved to strike the inner surface of the flue on the opposite side. This latter type prevents "curling" the

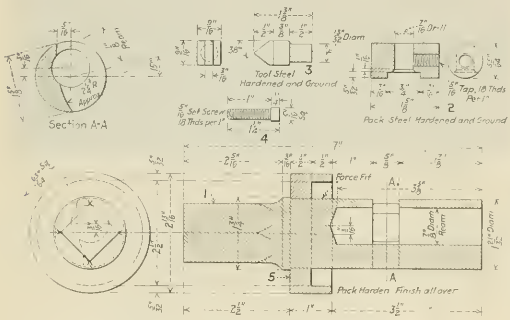


Fig. 2—An Effective Form of Power-Driven Flue Cutter

air hammer so much that the heel of the tool cuts the sheet. This particular feature has some merit in it with an unskilled man handling the tool; otherwise none.

Due to the severe service that beading tools receive, they rapidly become worn and over sized, requiring repairs, or rather frequent dressing if flue work is kept standard. It is believed that a gage of the general description of the one illustrated in Fig. 1 should be in the hands of the tool room foreman, boiler shop foreman and boiler inspector. The tools should be frequently checked and kept to gage. Workmen should be required to draw beading tools on tool checks and return them at the end of every job that each tool be checked by the gage before reissuing.

Removing Old Flues

The old style of ripping and closing in flues preparatory to removal is a practice so well known that a discussion of the operation would be without interest. The tools simply comprise a flat chisel, ripper, "oyster knife," and hammer. This method is practically universal when removing a single defective flue and is still in vogue on some of the less progressive railroads when removing full sets of flues. The use of a power-driven rotary cutter for cutting off flues just inside the front sheet is by far the best and most economical method of removal. In fact, the use of this type of cutter is rapidly superseding all other methods. The cutter, illustrated in Fig. 2, is but one of several of the same general type. It gives good results and has merit in its simplicity.

Referring to the illustration, 1 is squared shank of a round piece of steel provided with a 7/8-in. eccentric hole carrying tool holder 2 and hardened tool steel cutting point 3. The cutting point is held in place by set screw 4. The steel ring 5, recessed to extend over a flue bead, is a force fit on the body of the tool and provides for cutting flues at the proper point. From Section AA it is evident that revolution of the spindle clockwise will cut a flue and counter-clockwise will release the cutting point allowing the tool to be removed.

Pennsylvania to Make Extensive Additions to Altoona Works

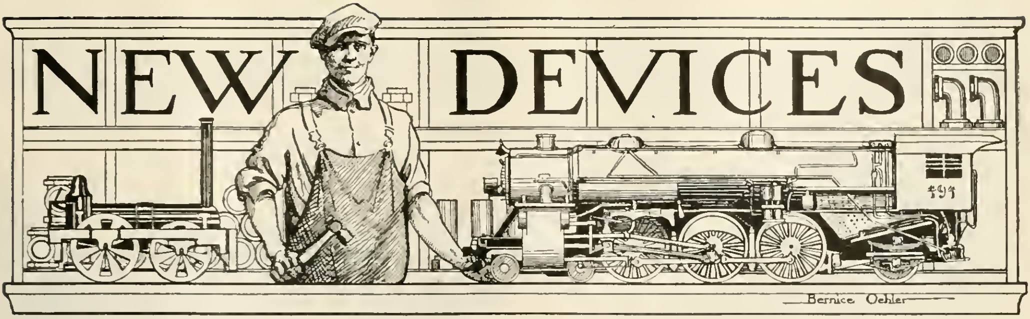
The Pennsylvania System has announced the program for extensive improvements to be made at Altoona, Pa., including the construction of two extremely large repair shops and the electrification of the heavy grades west of Altoona. The first of the improvements will be made at Juniata shops and includes the building of a new erecting and machine shop, 340 ft. by 670 ft., including a midway crane runway with a 105 ft. span and 715 ft. long. This large shop will be devoted to repairing and building locomotives, and will accommodate 49 locomotives at one time. The framework will be of steel and the walls of brick. The locomotives erecting bays will have two 250-ton capacity electric traveling cranes for lifting locomotives, and six 15-ton capacity cranes for lighter work. The machine bays will have two 25-ton capacity cranes, together with jib cranes of from 1 to 8 tons' capacity.

There will also be erected a reinforced concrete storehouse, three stories high, with basement, which building is to be 60 ft. by 400 ft. A crane runway for handling material will also be erected with a 95-ft. span and about 600 ft. long.

The building of the shop and storehouse will necessitate changes in the existing buildings as follows: the scale shop will be moved to a new location and will be changed to a flue shop, the machinery now in the scale shop being transferred to the present paint shop. The present storehouse building will be moved to a new location and will be used as a cab shop. The present erecting shop will be changed to a paint shop, while machinery will be installed in the present paint shop and the name changed to Machine Shop No. 2.

At the Altoona car shops will be located facilities for preparing repaired locomotives for service. The present circular building, known as the freight car shop, will be remodelled and 15 stalls will be used as a finishing shop. East of this shop will be located the necessary ash pits and coal handling facilities.

Further additions to the shops at Altoona will be made following the electrification of the heavy grade west of the city. After the electrification is completed, the roundhouse at Sixteenth street, Altoona, will be abandoned. On the site of the roundhouse a duplicate of the erecting and machine shop at Juniata will be built and the present erecting shop at the Altoona machine shop will be fitted up for the use of other departments.



The du Pont-Simplex Locomotive Stoker

A NEW design of locomotive stoker, known as the du Pont-Simplex type, has recently been developed by the Standard Stoker Company, New York. The principal features of the machine are clearly shown in the assembled view, Fig. 1. When applied to the locomotive the tender trough, shown at the right, is built into the floor of the tender. The engine is located under the cab deck and the vertical conveyor and housing, shown at the extreme left, are placed against the inside rear wall of the firebox, the housing being just above the level of the grate.

The operation of the stoker is briefly as follows: Coal from the tender drops into the trough below the tender deck by gravity and is moved forward by a screw conveyor which carries the coal through a crusher and into a covered trough extending forward under the engine deck and mud ring. At the front of this trough the coal is delivered into a housing containing a vertical lifting screw, which raises the coal until it overflows onto a horizontal surface, from which it is distributed to the various portions of the grate by continuous steam jets manually controlled. The amount of coal fired is determined by manual control of the speed of the driving engine and its distribution to various parts of the firebox is effected by manipulation of the valves controlling the steam supply to the jets.

The construction of the stoker has been carefully worked out to insure continuous operation with the minimum of maintenance. The tender trough is of steel plates and angles and is so secured that it may be removed when the engine and tender are separated. A cast-steel gear casing at the rear of this trough drives the entire horizontal conveyor screw which delivers the coal into the vertical housing. The coal drops from the tender into the tender trough through a longitudinal slot in the deck. Sliding plates permit closing off the coal entirely from the trough, or allow admission to any section desired. The crusher consists of a heavy steel casting with rearwardly projecting spikes at the front of the tender trough, against which oversize lumps of coal are broken. The portion of the conveying system between the locomotive and tender is made in two parts, one of which slides inside the other. The entire construction is such that the tender may be backed away from the locomotive without disconnecting any portion, or removing any bolts. A section of the locomotive trough is open at the top and provided with a slotted cover through which the movement of the coal may be seen. This is very helpful to the operator.

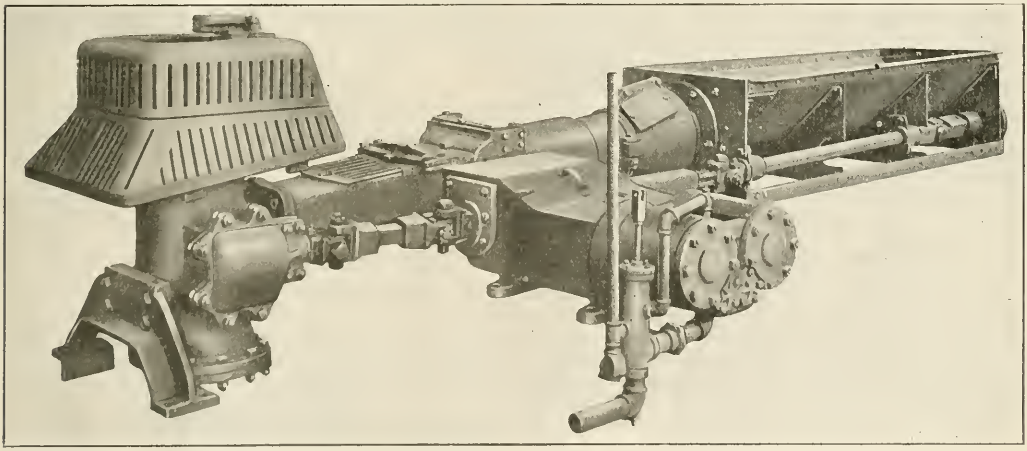


Fig. 1—Assembled View of du Pont-Simplex Stoker

The vertical, cylindrical housing into which the coal is discharged from the horizontal conveyor has a vertical screw which makes two revolutions to one revolution of the horizontal screw. This avoids any possibility of choking when the coal changes its direction of movement. The weight of the locomotive trough and the vertical housing is carried directly on the locomotive frame.

To adapt the vertical housing to various designs of locomotives, it is made in two parts, the lower half of standard construction, and the upper of variable length to suit the grate of the locomotive to which it is applied. The lower section contains the gears which transfer the motion of the driving engine shaft to the vertical screw. The construction is such that it is impossible for any of the coal dust to work into the gear housings. Even if moisture is carried over with coal, the water can drain from the trough before it can gain access to the gear casing. The gears are all steel with cut teeth and run flooded in oil.

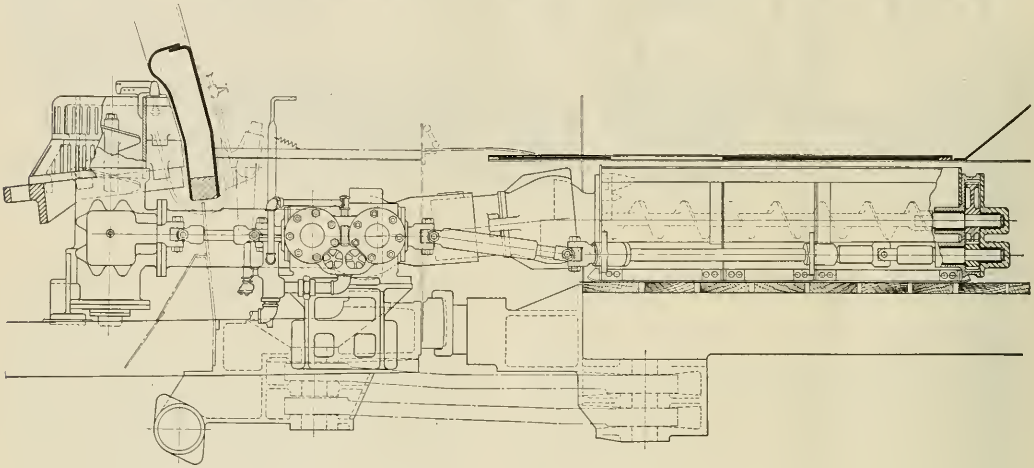


Fig. 2—Side Elevation Drawing Showing Arrangement of Parts on the Locomotive

The upper portion of the vertical housing extends above the level of the grates, and would be subject to overheating if provision were not made to protect it. For this reason the vertical section of the housing is enclosed in a cast-iron protecting grate with an air space between. This protecting grate is provided with slots through which air is drawn from the ash pan by the stack draft when the locomotive is running. This air serves a dual purpose, preventing overheating of the protecting grates, and supplying above the fuel bed an amount of air sufficient to furnish the oxygen necessary for the combustion of the volatiles from the coal.

The coal as it rises to the top of the vertical housing overflows on the upper surface of the protecting grate. From this surface it is blown into the firebox and down upon the surface of the fire by steam jets. These steam jets are divided into five groups, each group being controlled by a separate valve, and by manipulation of these valves varying amounts of coal may be discharged to different portions of the grate so as to maintain an even and uniform depth of fuel bed. The control valves are placed in a convenient position on the boiler front where they may be readily reached by the fireman.

The driving of the stoker is effected by means of a two-cylinder, double-acting, slow-moving engine and the amount of coal discharged by the stoker is controlled by varying the speed of the engine. During normal operation and when normal run of mine coal is being fed, this engine runs along with very low cylinder pressure, the throttle valve being only slightly open. If an unusually large or hard lump of coal reaches the crusher plate, the speed of the engine will be checked and the pressure in the cylinders will rapidly rise until the obstruction is crushed, after which the engine will make one or two revolutions at increased speed, dropping back at once to its normal rate. The amount of reserve power is ample to crush the hardest fuel employed and the design is such that all parts have sufficient strength to permit the engine to be abruptly stopped when running at delivery speed without anything giving away.

The design of the engine, as will be noted from the illustrations, is extremely simple and rugged. The crank shaft, connecting rods, cross-heads and valve gear are all enclosed

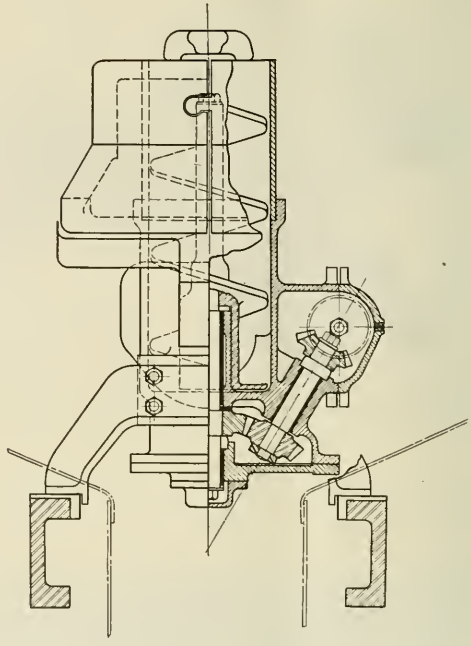


Fig. 3—The Vertical Housing Is Carefully Designed to Prevent Coal Dust or Water from Reaching the Bearings

in a box casting, the cover of which is made of sheet metal for easy removal to provide accessibility. With the exception of the cylinders, all working parts are lubricated by splash lubrication. The box and the cover are of such a design as to avoid loss of oil and to prevent admission of dust to the enclosed box itself.

The valves of the engine are of the piston type, each driven by a single eccentric. It is necessary in any stoker to be able to reverse the driving engine to loosen a jam, and to effect this a simple outside valve is provided which interchanges the functions between the inlet and exhaust passages of the engine.

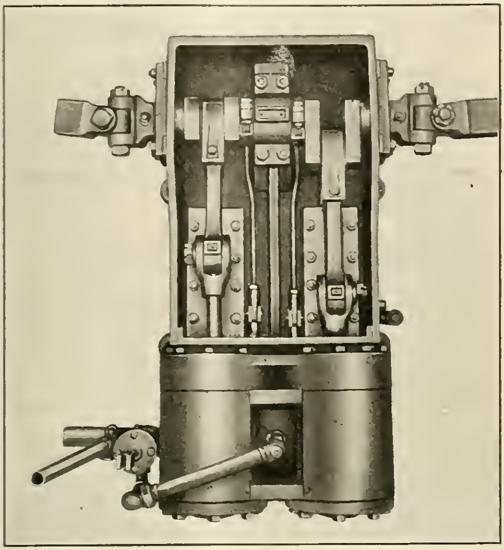


Fig. 4—Top View of Stoker Engine

At each end of the crank shaft of the driving engine is a universal joint, which on the rear side connects to the driving shaft for the horizontal conveying system. A slip joint is provided to allow for the movement between the tender and the locomotive which occurs when rounding curves or passing over uneven track. This joint, like the conveying system between the locomotive and tender, can be disconnected without removing any bolts or other fastenings.

The universal coupling on the forward end of the driving engine crank shaft is connected through universal couplings to a short section of a shaft on the end of which is the first gear of the enclosed train which drives the vertical screw. The details of this drive are clearly indicated in the illustration and have been referred to above.

One of the special features of the stoker is that the coal is delivered into the firebox at a relatively low level. This method of delivery, together with the downwardly directing force of the steam jets, it is stated, avoids fuel losses due to the fine particles being swept above the arch by the action of the draft before being consumed. The continuous introduction of the fuel is also claimed to be a decided advantage from an operating standpoint.

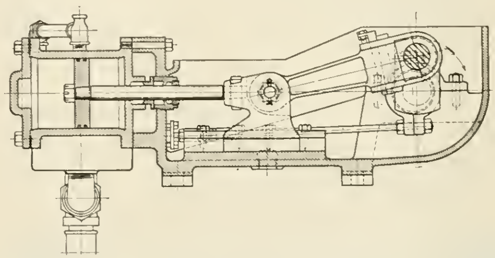
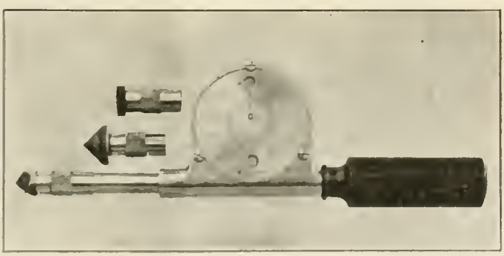


Fig. 5—Section Through Engine, Showing Simplicity of Construction

Extreme care has been used in the design of this stoker to avoid all elements of weakness which have apeared in past practice. The flexibility of the arrangement provided by the universal couplings and slip joints makes it relatively easy to apply the standard design to the many varying types of locomotives. Only 14 parts in the entire stoker have variable dimensions for different installations, the rest being standard for all sizes and types of locomotives.

Convenient Speed Indicating Device

THE new speed indicator No. 748, placed on the market by the Brown & Sharpe Manufacturing Company, Providence, R. I., is designed to determine accurately the revolutions of shaftings, motors, etc., in either direction and measure both high and low speeds equally well. The design of this indicator is new. It has few parts and is simple in operation. The readings are taken from one side of the indicator, which can be quickly set at zero for repeated use.



Brown & Sharpe Speed Indicator No. 748

The indicator registers up to 5,000 revolutions by every 5 revolutions, although speeds much faster than 5,000 r.p.m. can be readily determined. The two arrows on the face of the dial indicate the figures to use for the different directions of rotation, eliminating any confusion. The figures showing through the small round windows on the dial read every 5 revolutions direct. The small inside dial is quickly turned to 0 for repeated use by the knurled knob on the back of the indicator.

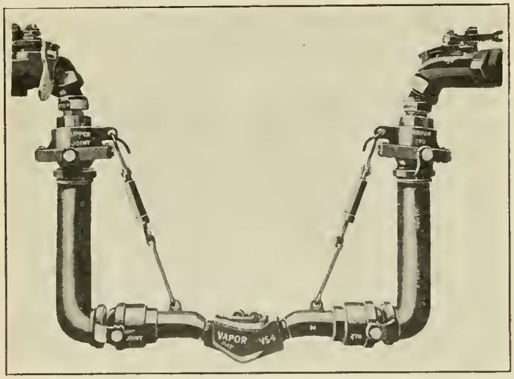
The fibre handle is especially shaped to fit the hand and the fibre is an insulation against electricity. The working parts are enclosed in a heavily dull-nickeled case. Three points are furnished as shown: a steel point for ordinary speeds, and rubber points for high speeds. All projections, rough edges, and corners which might interfere with its ready use have been eliminated. It is light, easily handled, and convenient to use.

Flexible Metallic Steam Heat Connections

BURST steam hose are the cause of constant trouble in passenger train service, not only resulting in delays to trains, steam heat failures and frequent freeze-ups, but requiring a continual and excessive maintenance expense in rubber hose renewals. It has long been recognized that a practical substitute for steam heat hose is needed. The demands upon any steam-hose substitute require perfect flexibility, particularly when under high pressures; a device easily attached to a car, in which there will be no necessity for adjustments or tightening up of packing; and one that will be economical in service without continual maintenance expense.

A flexible metallic conduit has been designed by the Vapor Car Heating Company, Chicago, to meet these requirements and it has been in successful use on a number of roads during the past winter.

This conduit is constructed on a different principle from any flexible joints heretofore used in car heating. The ball and casing members are not themselves in direct contact and the only friction on the ball is that from the gasket, which maintains a tight seal between the two members under the action of the internal steam pressure. Wear in the outside bearings has no effect on the tightness of the joint.



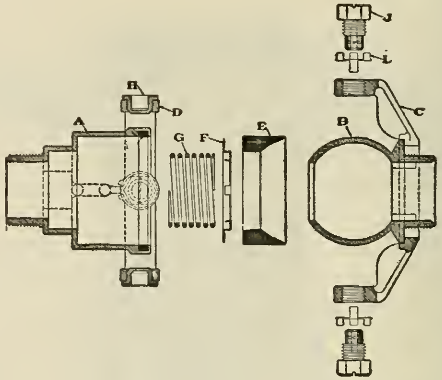
Vapor Metallic Steam Heat Connection

The tendency for the two parts of the joints to separate under internal steam pressure is prevented by the use of a universal or gimble joint arrangement supported by steel bearing pins which rock in graphite-lubricated steel bushings. The pins and bushings in which they rotate are outside of and away from the steam conduit itself, and are inexpensive and easily renewed when necessary. In the double acting joint used at the top of the connection, the ball member forms a loose fit in the straight sleeve member. The two are held together in their relative positions by an external horizontal ring *D* and yoke *C*, carried on four steel bearings or pins *J* arranged in pairs and operating at right angles to each other, one pair bearing in the sleeve member *A* and the other in the ring *D*. This arrangement permits of a swinging or rocking movement of 30 deg. in any direction from the vertical.

The single-acting joint used at the bottom of the connection operates the same as the double-acting top joint except that the trunion pins of the yoke *C* have their bearings directly in the sleeve or casing member and the joint can rock in only one direction, 30 deg. up or 30 deg. down from the horizontal.

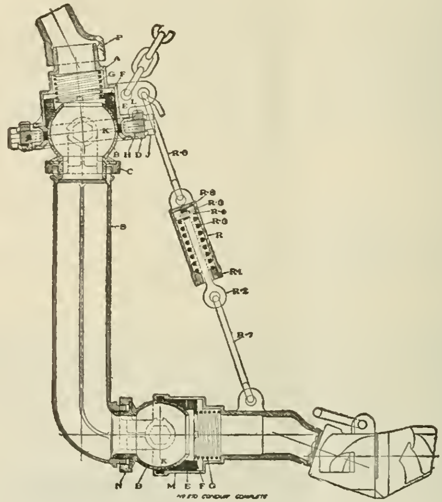
The ball members of the upper and the lower joints are each free to rotate in the yoke and on the gasket about the axis of the steam passage through the joint. This twisting movement, together with the rocking movements provided by the outside suspension pins, gives complete universal motion between the two ends of the conduit.

The ball joints are each packed with a tough, flexible



Details of the Universal Joint

"follow-up" gasket *E* which makes a steam tight joint between the ball *B* and the surrounding sleeve *A*. The gasket carries no weight and is only subjected to the pressure of steam behind it, plus the spring tension. As wear takes place, either on the gasket or on the outside bearing pins, the gasket "follows-up" and the steam pressure keeps it



Sectional View of the Assembled Connection

tight until it is entirely worn out. The higher the pressure, the tighter the joint because the steam pressure blows the gasket into the leak, thus keeping it automatically steam tight.

Either of the joints may be separated by unscrewing the two opposite bearing pins. A new gasket can then be easily applied when required, and the joints quickly re-assembled. The threaded ends of the brass balls are provided with internal lugs for connecting or disconnecting the balls and the vertical tube member.

It will be noted that provision is made in the lug on the top joint casing for a chain attachment from the top joint to the car body or platform, as an added precaution to prevent any part of the joint falling on the track in case of the possible breaking of a weak thread on the end of an old or weak train line pipe. A breakage groove is also turned around the outside of the horizontal nipple end of the lower joint, just back of the hose coupler head. This is done to insure a safe place to break, should two cars break apart while running. The flexible joint connections would thus remain in place on the cars, held up from the track by the flexible link support.

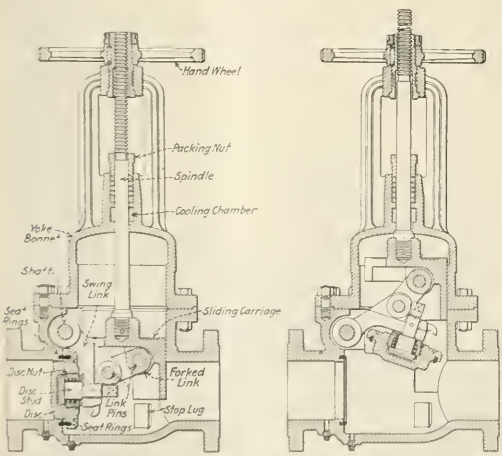
This flexible link support also serves to provide for the drainage of condension from the connection when uncoupled, without danger of its dragging on the track.

The flexible metallic conduit is easily attached to the car. It may be used with the present 1½-in. end valves, or by eliminating the adapter fitting it may be used with 2-in. port end valves. The 2-in. port steam couplers may also be used later, if desired without purchasing new joint equipment, by simply cutting off the angle end of the lower joint sleeve and re-threading with 2-in. threads.

On a recent test made in railroad service a train was equipped with the flexible metallic conduit, fitted with 2-in. port end train pipe valves and 2-in. port steam couplers, with which it was demonstrated that the usual delays incident to getting steam through to the rear of the train were eliminated. The drop in pressure towards the rear of the train averaged only about one pound per car, as against an average of about five pounds where the present standard connections with rubber hose are used.

Regrinding Swing Gate Type Valve

The principal advantages claimed for the regrinding swing gate valve, two views of which are shown in Fig. 1, include (1) no obstruction to the steam flow, or change of direction; (2) higher effective working pressure and rate of steam flow are possible than with an ordinary mushroom valve; (3) ease of valve operation is secured due to the special toggle lever movement; (4) the valve disc is readily accessible for regrinding purposes without dismounting the valve.



Regrinding Swing Gate Valve in Closed and Open Positions

As indicated by the name, the valve seat may be ground without dismounting. The valve seat is at right angles to the horizontal axis of the body. Closing is effected by the disc rigidly connected to the swing link centered on a shaft. Attached to the swing link is a threaded disc stud, secured to the valve disc by means of a disc nut. The disc is designed to insure perfect seating of the contacting surfaces The purpose of the spring shown is merely to prevent vibration of the disc and at the same time give a slight flexibility of operation.

Opening and closing the valve are accomplished by means of a sliding carriage which moves at right angles to the horizontal axis of the body. This carriage slides practically without friction. It is rigidly attached to the vertical sliding spindle and can be made to move up and down by turning the hand wheel. A forked link is connected by pins with the sliding carriage and the swing link. This forked link is inclined slightly from the horizontal and forms with the slide a toggle lever exerting pressures in both the swing link and the disc, thereby forcing the disc against the valve seat. Lugs are provided in the housings for limiting the downward movement of the slide in cases where the piston rings are excessively worn.

In order to grind the valve seat, the bolts binding the bonnet to the housing are both removed. Then the pin connecting the forked link and the swing link is removed and all the internal parts are taken out with the exception of the swing link and the valve disc. The grinding operation is performed in the customary manner (Fig. 2) by adjusting a suitable wrench in the end of the disc stud, an extension of the wrench fitting into one of the holes provided around the circumference of the valve disc. By rotating the disc alternately, clockwise and counterclockwise, at the same time exerting pressure against the valve seat, the latter will be ground.

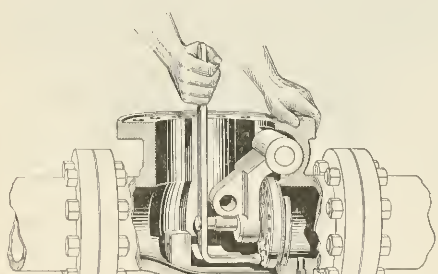


Fig. 2—Drawing Illustrating Method of Grinding Valve Seat

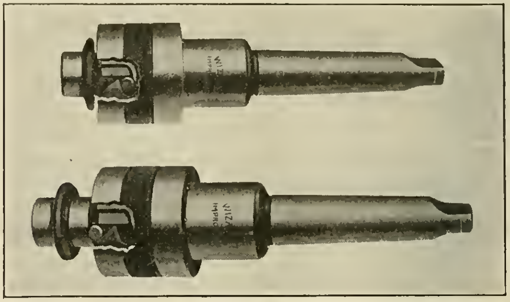
The valve disc in its high position, is so located that the valve seats are above the flange of the valve body when the bonnet is removed. Thus the rings are conveniently accessible and can be readily inspected whenever necessary. This valve is made by the Schutte & Koerting Company, Philadelphia, Pa.

Improvements Made in Quick-Change Chuck

The McCrosky Tool Corporation, Meadville, Pa., has made improvements recently in what is known as the Wizard quick-change chuck. These improvements have demonstrated their value over a considerable test period and the new chuck is now ready for the market. The illustration shows in the lower view the improved chuck with the collet just entering. In the upper view the collet is locked firmly in place.

The improvements in the new chuck are designed to provide greater strength, simplicity and ease of operation than the original chuck possessed, although these were the features of the original design. The McCrosky improved Wizard chuck consists of only two main parts, a driving body with a Morse taper shank to fit the drill press spindle, and a slotted collar to hold the collet up in the driving body. This collar is straight and uniform in shape and is hardened all over. The bayonet locking slots in the collar that admit the driving lugs of the collet are now so designed that the collet can be inserted or released with one hand without slowing or stopping the machine.

No mechanical skill is necessary. To insert a tool the operator simply pushes the collet into the revolving chuck. The positive automatic latch locks it instantly. Releasing is likewise said to be rapid and easy. A slight pressure of the thumb and forefinger on the knurled collar of the chuck releases the collet instantly and allows it to drop into the operator's hands. All styles and sizes of McCrosky Wizard collets will fit the new chuck.



McCrosky Wizard Quick-Change Chuck

Double End Staybolt Threading Machine

The machine, illustrated in Fig. 1, is made by the Cleveland Automatic Machine Company, Cleveland, Ohio and designed to thread reduced center forged or rolled locomotive boiler staybolt blanks, on both ends at the same time. By this method there is no loss of time passing the die over the center part, the amount of time required to complete any length of staybolt being only that necessary to thread the longest end.

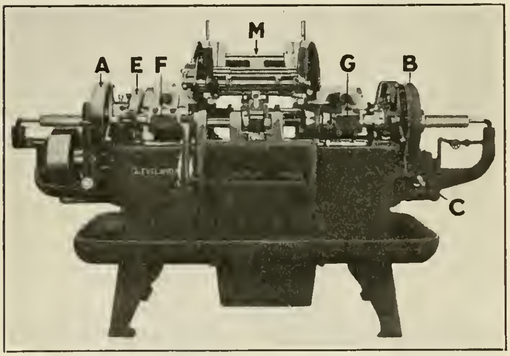


Fig. 1—General View of Cleveland Double End Staybolt Machine

Also, on account of the hopper magazine the operation of the machine is continuous, not being subject to delay as in the case of machines where the staybolts are chucked by hand. By means of a small independent vertical conveyor each staybolt is carried from the main magazine down in line with the threading dies to be gripped and this continues until the magazine *M* is empty.

Because of threading from both ends the staybolt must be gripped in the center. For this reason the gripping jaws are floating so that the two ends of the staybolt may be presented to the dies in accurate alinement regardless of the center part, which is always somewhat out of true with the ends. This means that the threaded ends in the rough can be over 1/16 in. out of line and still the dies thread both ends in line with one another—a great saving in forging.

The gripping jaws are composed of an upper half *N* (Fig. 2) and a lower half pivoted on stud *O* and opened or closed by toggle mechanism *P* operated by levers *Q* and suitable cams.

In setting up a job a master staybolt or long thread gage is inserted in the die heads, one of which is closed upon the gage, and then by a fine adjustment provided, the other die head is brought to a position where it may also be closed upon the gage which sets the die heads so that continuous lead will be produced. The lead screw which is mounted back of the die spindles is driven by gears at *E* (Fig. 1) direct from the die spindle at the left.

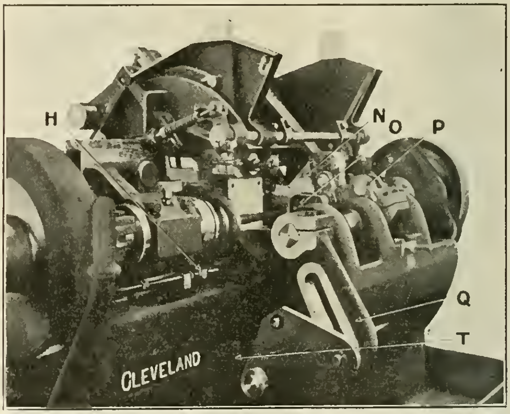


Fig. 2—Close-Up View Showing Chuck Details

The two die slides *F* and *G* (Fig. 1) are controlled by the lead screw during the cutting stroke and when the desired length of thread has been cut, the die heads are opened. When the return stroke is nearly completed and the die heads just clear of the work, the jaws open and move backward, ejecting the finished staybolt which drops into the pan and another is lowered from the magazine *M*.

Referring to the machine (Fig. 1) the pulley at the left drives a shaft extending through the inside of bed to the right-hand end and from this main driving shaft the die spindles are driven by gears at *A* and *B*, the feed shaft *C* by spiral gears, and from shaft *C* the cam shaft in the rear is driven by change gears at *D*.

Part of the backward movement of toggle mechanism opens the jaws, and the balance ejects the finished staybolt and withdraws the slide upon which the jaws are mounted, allowing another staybolt to be lowered from the magazine to a position in line with the die heads.

The forward movement of toggle mechanism advances the slide with the open jaws until they are in position to close on the staybolt, at the same time seating the staybolt into *V* blocks at each end just in front of the die heads, aligning the staybolt with the dies. The jaws then close, gripping the staybolt securely. A heavy spring cushion at the top of toggle lever allows for slight variations in diameter of bolts where the jaws grip.

The machine is equipped with a safety pin which will shear off in case of trouble from staybolts which are too much out of shape to be used. Cutting oil is pumped through both die heads, providing a heavy stream washing away chips, cooling and lubricating the chasers. Change gears regulate the cam shaft to suit different lengths of threads to be cut.

A lever at the left-hand end controls the starting and stopping of the machine through a friction clutch.

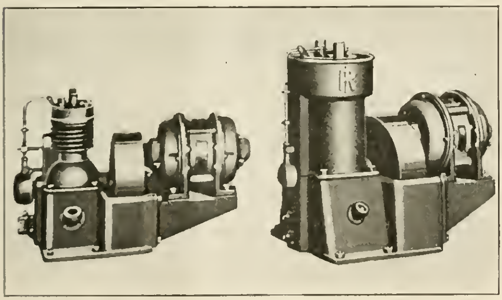
The machine is entirely automatic and threads staybolts up to 1 5/16 in. in diameter from 7 in. to 18 in. long.

The production time is 35 to 60 seconds per staybolt, depending upon the diameter and length of thread. The magazine only requires filling every 50 to 55 min., depending upon the size of the staybolts.

Adjusting the machine when changing from one length or size of bolt to another is a simple operation, as the two adjustable die head spindles can be moved longitudinally and located in a few minutes' time. The magazine is also adjustable for the different lengths to accommodate the location of the die heads.

Small Vertical-Type Air Compressors

The Ingersoll-Rand Company, New York, announces a new line of small vertical air compressors known as Type Fifteen. In addition to plain belt drive, each of the four sizes is built as a self-contained electric motor outfit, driven through a pinion and internal gears, or by employing a short belt drive arrangement. The compressing end and electric motor of both gear and short belt-drive units are furnished mounted on a common sub-base, so that they are in no way dependent upon the foundation for correct alinement.



3-In. by 3-In. Air-Cooled and 4½-In. by 5-In. Water-Cooled Ingersoll-Rand Air Compressors

Several noteworthy features of construction have been incorporated, of which the constant-level lubrication system is the most important. Others include the constant speed unloader for plain belt-drive machines; the centrifugal unloader for start and stop control machines; and the increased size of the water reservoir cooling pot.

The lubrication of small vertical compressors employing the enclosed crank case and splash system has often been a source of concern wherever oil in the air is a serious menace. The tendency of the old system has been to feed too much, resulting in the discharged air containing excess oil, or too little, causing scored cylinders, excess loads and burned out bearings.

As with the ordinary splash system, the base of the compressor forms an oil reservoir for the constant-level system. However, with this system, pet cocks determine the maximum and minimum amount of oil in the reservoir. Above this reservoir and directly underneath the connecting rod is a constant-level pan. Oil is pumped from the reservoir into this constant-level pan through a unique oil pump. Regardless of the amount of oil in the reservoir, so long as it is somewhere between the high and low level pet cocks, this system will function, insuring a constant-level of oil in the pan. A projecting stem on the connecting rod dips into this pan and distributes just a sufficient quantity of oil for proper lubrication.

The constant speed unloader controls the unloading of the compressor by automatically opening the inlet valve when the receiver pressure rises above that at which the unloader is set to operate. When the receiver pressure has fallen a predetermined amount, the unloader automatically releases the inlet valve and allows the compressor to return to work and thus build up the receiver pressure again.

The centrifugal unloader allows the compressor to start under "no load" such as is essential when automatic start and stop control is used, and permits the electric driving motor to come up to full speed before the load is thrown on automatically. This unloader accomplishes its purpose by holding the inlet valve open until the motor has reached full speed.

The smallest size is built with either ribbed cylinder for air cooling, where the service is intermittent, or a water-jacketed cylinder of the reservoir type for constant service. All other sizes are built with the water jacket of the reservoir type. The belt and electrically-driven machines include the 3 in. by 3 in. air-cooled, the 3 in. by 3 in., the 3½ in. by 4 in. and the 4½ in. by 5 in. water reservoir cooled machines.

The Day's Work on the New York Central.—This is the title of a display advertisement recently published by the New York Central reading as follows: From midnight to midnight the New York Central Lines haul 100,000,000 ton-miles of freight. A ton-mile, the measure of transportation, is one ton moved one mile. A hundred million ton-miles are equivalent to moving a ton a distance greater than from the earth to the sun; or of moving 4,000 tons [a train of 80 large cars] around the world. In the same twenty-four hours the passenger trains record 10,000,000 passenger-miles, the equivalent of carrying more than 10,000 passengers from Chicago to New York. The day's work of the New York Central Lines is about one-tenth of the rail transportation of the United States, and is greater than that of all the railroads of England and France combined.

GENERAL NEWS

The Finnish Railway Board has asked a Swedish factory to submit an estimate of the cost of introducing ball bearings on Finnish railway cars.

Milo S. Ketchum, director of the Civil Engineering Department of the University of Pennsylvania, has been appointed dean of the college engineering, and director of the Engineering Experiment Station of the University of Illinois.

The Republic of Poland has purchased 7,504 European type freight cars from the United States War Department, according to an announcement made in Washington recently. These cars were ordered during the war for use by the American army.

The recent report that Russia had cancelled her orders for locomotives from abroad is said to refer to 608 heavy locomotives, the reason for the cancellation being that many of the bridges on the Russian railways are badly damaged and would not be able to support the weight of these locomotives.

The first of a new type of locomotive—known as the "K" class—with a weight in working order of 103½ tons, has been completed in the Victorian State Railway workshops at Newport, Melbourne. The Railway Commissioners' construction programme provides for the building of ten of these engines at the Newport workshops within twelve months. This class of engine has a tractive force of 26,193 lb. It is of the eight-coupled type, and will be used exclusively for goods traffic.

The Railway & Locomotive Historical Society has issued Bulletin No. 3, a pamphlet of 54 pages, filled with reminiscences of old locomotives mostly those of New England roads, though space is given to the full story of the "General" of the Western & Atlantic, and the tragedy of the Andrews raiders of 1862. The illustrations include the "Uncle Tom," a 4-2-2 locomotive (with tender on the same frame) of about 18 or 20 tons, which flourished on the Fitchburg & Worcester Railroad about 1850-1860, and a number of others equally interesting. It is said that about 1843 Hinkley & Drury built a good many of this type. Charles E. Fisher, president of the society, 152 Harvard street, Brookline, Mass., desires information for a history of the early locomotives of the New York, New Haven & Hartford and of its predecessor companies in Connecticut.

Handbook of United States Safety Appliances

In response to demand from the members, another edition of the small Safety Appliance Handbook, covering all classes of cars and locomotives, for use of inspectors and others, similar to that issued in 1915 by the Master Car Builders' Association, revised to date, has been issued by the Mechanical Division of the American Railway Association. These books will be supplied on requisition to members or others by the secretary.

Illinois Central Roundhouse at Council Bluffs Partially Destroyed by Fire

Fire broke out in the roundhouse of the Illinois Central at Council Bluffs, Iowa, on October 16, presumably due to defective electric light wiring which ignited the roof of the building and destroyed all of the wooden parts of the structure. Eight engines were in the building at the time of the fire. The total damage to the engines and the roundhouse is estimated at $21,000.

Enginemen Urge More Rigid Locomotive Inspection

More rigid enforcement of the safety appliance and locomotive inspection laws was urged by counsel for the Brotherhood of Locomotive Engineers and Brotherhood of Locomotive Firemen and Enginemen at a conference with President Harding on October 11. The President was told that the condition of railroad power and equipment is such as to constitute "a menace to the traveling public" and that many railroads are disregarding the safety laws. They asked the President to compel the railroads to observe the requirements of the laws. The President pointed out that he had recently recommended to Congress an appropriation for additional inspectors for the Interstate Commerce Commission, but that this item was omitted from the bill as it was passed.

Prospective Large Equipment Inquiry from Argentina

The La Plata Meridiano Railway, owned and operated by the Province of Buenos Aires, Argentina, has been authorized to construct and equip 650 kilometers of new lines provided proper financial arrangements can be made, according to a cablegram received by the Bureau of Foreign and Domestic Commerce. Originally bids were to be opened October 31, but the date has been put off to December 31. Some of the equipment includes 44,300 tons of 31 kg. rails; 470, 30-ton covered-goods wagons; 30, 30-ton open-goods wagons; 50, 30-ton flat cars; 130, 30-ton cattle cars; 27 Pacific type locomotives; 10 first class, American type passenger cars; 10 second class, American type passenger cars; 39 baggage cars; machinery to equip the shops and numerous miscellaneous items.

Improper Billing for Foreign Car Repairs

The American Railway Association has issued a circular calling attention to the lack of compliance with the rules regarding billing for foreign car repairs and determining the responsibility for damage to foreign equipment necessitating repairs. This difficulty, the circular states, is largely due to incomplete supervision, lack of knowledge of the rules on the part of local shop officers and, in some instances, to improper practices. Railroad executives are urged to provide such supervision as will insure the proper observance of the Rules of Interchange with respect to repairs to foreign cars and billing therefor.

The Mechanical Division of the association has a small force of inspectors investigating these conditions. This work will be continued and in addition to calling the attention of the officers of the railroads concerned to the conditions found, similar reports will be made quarterly to the board of directors of the association.

Shop Strike Leaders Ask for Jury Trial in Injunction Case

Leaders of the recent strike of railroad shopmen, named in the temporary injunction obtained by Attorney General H. M. Daugherty, will seek a trial by jury in an effort to balk the government's move for a permanent restraining order. This announcement, which was hinted at in recent Federal Court proceedings at Chicago, was definitely made on October 13 by Donald R. Richberg, attorney for B. M. Jewell and the other strike leaders. Mr. Richberg formally presented his motion for this procedure to the court on October 16.

At the same time it became known that a motion by Blackburn Esterline, assistant solicitor general, that hearings on the government's request for a permanent injunction be referred to a master in chancery, was granted by Judge James H. Wilkerson.

J. M. Dickinson, secretary of war under President Taft and formerly counsel for the Illinois Central, has been appointed special assistant to Attorney General Daugherty and placed in charge of the government's case against the strike leaders. The appointment of Mr. Dickinson is part of the announced plan to prosecute vigorously the injunction suit now pending before Judge Wilkerson.

Sixteen Roads Sign Agreement With New Shop Organizations

Railroads representing a total mileage of approximately 55,910 miles have signed agreements with "company unions," according to information recently given out by the Railroad Labor Board. This mileage does not include the Pennsylvania System, which was conducting negotiations with its employees through "company unions" before the shop crafts strike began. The new agreements provide, in effect, that the men waive their right to strike and the companies pledge themselves not to carry their controversies into the court, both parties agreeing to abide by the decisions of the Labor Board.

The 16 roads which have signed agreements with new organizations of their employees and which are included in the Labor Board's announcement are: The Southern Pacific (Pacific System); the Missouri, Kansas & Texas; the Southern Pacific, Texas and Louisiana Lines; the Nashville, Chattanooga & St. Louis; the Central of Georgia; the New York, New Haven & Hartford; the Chicago, Burlington & Quincy; the Colorado & Southern; the Great Northern; the Lehigh Valley; the International Great Northern; the Union Pacific; the Illinois Central; the Florida East Coast; the Trinity & Brazos Valley, and the San Antonio, Uvalde & Gulf.

Mr. Loree on Labor Unions

State supervision of all voting which may result in a strike or lockout was advocated by L. F. Loree president of the Delaware & Hudson in an address on "Labor Unions" before the clearing house section of the American Bankers' Association convention in New York this week. He proposed that laws be enacted to this effect. Such control, to insure a secret ballot free from intimidation or misrepresentation, and its honest count was declared necessary to rescue the American worker from what he termed the tyranny of labor professionally organized. Mr. Loree urged his hearers to devote time and thought to ways and means of helping the laborer "in his safety and comfort * * * intellectually and spiritually." He would have laws enacted—

1. To provide that voluntary associations of seven or more members may sue or be sued.
2. To make the records and accounts of such associations subject to public authority, and to make political use of union funds a criminal offense.
3. To give State authorities better facilities for labor dispute investigation through the power of subpœna witnesses; also to make available to the public full reports of such investigations, then to compel fourteen days' notice of intention to strike or lockout.

The Rock Island Celebration

The celebration of the 70th anniversary of the founding of the Chicago, Rock Island & Pacific Railway was carried out at Chicago, Joliet and other places on Tuesday, October 10, in accordance with previous announcements. A large number of officers of the road, old-timers and friends of the Rock Island gathered at the LaSalle Station, Chicago, in the morning and an hour was spent in greetings, posing for pictures and other holiday activities. The train shed was jammed with the crowd. A holiday spirit permeated the entire Rock Island System. Among the other features at Chicago was a group of girls dressed in gowns similar to those worn by the women who were passengers on the first train which was run on the opening of the first section of the line from Chicago to Joliet, 40 miles.

At ten o'clock, a special train in charge of Charles Hayden, chairman of the board of directors, was started for Joliet. It was stopped for two minutes at the shops at 47th street, where the shopmen turned out in full force. This train was in charge of five employees whose aggregate service on the road equals 200 years. Among the passengers was a woman who rode on the first train 70 years ago.

At Joliet, the party proceeded to the Court House lawn, where a monument has been erected to Samuel Benedict Reed, the civil engineer who surveyed the route between Chicago and Joliet. The monument was unveiled by Anne Reed Bates, great granddaughter of the surveyor. A dedication speech was delivered by J. E. Gorman, president of the road. Mr. Gorman took occasion to call attention to the danger of super-regulation of the railroads. The anniversary day was brought to a close with the broadcasting of the story by radio from station KYW. This story was again spread throughout the western country, from other stations farther west, and employees and others at various points all over the system were able to listen to the music of the orchestra and parts of the addresses.

Labor Board Again Rules Against Contracting

On October 7 the Labor Board handed down twelve decisions, all of which involved principles of contracting. Nine of the decisions condemned this practice, while one favored it. In all of the cases decided unfavorably to the railroad contentions, the Board referred to its decision in a similar case involving the Indiana Harbor Belt and published in the Railway Age of May 13. The disputes so decided in this latest group of decisions involved the following carriers, contracting companies and facilities:

The Erie and the Meadville Machinery Company for the operation of shops at Dayton, Sharon, Meadville, Hammond, Huntington, Marion, Rochester, Avon, Elmira, Cleveland, Binghamton, Galion, Dunmore, Avoca and Stroudsburg;

The Cincinnati, Indianapolis & Western and the Kellogg-Grego Railway Service Company.

The Cincinnati, Indianapolis & Western for the contracting of certain clerical and station work.

The Pere Marquette and the Fort Street Union Depot for the contracting of the power plant and facilities at Baldwin, Mich.

The Cleveland, Cincinnati, Chicago & St. Louis and the Railway Service & Supply Corporation for the contracting of freight car repair shops at Brightwood and Beach Grove, Ind., and the locomotive repair shops at the latter point.

The Bangor & Aroostook for the contracting of its shops at Houlton, Maine.

The Chicago, Rock Island & Pacific for contracting of coal chutes at Cortland, Kan., Fairbury, Neb., and Lincoln, and a pumping station at South Bend, Neb.

The Michigan Central and the Illinois Car & Manufacturing Company for the contracting of the car shops at West Detroit, Mich.

The Chicago & Alton and Joseph Colianni & Bros. for the handling of coal, sand and cinders and for the pumping of water along its lines.

A dispute involving the New York Central and the Railways Employees Department of the American Federation of Labor, the hearings in which were described in the Railway Age of September 17, 1921, was decided by the board in favor of the New York Central. Contracts entered into by that carrier with the Western Union for the purpose of constructing and maintaining telegraph lines along the New York Central right of way were declared legal by the board inasmuch as they were made in the public interest and the practice had been in effect prior to the passage of the Transportation Act.

Several alleged disputes over the practice of contracting were at the same time dismissed by the board. Among the cases of this character being two involving the Ann Arbor and one involving the Southern Pacific, Texas & Louisiana lines.

Bad Order Cars

Reports received by the Car Service Division, of the American Railway Association, show that 32,929 fewer freight cars were in need of repairs on October 1 than on July 1 last when the strike of railway shopmen began. The total was 291,654 or 12.8 per cent of the cars on line. This was a decrease of 12,894 cars as compared with the number on September 15, at which time the total was 304,548 or 13.4 per cent. On October 1 last year, 364,372 or 15.8 per cent were in need of repairs. Of the total 230,565 required heavy repairs, while 61,089 required only light repairs. This is a decrease compared with September 15 last of 11,114 in the number requiring heavy repairs, and a decrease of 1,750 in the number needing light repairs. Every district reported a decrease as compared with September 15.

MEETINGS AND CONVENTIONS

C. I. C. I. & C. F. A. Convention

The annual convention of the Chief Interchange Car Inspectors' & Car Foremen's Association will be held at the Hotel Sherman, Chicago, November 9 and 10. Papers will be presented on the following subjects: Apprentices in the Car Department and the Way to Make Them Properly Efficient; Repairs and Maintenance of Tank Cars; the Broad Question of Lubrication; Loading of Metal Sheets and Plates in Box Cars, Single Overhanging and Twin Loads of Long Flexible Concrete Bars, Superimposed Loads of Steel Plates on Sides of Gondola Cars; the Car Department and Freight Claims; Transportation; and Scheduling of Equipment through Repair Shops.

The following committees will also submit reports: The Arbitration Committee; Committee on Prices for Labor and Material; Committee on Tank Cars; Committee on Loading Rules; also reports of Committee on Scheduling of Equipment Through Repair Shops.

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

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City. 1923 annual convention; Denver, first Tuesday in May.

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

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago.
Division V—Equipment Painting Division.—V. R. Hawthorne, Chicago. Annual meeting postponed.
Division V—Purchases and Stores.—W. J. Farrell, 30 Vesey St., New York.

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

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, A. F. Steubing, 2201 Woolworth Building, New York. Annual meeting, New York, December 4-7.

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

American Society for Steel Treating.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio.

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

Canadian Railway Club.—W. A. Booth, 53 Rushbrook St., Montreal, Que. Next meeting November 14. A paper on Some Recent Developments in Locomotive Construction will be presented by Grafton Greenough, vice-president, Baldwin Locomotive Works. Moving pictures on Prosperity Special.

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

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo.

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Next meeting November 23 at 2:00 p.m. A paper on the Training of Men To Act in Supervisory Capacities and Best Results in Handling Men will be presented by F. W. Brazier, assistant to general superintendent rolling stock, N. Y. C. Annual dinner at 7:30 p.m.; program not completed.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill. Annual convention, November 6-8, Hotel Sherman, Chicago.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Regular meetings second Tuesday, February, May, September and November.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabash Ave., Winona, Minn. The 1922 annual convention has been cancelled.

Master Boilermakers' Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting November 14. A paper on New England Railroads from a Commercial Purchasing Agent's Standpoint will be presented by Charles F. Shirley, purchasing agent, Fortes Lithograph Manufacturing Company.

New York Railroad Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Regular meetings third Friday of each month, except June, July and August, at 29 West Thirty-ninth St., New York.

Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa.

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

Traveling Engineers' Association.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Regular meetings third Monday of each month, except June, July and August.

SUPPLY TRADE NOTES

J. W. Floto has been appointed sales manager of the Globe Steel Tubes Company with headquarters at Chicago.

F. N. Bard, president of the Barco Manufacturing Company, Chicago, has been elected president of the Argyle Railway Supply Company, Chicago.

The Brown Instrument Company, Philadelphia, Pa., has opened a New England branch at 185 Devonshire street, Boston, Mass., with George Goodman in charge.

The Bridgeport Brass Company, Bridgeport, Conn., has opened an office in the General Motors building, Detroit, Mich., with Frank H. Longyear as district manager.

Allen Sheldon, one of the Chicago representatives of the Gold Car Heating & Lighting Company, Brooklyn, N. Y., died at his home in Chicago on September 27.

R. S. Dean has been appointed district sales manager of the machinery and crane departments of Manning, Maxwell & Moore, Inc., Chicago district, with headquarters in that city.

The Brown Hoisting Machinery Company, Cleveland, Ohio, has placed its conveyor sales in charge of E. P. Sawhill, who has had nearly 30 years' engineering and selling experience on this type of equipment.

Walter S. McKee has resigned as vice-president and director of the American Manganese Steel Company and in future will develop the business of the Inland Engineering Company, Chicago, of which he is president.

John Francis Harrigan, vice-president of the Magnus Company, Inc., New York, died on October 1 at his home in Detroit, Mich. Mr. Harrigan was 54 years old and had been connected with the Magnus Company in Detroit continuously since 1885.

A. F. O'Connor, mechanical engineer of the Union Railway Equipment Company, Chicago, has been elected vice-president, with headquarters at Chicago; R. C. O'Connor has been appointed mechanical engineer, and B. Smith, purchasing agent, with the same headquarters.

The Consolidated Machine Tool Corporation of America, New York City, has let a contract to the Shoemaker-Satterthwait Bridge Company, Philadelphia, Pa., for building a two-story foundry, 98 ft. by 240 ft. of steel and concrete construction, at its Hilles & Jones plant, Wilmington, Del.

The Pawling & Harnischfeger Company, Milwaukee, Wis., has appointed new agents for its machine tool line as follows: The Cadillac Machinery Company, Detroit, Mich.; the Cleveland Duplex Machinery Company, Cleveland, Ohio, and the Seifreat-Woodruff Company with offices at Dayton and Cincinnati, Ohio.

The Krantz Works of the Westinghouse Electric & Manufacturing Company have been moved to Mansfield, Ohio, from Brooklyn, N. Y., where they have been situated for a number of years. The transfer to Mansfield offers better facilities for increased production, gives the works location in the central part of the country with easy access to a large number of railroads and to both middle west and eastern offices of the Westinghouse Company.

The Federal Trade Commission has announced the dismissal of its complaint against the Midvale Steel & Ordnance Company, Republic Iron & Steel Company, and Inland Steel Company, in which it was alleged that the proposed merger of the companies was an unfair method of competition. The complaint was dismissed upon the filing with the commission of a formal statement by attorneys of record for the three companies, that the merger had been abandoned.

The Davis Boring Tool Company, St. Louis, Mo., has bought land for a new factory site fronting on Forest Park boulevard at the corner of Spring avenue. Preliminary work is now under way for putting up a modern three-story daylight factory in the near future. This company manufactures expansion boring tools and expansion reamers for all classes of metal boring in railroad shops. The company during the past 18 years has found it necessary to seek larger quarters on account of increased business and during that time outgrew four different factory buildings.

Johns-Manville, Inc., New York City, has been appointed joint selling agents by the H. H. Robertson Company, Pittsburgh, Pa., and in future all asbestos protected metal roofing, siding accessories and ventilators will be manufactured and shipped from the plant of H. H. Robertson Company at Ambridge, near Pittsburgh. Hereafter, in the manufacture of asbestos protected metal products by H. H. Robertson Company, Johns-Manville asbestos saturated felts will be used. Asbestos protected metal is largely used by all industry for conditions where an unprotected metal or other equally perishable roofing would quickly disintegrate.

A. W. Donop, formerly Pacific Coast district manager of the U. S. Light & Heat Corporation, with headquarters at San Francisco, has been appointed district manager in the railway department of that company, with headquarters in Chicago, to succeed E. C. Wilson. Mr. Donop has been identified with electric car lighting since its inception, having operated and maintained some of the original headend equipment on Pullman cars. He entered the service of the Pennsylvania at the time when that road established a carlighting maintenance department. He later was in the employment of the Gould Storage Battery Company, and the Lehigh Valley, respectively. In 1907, he entered the service of the U. S. Light & Heat Corporation, with which organization he has been chief inspector, traveling engineer, and a district sales representative.

E. deH. Caldwell has joined the staff of the Franklin Railway Supply Company, New York, as special engineer in its service department. Mr. Caldwell began his railroad service with the Aurora, Elgin & Chicago Electric Railway Company, and from there entered the service of the White Company as superintendent of repairs, in which position he had an active part in the design of steam operated automobiles. After five years in that work, he devoted the next five years as chief engineer of the Webb Jay Motor Company in the design of steam automobile engines. For the next seven years he was vice-president and chief engineer of the Empire Axle Company, following which he served for one year as chief engineer of the Hammond Steel Company, with which organization he was connected at the time of entering the service of the Franklin Railway Supply Company.

Charles E. Fisher, assistant engineer, test department, New York, New Haven & Hartford, has been appointed service engineer of the Franklin Railway Supply Company, New York, in charge of New England territory, with headquarters at Boston, Mass. After graduation from the University of Michigan, Mr. Fisher served the Pennsylvania Railroad in various capacities for three and one-half years. He then joined the Midvale Steel & Ordnance Company in its material department. While in that position, he was called to Rochester by the Signal Corps and later assigned to the Bureau of Aircraft of the U. S. Government, in which branch of the service he had charge of inspection of all material supplied to the government in that district. Upon completion of the government work, Mr. Fisher entered the service of the New York, New Haven & Hartford in its department of tests and from there went to the Franklin Railway Supply Company.

W. S. Rugg, assistant to the vice-president, has been appointed general manager of sales of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. The position of general sales manager is a new one in the Westinghouse Company and Mr. Rugg was appointed to the position because of his long experience in the electrical industry and in sales work. Mr. Rugg was born in Broadhead, Wis., and was graduated from Cornell University. He entered the service of the Westinghouse Electric & Manufacturing Company in 1892 and three years later was transferred from Pittsburgh to the Chicago office as district office engineer. In 1901 he was transferred to the New York office as special sales engineer, and in 1909 was made manager of that office. He was again transferred in 1917 to the East Pittsburgh works and was appointed manager of the railway department and shortly after he became manager of the marine department also. In 1920 he was promoted to assistant to vice-president in charge of sales, and now becomes general manager of sales as above noted.

TRADE PUBLICATIONS

Electric Hoists.—Sprague electric type WX worm drive hoists are described in a two-page folder issued by the Sprague Electric Works of the General Electric Company, New York. The folder includes a sectional drawing of the hoist and furnishes a brief description of each part.

Cinder Plants.—The Roberts & Schaefer Company, Chicago, has issued a four-page folder illustrating and describing its N. & W. type cinder plant. The text matter contains a list of 11 advantages of this type of plant while the illustrations show the construction and method of operation.

Electric Furnaces.—Baily electric furnaces for melting non-ferrous metals are described in a six-page folder issued by the Electric Furnace Company, Salem, Ohio. The folder also lists and illustrates a large number of products, for the manufacture of which the electric furnace is most suitable.

Multi-Speed Motors.—Applications of Watson multi-speed motors for adjustable speed control on alternating current polyphase circuits are described in a two-color, illustrated, 12-page bulletin issued by the Mechanical Appliance Company, Milwaukee, Wis. These motors are designed to run at any one of four different speeds namely, 600, 720, 900 or 1,200 r.p.m.

Bearing Metals.—The A. W. Cadman Manufacturing Company, Pittsburgh, Pa., has recently issued engineering bulletins M-1 and M-2. The first bulletin deals with the properties of bearing metals, especially those alloys known as Cadman metals. The second contains miscellaneous technical information pertaining to bearings and bearing metals, discussing such questions as the theory of bearing metals, friction in bearings and permissible bearing pressures.

Locomotive Repairs.—The Metal & Thermit Corporation, New York, has issued the fourth edition of "Thermit Locomotive Repairs." This pamphlet, No. 21, contains many revisions, chief among which are instructions for applying important improvements in practice in Thermit welding which have been developed by exhaustive research; also, revised drawings and instructions illustrating and describing the making of Thermit welds in various parts of locomotive frames and other locomotive and railroad equipment.

Questions and Answers.—A 15-page pamphlet of Questions and Answers has just been issued by the Skinner Chuck Company, New Britain, Conn., for use in connection with its booklet, "Chucks and Their Uses." This pamphlet is valuable as an aid to shop and apprentice instructors in directing attention to those points of chuck construction and use which practice and experience have proved to be particularly essential. It has also been adopted by vocational and industrial schools as a text book of information regarding chucks.

Lighting System Maintenance.—A 12-page pamphlet under the title of "Lamp Maintenance Equipment" has been issued by the Thompson Electric Company, Cleveland, Ohio. The booklet illustrates and describes the safety disconnecting hangers manufactured by this company, including methods of wiring and the application of various types of reflectors. The reasons for cleaning reflectors and the risks which may be involved in doing so are described and particular stress is laid to the suitability of the hanger where the lighting units are placed close to moving belts or above traveling cranes.

Control, Signaling and Alarm Instruments.—The Brown Instrument Company, Philadelphia, Pa., has issued a 24-page booklet describing and illustrating the automatic control, signaling and alarm instruments manufactured by that company. The catalogue covers a control pyrometer as applied to electric, gas and oil furnaces, indicating control thermometers, a recording control thermometer a recording pyrometer, a signaling pyrometer which shows by means of lights when the temperature is within certain prescribed limits, an alarm thermometer, control relays and a motor operated control valve.

EQUIPMENT AND SHOPS

Locomotive Orders

The Pennsylvania will build 3 electric locomotives in its Altoona shops.

The Lehigh Valley has ordered 15 Mikado type locomotives from the American Locomotive Company and 15 Mikado type from the Baldwin Locomotive Works.

The Atchison, Topeka & Santa Fe has ordered 26 Santa Fe type, 8 Mountain type, 15 Mikado type, and 10 Pacific type locomotives from the Baldwin Locomotive Works.

The Erie has ordered 10 Mikado type and 20 Pacific type locomotives from the Baldwin Locomotive Works. This is in addition to the 30 Mikado type ordered from the same builder as reported in the September *Railway Mechanical Engineer.*

The Baltimore & Ohio has ordered from the General Electric Company 2, 120-ton, 600 volt, direct current electric locomotives to be delivered in March, 1923. The locomotives will be practically duplicates of those now in use in the Detroit tunnel on the Michigan Central.

The Chicago, Rock Island & Pacific has ordered 30 Mikado type and 10 Mountain type locomotives from the American Locomotive Company. The Mikado type engines will have 28 by 30 in. cylinders and a total weight in working order of 332,000 lb.; the Mountain type will have 28 by 28 in. cylinders and a total weight in working order of 369,000 lb.

The New York, New Haven & Hartford has ordered five 181-ton electric locomotives from the Westinghouse Electric & Manufacturing Company. These locomotives will practically duplicate the ones now in use for high-speed passenger service. They will be equipped for operation on either alternating or direct current, the direct current equipment being used to permit operation into the Grand Central Station, New York.

Locomotive Repairs

The Temiskaming & Northern Ontario has placed an order with the Canadian Locomotive Company for rebuilding and repairing 6 locomotives.

Freight Car Orders

The Live Poultry Transit Company, Chicago, will build 100 poultry cars in its own shops.

The Chicago Great Western has awarded a contract to the Pullman Company for 500 box cars.

The Grand Trunk has ordered 250 refrigerator cars from the American Car & Foundry Company.

The Norfolk Southern has ordered 240 steel underframes from the Virginia Bridge & Iron Company.

The Pacific Electric has ordered 200 National dump cars from the American Car & Foundry Company.

The United Fruit Company has ordered from the Magor Car Corporation 25 cane cars for the Tela Railroad.

The Interstate Railroad has ordered 1,000 box cars of 55 tons' capacity from the Pressed Steel Car Company.

The Atlantic Coast Line has ordered 2,000 box cars of 40 tons' capacity from the Standard Tank Car Company.

F. M. Pease, Chicago, has ordered 100 tank cars of 8,000 gal. capacity from the Pennsylvania Tank Car Company.

The Atlantic Coast Line has ordered 500 steel underframes for box cars from the Standard Tank Car Company.

The Chicago & North Western has ordered 800 gondola cars and 200 flat cars from the General American Car Company.

The Tennessee Coal, Iron & Railroad Company has ordered 195 miscellaneous cars from the Chickasaw Ship Building Company.

The New York, Chicago & St. Louis has ordered 300 steel underframes for stock cars from the Illinois Car Manufacturing Company.

The Bethlehem-Chili Iron Mines Company has ordered 25 hopper bottom ore cars of 50 tons' capacity from the Magor Car Corporation.

The Detroit, Toledo & Ironton has ordered 500 coal cars from the Cambria Steel Company and 500 from the Standard Steel Car Company.

The Pennsylvania Coal & Coke Corporation has ordered 1,000 hopper cars, of 50 tons' capacity, from the American Car & Foundry Company.

The Cincinnati, Indianapolis & Western has placed an order for 209 composite gondola cars with the American Car & Foundry Company.

The East Jersey Railroad & Terminal Company has placed an order with the American Car & Foundry Company for 25 tank cars of 10,000 gal. capacity.

The Transcontinental Oil Company has placed an order with the American Car & Foundry Company for 75 tank cars of 8,000 gal. capacity and 75 of 10,000 gal. capacity.

The Fruit Growers' Express will build 1,000 refrigerator cars in its own shops at Indiana Harbor, Ind. The company has also ordered 1,000 steel underframes from the General American Car Company.

The Pennsylvania has bought trucks of 70 tons' capacity for 10,000 freight cars. These trucks are to be placed under 50-ton cars at the Altoona shops. The company also will build 100 steel caboose cars at these shops.

The Maine Central has ordered 350 single-sheathed box and 100 open rack cars of 40-tons' capacity, 10 dairy products cars from the Keith Car & Manufacturing Company, and 50 all steel self clearing gondola cars of 50-tons' capacity from the Standard Steel Car Company.

The Atchison, Topeka & Santa Fe has ordered equipment as follows: 1,000 refrigerator cars, 1,000 automobile cars, and 500 stock cars from the Pullman Company; 1,000 refrigerator cars, 500 gondola cars, 500 box cars and 150 caboose cars from the American Car & Foundry Company and 500 box cars from the Standard Steel Car Company.

Freight Car Repairs

The New York Central will have 500 box cars repaired at the shops of the Streator Car Company.

The New York Central is having general repairs made to 200 stock cars at the shops of the Streator Car Company.

The Seaboard Air Line has ordered repairs to 500 composite gondola cars at the shops of the Virginia Bridge & Iron Works.

The Chicago & Alton has placed orders for repairing 200 steel gondola cars with the Illinois Car Company and 200 steel gondolas with the Mount Vernon Car Manufacturing Company.

The Grand Trunk is having repairs made to 1,000 box cars at the shops of the National Steel Car Corporation, Hamilton, Ont.

The Erie Railroad has given a contract to the Magor Car Company for making repairs to 500 cars, most of which are gondola cars.

The Hocking Valley has equally divided an order for repairs to 500 composite gondola cars between the shops of the Pressed Car Company and the Greenville Steel Car Company.

The Chicago, Rock Island & Pacific has awarded a contract to the Western Steel Car & Foundry Company for repairs to 100 furniture cars, 100 wooden box cars and 200 steel frame box cars.

Passenger Cars

The Baltimore & Ohio has ordered 30 baggage cars from the American Car & Foundry Company.

The Maine Central has ordered 7 steel combination baggage and mail cars from the Osgood Bradley Car Company.

The Richmond, Fredericksburg & Potomac has ordered four steel passenger coaches and six steel express cars from the Bethlehem Shipbuilding Corporation, Ltd., Harlan Plant.

The Chicago, Rock Island & Pacific has awarded a contract to the Pullman Company for overhauling and repairing 5 dining cars.

The Central of New Jersey has ordered 30 all-steel coaches from the Standard Steel Car Company, 20 all-steel coaches, 10 steel baggage cars and 5 steel combination passenger and baggage cars from the American Car & Foundry Company.

Machinery and Tools

The Delaware & Hudson has ordered a 500-ton double end wheel press from the Niles-Bement-Pond Company.

The Chicago, Milwaukee & St. Paul has ordered two 3-ton hoists from the Shepard Electric Crane & Hoist Co.

The Chicago, Rock Island & Pacific has ordered a 36-in. planer and a 36-in. lathe from the Niles-Bement-Pond Company.

The New York Central has ordered a car wheel lathe and one or two engine lathes from the Niles-Bement-Pond Company.

The Atlantic Coast Line has ordered a 60-in. planer and a 6-spindle multiple drill from the Niles-Bement-Pond Company.

The Baldwin Locomotive Works has ordered two triple-end frame slotters and several frame planers from the Niles-Bement-Pond Company.

The Crucible Steel Company has ordered a 90-in. driving wheel lathe, also a 96-in. 600-ton wheel press from the Niles-Bement-Pond Company.

The New York Central has ordered one 23-in. lathe from the Niles-Bement-Pond Company. This company is also inquiring for one 27-in. by 18-ft. lathe.

The Atchison, Topeka & Santa Fe has ordered a 150-ton overhead electric traveling crane for its Albuquerque, N. M., shop from the Morgan Engineering Company, Alliance, Ohio.

The Illinois Central has placed orders for about $320,000 worth of machine tool equipment which include a car wheel lathe and two combination turning and axle lathes from the Niles-Bement-Pond Company.

Lima Locomotive Works, Lima, Ohio, has ordered 12, 6-ft. Right line radial drills; 6 Pond planers (5 of 60-in., one of 90-in.); and a 50-ft. triple-head Bement locomotive frame slotting machine. The company divided an order for additional tools among three other builders, including three planers, a vertical rod milling machine, axle turret lathe, vertical rod boring machine, four 20-in. engine lathes, two tool makers' lathes, a 60-in. wheel press, two 18-in. slotting machines, a horizontal boring and milling machine, cylinder boring machine and two turret lathes.

The Pennsylvania has ordered from the Niles-Bement-Pond Company two cranes of 250 tons' capacity, two of 60 tons', two of 25 tons' and 10 of 15 tons' capacity. A list of heavy machine tool requirements has been issued by this company. These include: Three No. 5 knee type milling machines; 17 engine lathes with 16-in. to 48-in. swing; six, 36-in. and three, 42-in. vertical turret lathes; two, 36-in. and two, 48-in. planers; two, 90-in. driving wheel lathes; three, 5-ft. and one 6-ft. radial drills; four horizontal turret lathes; five, 24-in. shapers; two, 15-in. and three, 18-in. slotters; ten, 36 in. by 4 in. wet emery grinders; three turret lathes, an axle lathe; journal-turning lathe; 42-in. coach wheel lathe; 90-in. tire mill; 2-in. pipe machine; crown and staybolt threading and reducing machine, 6 spindles; bolt turning machine, 4 spindles; bolt pointing machine and bolt heading machine

Shops and Terminals

Texas & Pacific.—This company will construct a 100-ft. turntable and a three stall extension to its roundhouse at El Paso, Tex.

Minneapolis, St. Paul & Sault Ste. Marie.—This company has awarded a contract for a 20-stall roundhouse at Gladstone, Mich., to Smith & Vaudanaker, St. Paul, Minn.

The Erie has awarded a contract to the Truscon Steel Company, Youngstown, Ohio, for the sash required in the construction of its new machine shop at Hornell, New York.

Chicago, Burlington & Quincy.—This company has awarded a contract for a one-story reclamation plant, 50 by 301 ft., at Eola, Ill., to the Great Lakes Construction Company, Chicago.

Green Bay & Western.—This company has awarded a contract to the Ogle Construction Company, Chicago, for coal handling machinery to be used in a 200-ton frame coaling station at Whitehall, Wis., which the company will erect with its own forces.

Northern Pacific.—This company has awarded a contract to the Winston-Grant Company for the construction of a 50-ft. by 153-ft. two-story brick storehouse with platforms; also the construction of a 45-ft. by 95-ft. concrete and brick boiler and engine room, including a coal trestle, at Glendive, Mont., to cost approximately $70,000.

New York, New Haven & Hartford.—This company has awarded contracts to the Roberts & Schaefer Company, Chicago, for the installation of a 300-ton reinforced concrete automatic electric locomotive coaling plant at South Worcester, Mass., and for a 600-ton reinforced concrete three-track, Rands shallow pit automatic electric locomotive coaling plant for installation at Boston, Mass.

Cuba Northern.—Improvements are being carried out at Moron, Cuba, to include the construction of a locomotive repair shop, car and coach shop, transfer table, smith shop and foundry, power house and saw mill. A contract for the construction and all necessary tools has been given to the Baldwin Locomotive Works. All the buildings will be of steel frame with galvanized sides and the improvements will cost about $675,000. The shops are to be ready for operation by November 1, 1922.

Missouri Pacific.—This company has awarded a contract to Jerome Moss & Co., Chicago, for the construction of a car repair shop at Kansas City, Mo. Contracts have also been awarded to the National Boiler Washing Company for the erection of new water treating plants at Ford, Ill., Knobel, Ark., Jefferson City, Mo., Waverly and Nevada and for the remodeling of existing plants at Kansas City, Mo., Herington, Kan., Marquette, Concordia and Eads, Col. and Haswell, Union, Neb.

The Missouri, Kansas & Texas.—Contracts have been awarded to the Graver Corporation, Chicago, for one 15,000-gallon per hour Graver Type "K" ground operated water softener with storage capacity at top of softener capable of holding 100,000 gallons of treated water for installation at Glen Park Yards, Kansas City, Kan.; one 10,000-gallon per hour Graver Type "K" ground operated water softener for installation at Nelogony, Okla.; one 5,000-gallon per hour Graver Type "K" ground operated water softener for installation at Eufaula, Okla., and for four standpipes 14 ft. diameter by 32 ft. high and one 18 ft. diameter by 32 ft. high for installation in Texas.

Canadian Pacific.—This company has awarded contracts to T. Jamieson and Mr. Kenzie, Ltd., Calgary, Alta., for the extension of 12 stalls of the locomotive house at Calgary, Alta.; to A. C. Creelman & Company, Calgary, Alta., for the building of stations, section houses, grain loading platforms, stockyards and water tanks and for the fencing on 50 miles of the branch from Lanigan, Sask., to Naicam; to the Northern Construction Company, Winnipeg, for the completion of the grading on the extension from Cracknell, Man., to Inglis, a distance of 6.2 miles; to the Hamilton Bridge Company, Hamilton, Ont., for the construction of two 90-ft. turntables for installation at Brandon, Man., and at North Bend, B. C.; and to A. E. Hamilton, Moose Jaw, Sask., for a 100-ton standard mechanical coaling plant at Secretan, Sask.

Long Island.—This company is making some improvements at their repair shops at Morris Park, L. I., to include a new office building and a new storehouse, both to be of reinforced concrete; the installation of new machinery and two new overhead cranes in the locomotive shop; the remodeling of the old office building into a wheel shop with new machinery. The new office building will be 40 ft. by 80 ft. and will have three floors and basement, the basement to accommodate a modern restaurant for supervisory and office forces, rooms for records, and lavatory for men. The first floor will accommodate the superintendent of motive power's general office force and an information and employment bureau. The second and third floors to have offices of the superintendent of motive power and engineering forces. The new storehouse will be 40 ft. by 100 ft. and will have three floors and a basement, to be equipped with electric elevators for freight and an electric dumb-waiter to speed up delivery for light material to the delivery counter located on first floor. The entire building will be equipped with modern type of adjustable steel shelving. On the third floor will be located the office of the storekeeper and his office force. The old office building and present storehouse will be remodeled into a wheel shop and will have installed a complete monorail system for unloading wheels and axles and for handling this material in shop. New axle lathes, boring mills, wheel press and grinding machines will be installed. The locomotive shop will have a number of new machines, among which are a side head boring mill, a slotter, a bushing press, a radial drill, and a 20 ft. by 10 ft. bed engine lathe. To speed up the handling of locomotives for repairs, the present slow method of unwheeling locomotives by a drop pit will be done away with and the two present 25-ton cranes will be replaced with a new 150-ton crane, running on a new steel runway the entire length of the locomotive shop. The light work will be handled by a new 10-ton crane, running on this same runway. The entire plant will be equipped with automatic telephones.

PERSONAL MENTION

GENERAL

B. F. Kuhn, district superintendent of motive power of the New York Central, Lines West, with headquarters at Collinwood, O., has been promoted to assistant superintendent of motive power, Lines West, with headquarters at Cleveland, Ohio.

O. M. Foster has been appointed district superintendent of motive power of the New York Central with headquarters at Collinwood, Ohio. W. R. Lye has been appointed district superintendent of motive power with headquarters at Elkhart, Ind.

John J. Hanlin, whose appointment as assistant superintendent of motive power of the Seaboard Air Line was announced in the October issue of the *Railway Mechanical Engineer*, was born on June 1, 1871, in Texas county, Mo. He was educated in the high schools of Birmingham, Ala., and left school in 1888 to enter the employ of the Savannah, Americus & Montgomery (now Seaboard Air Line). A short time thereafter he left this road for a private machine shop where he completed his apprenticeship as a machinist and in July, 1891, re-entered the service of the Savannah, Americus & Montgomery as a machinist. From 1891 to 1898 he served the same company as a hostler, fireman and yard engineman at Americus, Ga.


J. J. Hanlin

From 1898 to 1900 he was in the employ of the Louisville & Nashville at Birmingham as a machinist and gang foreman. From 1900 to 1903 he was general foreman and locomotive engineman for the Birmingham Southern at Pratt City, Ala. During the latter year he entered the service of the Southern as a machinist and roundhouse foreman at Birmingham and, the following year, entered the employ of the Seaboard Air Line in the same capacity at Birmingham; in 1906 he was promoted to general foreman at the same place and, in 1907, to master mechanic of the Georgia division. In this latter capacity he was serving at the time of his recent promotion.

F. A. Torrey, general superintendent of motive power of the Chicago, Burlington & Quincy, with headquarters at Chicago, retired on November 1.

E. W. Smith, engineer of transportation of the Pennsylvania with headquarters at Philadelphia, has been appointed general superintendent of motive power of the Southwestern region with headquarters at St. Louis, Mo. W. C. A. Henry, general superintendent of motive power at St. Louis, has succeeded Mr. Smith as engineer of transportation.

MASTER MECHANICS AND ROAD FOREMEN

C. Peterson has been appointed acting master mechanic of the Denver & Salt Lake with headquarters at Denver, Colo.

A. McCormick has been appointed master mechanic of the Graysonia, Nashville & Ashdown with headquarters at Nashville, Ark.

George Weller and Andrew W. Dow have been appointed traveling firemen of the Central Railroad of New Jersey on the Central division.

Walter Freyman, Daniel O'Connell, Fred G. Ripkey and Thomas Sheehan, have been appointed traveling firemen of the Central Railroad of New Jersey on the L. & S. division.

J. D. Young has been appointed assistant master mechanic of the Central of New Jersey, with headquarters at Ashley, Pa. David Evans has been appointed road foreman of engines with the same headquarters.

N. B. Garrett has been appointed master mechanic of the Montgomery district of the Mobile & Ohio with jurisdiction extending from Montgomery, Ala., to Artesia, Miss., inclusive, with headquarters at Tuscaloosa, Ala.

T. C. Raycroft has been appointed master mechanic of the Seaboard Air Line, with headquarters at Hamlet, N. C., succeeding G. W. Gilleland, who has been transferred in a similar capacity to Howells, Ga., succeeding J. J. Hanlin, promoted.

W. W. Payne has been appointed road foreman of engines of the Seaboard Air Line, with headquarters at Jacksonville, Fla., succeeding W. W. Shoemaker, appointed trainmaster of the East Carolina division. H. M. Agin has been appointed assistant road foreman of engines, with headquarters at Waldo, Fla.

H. Jefferson has been appointed road foreman of engines of the Second and Third Districts of the Plains division of the Atchison, Topeka & Santa Fe, with headquarters at Amarillo, Texas. W. C. Sherman has been appointed road foreman of engines of the First Shattuck and Buffalo districts, including the Canadian terminal of the Plains division, with headquarters at Canadian, Texas.

PURCHASING AND STORES

C. F. Leatherman has been appointed acting purchasing agent of the Kansas, Oklahoma & Gulf with headquarters at Muskogee, Okla.

CAR DEPARTMENT

J. W. Riley has been appointed district manager of the Car Service Division of the American Railway Association with headquarters at St. Louis, Mo. He will have the authority of the Car Service Division in the territory which includes terminals at St. Louis, Kansas City, St. Joseph, Omaha, Council Bluffs, and other outlying points as may be directed.

OBITUARY

T. W. Place, who was master mechanic of the Illinois Central with headquarters at Waterloo, Iowa, until he retired on a pension on November 1, 1901, died on October 9 at Waterloo after a few months of ill health. He was born on January 2, 1833, at Acworth, Sullivan county, N. H., and entered railway service in 1853 as a locomotive fireman on the Boston & Maine. In 1854 he became a locomotive engineer on the Illinois Central, and on September 1, 1861, he was promoted to master mechanic at Dubuque and later at Waterloo.

Railway Mechanical Engineer

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The Importance of Knowing Shop Costs

One serious weakness of most railroad shop organizations is the lack of an accurate system for rapidly computing detailed shop costs. Shop costs are fundamental to a manufacturer and absolutely limit the minimum selling price under which he can continue to do business. Costs are also fundamental to a railroad mechanical department which, however, is not compelled to go out of business when the costs become excessive. In this case the loss is simply transmitted to the stockholders, affects railroad credit adversely, and therefore is harmful to everyone connected with the railroad industry, if not the country at large. Shop costs must be both accurately and promptly known. It is of no avail to discover the costliness of a certain operation several months after it has been carried to completion. In fact, whenever a new method or practice is to be installed, the effort should be made to predict in advance what the cost will be, thereby avoiding those practices which are uneconomical.

It is only by the use of some reliable cost system that shop operations can be controlled with any degree of efficiency and economy, pointing out those practices which are expensive and enabling them to be corrected. Simplicity must also be a feature of any cost system successfully applied in railroad shops. It is recognized that in this case costs cannot be figured with the same detail as in a manufacturing plant where repetition work is carried on, but the essential costs can, and should, be known. The fact that many details are eliminated will reduce the clerical force required to operate the cost system and enable estimates to be made more promptly. That railroads are becoming more deeply appreciative of the need for simple, reliable cost systems is indicated by the fact that an eastern road at the present time is installing a new cost accounting system in accordance with the best modern thought. The experience of this road in installing the new system will be followed with interest by railroad men in general.

Reasons for Three-Cylinder Locomotives

Attention already has been called to the increasing number of three-cylinder locomotives which are being placed in service on European railroads. Several locomotives of this type were chosen as examples of recent British designs for the article which appears in this issue, and additional examples have been selected for the next installment. The Spanish locomotive described in the August issue is reported to have proved so satisfactory in service that 17 more have been ordered. Three-cylinder locomotives are also making excellent records in France, while the German State Railway has adopted this cylinder arrangement for the latest standard types of 4-6-0, 2-8-2 and 2-10-0 passenger and freight locomotives.

Some of the characteristics which have caused the adoption of this type were well brought out in an article in the November issue. The fact that the three-cylinder locomotive is capable of attaining some 15 per cent more hauling power for the same adhesive weight than the two-cylinder locomotive is a matter of prime importance, because the economic efficiency of a locomotive depends to a considerable extent upon the total weight per unit of power. The lighter reciprocating parts with a corresponding decrease in dynamic augment, together with the more uniform torque, result in smoother running and less stress upon track and bridges. In starting power and in rapidity of acceleration, three-cylinder locomotives also are superior, while the draft on the fire from six instead of four exhausts per revolution is more uniform and tends to better economy in combustion.

The results which are obtained from three-cylinder locomotives as their number is increased and as additional data in regard to operating and maintenance costs have been accumulated, will be watched with great interest. However, the adaptability of the type for American railroad conditions can be determined only by experience and tests on American lines.

Draft Gear in Theory and Practice

From a theoretical standpoint, it is easy to demonstrate that the desirable characteristics for a draft gear are high final resistance, building up gradually from a low initial value, long travel and slight recoil. It is also easy to show that these characteristics can be obtained only in a friction gear. An analysis of gears from the standpoint of capacity or work absorbed indicates that the ordinary draft springs would be so far inferior to the average friction gear that the use of the two types in the same service would seem almost out of the question. Two class *G* springs would go solid from the impact of a 40-ton car at two miles per hour, while an efficient friction gear would absorb five times as much energy and would not go solid until a speed of about 4½ miles an hour was reached. There are still many cars in service equipped with spring gears and in practice the capacity of springs does not seem to be so greatly inferior to that of friction gears as these figures would indicate. The fact that spring gears prove satisfactory at speeds of impact considerably in excess of their theoretical rating and that friction gears sometimes do not protect the car at moderately low speed indicates that there is further need for investigation of the action of draft gear under service conditions.

There are probably a number of reasons which account for the difference between theory and practice in draft gear action. The yielding of the car members is no doubt an important factor in relieving the high stresses that would be set up by solid impact. An advantage of the spring gear, which often is not considered, lies in the fact that there is always a considerable force acting to return it to the normal position. It is not improbable that in attempting to eliminate recoil the return force in many friction gears has been reduced too much to afford satisfactory action in trains. A great many friction draft gears after they have been compressed require only 10,000 lb. to 30,000 lb. to keep them in the closed position and, when in this position, they have very low capacity. If the gear is not in first-class condition, even less pressure may be sufficient to hold it closed. It is evident that a draft gear may be closed by shock while it is in a train behind a locomotive with a high tractive force, and if under this condition another shock is imposed on the gear, it is practically equivalent to a solid impact. Observation of cars in the head ends of trains will show that the coupler is often drawn out a considerable distance beyond its normal position, indicating either that there is free slack in the draft gear, or that it creeps toward the closed position under the varying drawbar pull exerted by the locomotive.

If parts of friction draft gear wear the resistance may be reduced very greatly, or if the surface is cut the resistance may increase and the force of release may not be sufficient to overcome the internal resistance and bring the gear back to the open position. Friction draft gears are very sturdy devices, but it is too much to expect that they will continue to protect the car properly, without attention under the severe stresses imposed upon them. There is no question but what periodical inspection and repair would eliminate many of the troubles that are now experienced and such work, if properly organized, should save considerably more than it would cost. The draft gear problem has probably been approached too much from the theoretical standpoint. If practical car men would give designers the benefit of their experience, it would be helpful in determining the type of equipment that is most satisfactory under average service conditions.

Analyzing Test Results

No one who has studied carefully the results of numerous tests of materials and appliances made by the railroads can fail to be impressed by the inconclusive results upon which large purchases are often based. To conduct tests that will determine accurately the relative performance to be expected from different products requires that the conditions which might influence the results shall be uniform, that the observations be made with such accuracy that the effect of possible errors will be negligible, and that all factors involved shall be given proper consideration.

These facts may seem self-evident, but nevertheless they are frequently overlooked. For example, a railroad conducted a test of two devices which indicated that one gave an economy of 25 per cent in coal per car mile and per pound of water evaporated over the other. An analysis of the conditions, however, showed that the results of the test could not possibly be accurate. One device was tested while the average temperature was 67 deg. and the other in much colder weather with an average temperature of 24 deg. During two of the cold weather trips the boiler was leaking, which would, of course, have an adverse effect on the evaporation. The temperature of the feedwater on some trips was estimated. The character of the coal varied from good lumps to 90 per cent slack. Yet the heating value of the various grades of coal was not ascertained. It is beyond the power of any engineer to make proper corrections for the many variable factors that would have influenced the results of this test, and it certainly cannot be accepted as a true measure of the relative economy of the two appliances.

In another case, a device which is designed to improve combustion was applied to a locomotive and as a result of tests conducted with and without the appliance, an economy of 10 per cent in fuel was claimed. This was based on the coal consumption per horsepower hour, which would be effected by the efficiency of the cylinders and valves as well as by the boiler efficiency. The boiler efficiency, which would give a far better indication of the relative performance, was practically the same in both cases.

Many tests to determine coal consumption are conducted by counting the number of scoops of coal fired, on the assumption that the weight of coal with a given size of scoop is always practically the same. The fallacy of this idea is clearly shown by a series of tests in which the coal was carefully weighed and the number of scoops used also counted. The same man fired the locomotive in all the tests and he used the same size scoop, but the weight per scoop varied from 13.8 lb. to 16.3 lb.; thus any results based on the number of scoops would have been subject to an error of 18 per cent and might have resulted in the endorsement of a worthless device, or the condemnation of a meritorious device.

Carefully conducted tests are invaluable to the railroads, enabling them to operate in the most efficient and economical manner. The slight expense required to get accurate results is usually negligible by comparison with the sums which railroads may save or lose as a result of the tests. In this work, more than in any other, exact knowledge is indispensable.

Second-Hand Machine Tools

The fact has been emphasized in these columns before that second-hand machine tools should be purchased by the railroads only with the greatest caution. Unquestionably, used machinery which has been in service only a short time and received proper care and attention during that period can sometimes be purchased at a material reduction in cost and be practically as good as new. The railroads are badly in need of large amounts of new machinery for which in many cases appropriations are not available. No one will quarrel with the roads if, by purchasing machines which are practically new at a reduced price, they are enabled to fill a larger proportion of their needs. As a rule, however, the results of buying second-hand machine tools are uncertain and frequently unsatisfactory. In a specific case a large railroad in the middle west ordered two turret lathes of a manufacturer and cancelled the order when it heard of two second-hand machines of the same type in the hands of a machinery dealer. The manufacturer was naturally anxious to keep the order and, checking up the serial numbers, found that these two turret lathes had been working three eight-hour shifts in a Canadian shell plant since 1914 and were in extremely bad shape. By explaining the situation in detail, the railroad was induced to cancel its order for the second-hand machines and reinstate the order for new ones. The point is that second-hand machinery should be purchased only when it is in good condition, which is sometimes difficult to decide even by the most competent inspectors. Particular care should be observed in buying machines which may have been used on repetition work with the consequent undue wear of certain parts which may not be evident on inspection. An important query is put by this turret lathe manufacturer as follows: "If the average large industrial manufacturer does not feel it safe or a good investment to buy second-hand machinery unless he knows all about it, how can the railroads afford to save money in that way when most of their present equipment is hopelessly out-of-date?"

Stop Leaks or Maintain Air Compressors?

The air compressor has well been called the heart of the air brake system, for the ability of the air brake to perform its functions depends entirely upon its continued operations. Air compressor maintenance is consequently an important matter both in the roundhouse and in the back shop. Changing conditions have steadily increased the legitimate demands for air and while the capacity of the compressors has been correspondingly increased, and at the present time many of the heavier locomotives are equipped with two compressors of the largest size, with some freight trains their combined capacity is none too great. The air brake system, moreover, is not the only source of demand upon the compressor. Locomotive auxiliary devices, such as reverse gears, bell ringers, fire doors, coal pushers, sanders, water scoops and cylinder cocks, are now most conveniently operated by compressed air and unless maintained in good condition they require much more air than is commonly supposed. The greatest drain upon the compressor, however, is the need of maintaining the required pressure in the air brake system in the face of many leaks. Even though none of these may be large the combined drain may be sufficient to render the proper control of the train difficult while the additional work which their presence throws upon the air compressor soon brings about such a degree of wear that an overhauling with reboring of cylinders and renewals of piston rings, valves and other parts is rendered necessary. It is not infrequent to find a long freight train on which the leakage and consequent waste of air is as much as would be required to fully apply the brakes every few minutes.

During recent months many roads have not been able to maintain their locomotive air compressors in the condition which experience has shown to be advisable for satisfactory train operation and have done even less than usual in the direction of correcting leakage in the piping of freight car brakes. The air brake situation is serious for upon its performance the ability of the railroads to handle the large amount of traffic now being offered depends to a considerable extent. Some definite maintenance policy must be decided upon. To allow matters to drift will necessitate a reduction in the length of freight trains to that for which the compressor or compressors with which the locomotives are equipped can supply the air to maintain the leaks and yet leave a sufficient margin to release and recharge the brake system in a reasonable time. To depend upon air compressor maintenance to meet the situation will mean running compressors at high speed, rapid wear with frequent renewals and expensive repairs by mechanics none too easily secured, not to mention the large bills for coal consumed unnecessarily. The only proper way and the one which will have to be adopted eventually is to employ additional men at terminal yards to tighten up pipes and joints and so reduce the excessive air waste which is now to be found in so many parts of the country.

New Books

The Welding Encyclopaedia—*Edited by L. B. Mackensie and H. S. Card, 388 pages, 550 illustrations 6 in. by 9 in., bound in flexible imitation leather. Published by The Welding Engineer Publishing Co., 608 Dearborn St., Chicago, Ill.*

A reference book on the theory, practice and application of the four autogenous welding processes. The first half of the book consists of a dictionary of all words, terms and trade names used in the welding industry. Included in this portion are instructions for welding operations on the most common types of repair work and their application to the various industries. Oxyacetylene welding, electric arc welding, electric resistance welding and thermit welding are each treated and general instructions are given for the use of each process with every metal that can be welded by it. Separate chapters are included on the subjects of boiler welding, tank welding, pipe welding and rail joint welding. Another section is devoted to the rules and regulations enforced by federal and state authorities and insurance companies on the construction, installation and operation of welding equipment. A collection of charts and tables is also included. The catalogue section at the end of the book describes and illustrates the standard lines of welding equipment and apparatus.

AIR BRAKE CORNER

Adjustment of E-7 Safety Valve for Type L Triple

Question.—When making a test to determine the action of an E-7 safety valve which is used with type L triple valves, I have noticed that after the regulating nut had been adjusted to give the desired opening pressure of 62 lb., a second test made after the cap nut had been replaced did not give the same result. It is not uncommon to find that the opening pressure after the cap has been screwed on is several pounds higher than it was when the cap was removed. In order to secure the proper setting, it is necessary to first adjust the pop at a lower pressure than desired. Can you explain the reason for this action?—A. D. P.

Answer.—When the regulating nut of the E-7 safety valve has been tightened down so that the valve opens at the desired pressure, a certain spring tension has been set up. When the cap nut is screwed on it may cause the regulating nut to turn slightly and thus increase the spring tension. The extent of such movement will depend upon the fit of the threads on the adjusting screw and in the cap nut, the presence of rust or dirt tending to increase the change in adjustment. With a proper easy fit no change in adjustment should occur. If it is found necessary to allow something for putting on the cap nut, it is evident that the fit of the cap nut threads is too tight.

What Our Readers Think

A or B End of Car

Chicago, Ill.

To the Editor:

Referring to the question by F. J. B. in the August number of the *Railway Mechanical Engineer* relating to designation of *A* or *B* end of cars in accordance with A. R. A. Rule 14.

It is the writer's opinion that Rule 14 as now written is misleading and does not cover the various forms of brake equipment now in use and that therefore this rule should be re-written along the following lines:

The end of car toward which the cylinder push rod travels shall be known as *B* end and the opposite end shall be known as *A* end on all cars with only one brake equipment and only one hand brake, except that on such cars on which the push rod travels downward or upward in a vertical direction or on cars on which the cylinder push rod travels at right angle with the longitudinal sills or on cars where the cylinder is underneath the hoppers on end of car with the push rod traveling in an opposite direction to the pull of the hand brake rod and chain. On such cars the end on which the pressure retaining valve and the brake mast is located shall be known as the *B* end, it being understood that the pressure retaining valve be always located on the brake mast end of car.

On cars equipped with two hand brakes and two brake cylinders, the push rods of which are traveling in opposite directions, the end where the two pressure retaining valves are located shall be known as *B* end.

Car Inspector.

Influence of Manganese in Carbon-Vanadium Steel

Chicago, Ill.

To the Editor:

In the description of the Union Pacific Mountain type locomotive published in the July issue of the *Raiwlay Mechanical Engineer,* special mention was made of the annealed carbon-vanadium steel used in rods, axles and crank-pins. The saving in weight due to this material was discussed also in an article by R. J. Finch in the October number.

Both of these articles would give the impression that the improved properties of the carbon-vanadium steel were due entirely to the presence of vanadium. On looking into the matter, however, it is evident that there are other differences in chemical composition which might account for a large part of the improvement in the properties of the steel. The specifications of the Mechanical Division of the A.R.A. for axles, shafts and other forgings require that the carbon shall be between 0.38 and 0.52 per cent and the manganese between 0.40 and 0.70 per cent. Carbon-vanadium forging steel, on the other hand, has a carbon content between 0.45 and 0.55 per cent and manganese between 0.70 and 0.95 per cent. Since the higher percentage of carbon and manganese would both tend to increase the ultimate strength and elastic limit of the steel, I should like to know what difference there would be between a carbon-vanadium forging steel and a steel without vanadium having the same proportion of carbon and manganese? Designer.

The above letter was referred to the Vanadium Corporation of America, from whom the following reply has been received.

New York, N. Y.

To the Editor:

Referring to your letter enclosing a communication from "Designer" requesting information as to the influence of manganese in carbon-vanadium steel. Your correspondent calls attention to the higher percentage of manganese specified for carbon-vanadium steel locomotive forgings than in the case of the A.R.A. specification, and queries whether this higher percentage of manganese rather than the vanadium is not largely the cause of the increased physical properties.

The difference he calls attention to in the carbon percentage range between the A.R.A. specifications and the carbon-vanadium steel specifications is more apparent than real. While the A.R.A. specifies 0.38 per cent to 0.52 per cent carbon it is unusual to find forgings containing under 0.40 per cent and the bulk of the forgings will be within the range of 0.45 per cent to 0.55 per cent specified for carbon-vanadium steel. The actual difference in the carbon specified only amounts to 0.03 per cent or the difference between 0.52 per cent and 0.55 per cent the upper limits specified. This disposes of the supposition that the increased physical properties of the carbon-vanadium steel are partly due to the higher carbon percentage.

The accompanying tabulated tests from normalized (reheated and air cooled) locomotive forgings show clearly the influence of vanadium in increasing the physical properties of steel of the same chemical composition. The carbon-vanadium steels given are all within the A.R.A. specification limits for carbon and manganese. All these forgings, both the plain carbon and the carbon-vanadium, were given a standard normalizing treatment, the temperatures being practically the same. It will be noted that there are only slight differences in carbon and manganese percentages; in some instances these are higher in the case of the plain carbon steels.

Furthermore, it will be noted that these tests demonstrate also that it is possible to meet the high tensile properties specified for carbon-vanadium steel with manganese within the limits specified by the A.R.A., viz. 0.40 to 0.70 per cent.

Additional evidence illustrating the effect of vanadium in increasing the physical properties of steel is shown in the second table, giving tests from rails of essentially the same composition with and without vanadium. These tests were all cut from the same position in the head of the rail; the rails were of the same section and weight, and rolled at the same mill. The tests were made from the rails as rolled.

From a comparison of the above tests from normalized plain carbon and carbon-vanadium forgings of practically identical manganese and carbon percentages, it is apparent that the higher physical qualities of carbon-vanadium steel are due to the presence of vanadium, and not to any difference in carbon or manganese percentages.

Geo. L. Norris,
Vanadium Corporation of America.

TABLE I.—COMPARATIVE TESTS OF LOCOMOTIVE FORGINGS.

To Illustrate the Effect of Vanadium on Steel of Otherwise Similar Chemical Composition.

All tests given are from normalized (reheated and air cooled) forgings.

Chemical Analysis						Physical Tests				Forging
C.	Mn.	P.	S.	Si.	V.	E. L.	T. S.	Elong.	R. A.	
.48	.64	.010	.041	....	...	48,200	89,660	23.5	37.8	Piston rods.
.48	.64	.010	.041	....	...	51,960	92,420	24.5	43.4	Piston rods.
.48	.64	.010	.041	....	...	45,230	87,920	24.0	40.3	Piston rods.
.50	.62	.014	.036	....	...	49,220	89,900	23.0	36.6	Pins.
.54	.69	.012	.024	....	...	42,210	81,430	26.0	40.4	Rod straps.
.51	.63	.018	.032	....	...	44,250	90,020	23.5	37.0	Main rods.
.48	.69	.016	.032	....	...	46,960	90,170	21.5	37.5	Main pins.
.51	.63	.018	.032	....	...	49,450	90,150	23.0	43.9	Front rods.
.48	.60	.015	.035	....	...	47,450	91,400	20.0	32.5	Main rods.
.48	.60	.015	.035	....	...	51,450	97,660	20.0	34.7	Main rods.
.59	.52	.014	.029	....	...	44,110	88,420	24.0	37.9	Main pins.
.45	.48	.014	.036	....	...	41,460	83,920	25.5	42.8	Int. rods.
.51	.61	.035	.037	.180	...	49,220	81,700	26.0	46.9	Piston rods.
.48	.40	.017	.045	....	..	42,250	85,500	21.5	35.7	Cross head pins.
.52	.52	.025	.025	.210	...	47,000	82,290	24.5	41.9	Main pins.
.44	.61	.026	.028	....	.19	63,940	92,400	22.0	40.4	Main rods.
.44	.61	.026	.028	....	.19	61,440	95,280	23.5	41.8	Trailer axles.
.44	.61	.026	.028	....	.19	60,140	94.500	23.0	49.2	Main pins.
.44	61	.026	.028	....	.19	61,690	96,900	21.0	40.4	Driving axles.
.44	.61	.026	.028	....	.19	63,940	92,400	22.0	40.4	Main rods.
.48	.68	.019	.024	.162	.15	64,520	100,000	24.5	47.7	9-in. rounds.
.48	.68	.019	.024	.162	.15	66,500	100,000	22.5	41.0	9-in. rounds.
.50	.57	.027	.023	....	.16	63,940	101,900	24.0	43.1	Rod straps.
.42	.65	....	....	....	.18	62,700	92,800	24.5	57.0	20⅜-in. dia. gear shafts.
.42	.65	....	....	....	.18	67,100	97,000	26.0	59.0	13-in. propeller shafts.
.55	.75	.018	.025	....	.21	50,700	101,900	22.5	42.8	10-in. snow plow shaft.

TABLE II.—TESTS FROM RAILS

C.	Mn.	P.	S.	Si.	V.	E. L.	T. S.	Elong.	R. A.
.74	.68	.011	.035	....	...	60,000	123,000	10.5	14.5
.72	.67	.035	.028	....	...	63,000	112,500	13.5	20.5
.68	.78	.018	.038	....	.24	95,000	143,000	10.0	17.0
.73	.76	.020	.030	....	.19	90,000	140,000	10.0	14.0
.56	.78	.017	.025	....	.16	80,000	118,000	13.0	22.0

Elastic limit and tensile strength are given in pounds per square inch. Elongation and reduction in area in per cent.

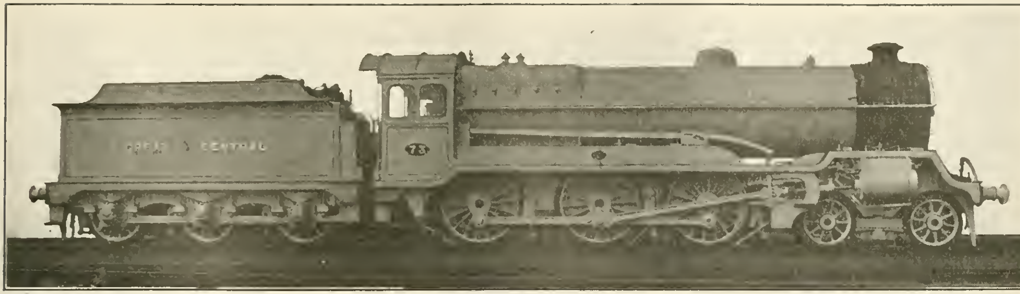


Fig. 1. Great Central, Four-Cylinder, 4-6-0 Type Fast Freight Locomotive

Recent Tendencies in British Locomotive Practice

PART 1

Description of Important Designs; Piston Valve with Relief and By-pass Features; Mechanical Lubricator

By E. C. Poultney

IN the present article the writer proposes to illustrate and describe some typical recent locomotives built for service on British railways which indicate the tendencies of modern practice.

Perhaps one of the most striking features is the large use made of either three or four cylinders, and of these the three cylinder arrangement seems to be rapidly gaining favor. On the North Eastern three-cylinder 4-4-2 type express locomotives have been in service since about 1910, and the same cylinder arrangement has more recently been extended to 4-6-0 and to mineral traffic locomotives of the 0-8-0 type on this railway. The Great Northern has also adopted three cylinders for both 2-6-0 and 2-8-0 type freight locomotives, and quite recently for some Pacific type express locomotives which are just out of the Doncaster shops. The Caledonian has also recently completed a new design of very powerful three-cylinder 4-6-0 type express locomotives.

The London & North Western, Great Central, and Great Western each has a considerable number of 4-6-0 type four-cylinder locomotives in service for express passenger traffic, and the second named line has a number recently built primarily for fast freight trains. About two years ago some powerful 0-10-0 type engines having four cylinders were built at the Derby shops of the Midland railway, designed for helper service on the Lickey incline on the West of England main line between Birmingham and Bath.

It is of course generally well known that the ordinary British type locomotive has two inside cylinders, and there are now and probably always will be large numbers of locomotives having this particular characteristic; nevertheless, there is no doubt that for the higher powers usually necessary to meet modern conditions, the two-cylinder locomotives when used will have their cylinders outside.

Steam pressures have undergone some changes during recent years. Previous to the general introduction of flue tube superheaters, boiler pressures ranged from about 170 to 200 lb. With the advent of superheating, there was a general tendency to reduce pressures to about 160 lb., and increase the cylinder volume. The practice is now towards the higher pressures, and those of 180 to 200 lb. are considered necessary, whilst cylinder volumes are continually increased to furnish the necessary power; in fact, it is largely the greater cylinder capacity now required that has prompted the introduction of three- and four-cylinder locomotives.

Locomotives now built for main line working are practically all fitted with flue tube superheaters, and older engines when requiring extensive repairs and renewals, or to be rebuilt, are as a rule superheated, and when this course is adopted, it is usual to fit new cylinders with piston valves. Whilst the type of superheater used is in all instances the same, there are in some cases considerable differences in details. This applies more especially to the design of the headers.

The Eastleigh, Horwich, and Swindon designs adopted on the London & South Western, Lancashire & Yorkshire (now London & North Western), and Great Western, are cases in point. Other superheating equipment used is either of the pattern designed by Marine & Locomotive Superheaters, Ltd., or the Superheater Corporation, which latter controls the "Robinson" patents.

The feature of the "Robinson" design is in the method of uniting the elements and header, which is effected by expanding the elements into the header in the same manner that the boiler tubes are fixed in the tube sheets. This is a simple method, and seems to give satisfactory results. In a written contribution to the discussion of a paper recently contributed to the proceedings of the Institute of Mechanical Engineers, entitled "British and American Locomotive Design and Practice," J. G. Robinson said that the extraction of the units was quite as easy as expanding them in place, and that there were cases in which the units had been expanded and extracted as many as six times, and were still in service. The mileage per set of units in a 4-6-0 engine was in one instance 378,448 for a life of 9¼ years, and in the case of 2-8-0 mineral engines a mileage of nearly 200,000 for 9½ years was realized.

Damper gear has been discarded now by all railways.

Automatic air valves are quite often fitted to the steam chests and sometimes on the header (wet steam side). The South Eastern, Chatham & Dover, Great Eastern, Great Northern, and Caledonian adopt this arrangement. The North Eastern fits a small valve which is opened to allow a little steam to circulate through the elements when drifting. Robinson superheaters are fitted with a header discharge valve which opens communication between the header and blast pipe when the throttle is closed, and a special blower valve is fitted which when turned in one direction starts the blower, and simultaneously allows steam to circulate through the elements, and from thence through the discharge valve to the exhaust, and in the other direction steam to the blower only is supplied.

Cylinder by-pass valves are not generally used, neither are pyrometers, the explanation regarding the latter usually given being that difficulty is experienced in obtaining reliable instruments.

Tests Show Value of Superheating

There seems to be some difference of opinion as to the utility of fitting superheaters to locomotives working intermittent services, that is, where there is much starting and stopping, and on some railways where the runs are short and stops frequent saturated steam locomotives are still much employed.

Recently some interesting tests have been carried out on the North Staffordshire, a small line employing for the most part tank engines on what may be called extensive local services. Three 0-6-2 type locomotives were experimented with, each alike in all respects except that one was superheated. The engines each had 18½ in. by 26 in. cylinders. 175 lb. steam pressure, 60 in. drivers and ordinary flat unbalanced valves. The engines were tried against each other on the same sections of road with similar trains on similar services, all water and coal consumptions being carefully recorded and reduced to a ton mile basis for comparison. The overall results may be summarized as follows:

		Saturated steam locomotives	Superheated steam locomotives
Trial 1— Passenger Service	Ton-miles	117,023	113,705
	Coal per ton-mile.	0.235 lb.	0.237 lb.
	Water per ton-mile	1.557 lb.	1.570 lb.
Trial 2— Passenger Service	Ton-miles	98,243	116,434
	Coal per ton-mile.	0.270 lb.	0.216 lb.
	Water per ton-mile	1.560 lb.	1.440 lb.
Trial 3— Freight Service....	Ton-miles	135,737	145,623
	Coal per ton-mile.	0.157 lb.	0.135 lb.
	Water per ton-mile	0.968 lb.	0.760 lb.
Trial 4— Passenger Service	Ton-miles	93,608	114,812
	Coal per ton-mile.	0.250 lb.	0.200 lb.
	Water per ton-mile	1.650 lb.	1.230 lb.

During the last passenger tests the superheated locomotive operated with a steam pressure of 160 lb., and with the blast pipe enlarged from 4⅞ in. to 5⅛ in. diameter. A Detroit lubricator for the valves and pistons, and also a Wakefield mechanical lubricator were tried separately, and both are reported to have given satisfaction. The wear of the valves on the superheated engine was found to be no more than normal. Records of the steam temperatures revealed the fact that when running the temperatures ranged from 550 to 620 deg. F., and that the drop was very rapid on closing the regulator. With stops of four minutes' duration, the header temperature fell to about 60 deg. F. above the normal temperature of the saturated steam. The above particulars are taken from a paper read by J. A. Hookham before the Institution of Locomotive Engineers, London, May 4, 1922.

Robinson Piston and Pressure Relief Valve Used on Great Central

Proceeding now to a delineation of some new locomotives, the first to be dealt with is illustrated by Fig. 1. This is a large four-cylinder engine of which several are now in traffic on the Great Central. The engines, which are of the 4-6-0 type, have been built to the designs of the chief mechanical engineer, J. G. Robinson. In general they are similar and in many of their details interchangeable with a series of 4-6-0 express locomotives introduced previously, and of which several have been built during the last two years. The principal difference is that whereas the engine illustrated has 68 in. wheels, those of the passenger engines have 81 in. drivers. The class represented by Fig. 1 have been built to handle heavy fast freight trains. The four cylinders are 16 in. by 26 in. and are in line across the engine, two in one casting between the frames and under the smoke box driving the crank axle of the leading coupled wheels, and the outside cylinders connected to the second pair of wheels. Two sets of link motion, the eccentrics for which are mounted on the crank axle, work four piston valves, one for each cylinder. Those for the inside cylinders have inside admission and those for the outside have outside admission. The adjacent cranks on each side of the engine are at 180 deg. to each other, so that with valves arranged as described each pair on each side can be operated by one set of valve gear by two upper parallel arms of a three-armed rocker, the lower arm being connected to the valve gear, and those above to each valve spindle.

The piston valves are of the type shown by Fig. 2, which has been made from a drawing furnished by J. G. Robinson. The valves are known as Robinson's patent combined

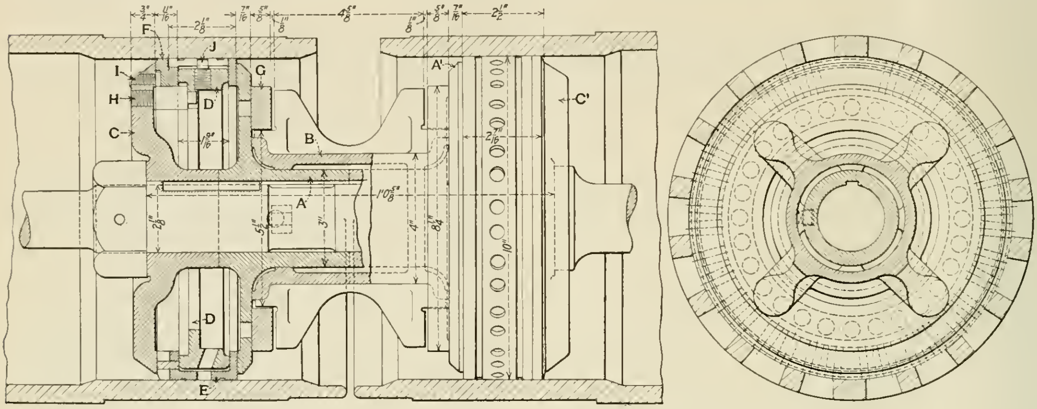


Fig. 2—Robinson Piston and Pressure Relief Valve Used by Great Central

piston and pressure relief valves, and have been designed to fulfill the following functions:

(a) To prevent sudden reversal of stresses in the motion when the engine is running without steam.

(b) To release any undue pressure from the cylinders when that pressure is higher than that in the steam chest.

(c) To provide for the circulation of air from one side of the pistons to the other, and thus prevent the influx of gases from the smoke box through the blast pipe when running with steam shut off.

The drawing is of a valve arranged for inside admission. The main part of the valve is formed in four sections which may be made of cast iron or mild steel. These pieces are slipped over the spindle on which they are prevented from turning by keys. The main packing rings *E* of L section are of cast iron, and have round their periphery a number of 7/16 in. holes, the object of which is to allow communication between the steam ports and the valve body. A number of ½ in. holes are drilled in the inner sections *D* of the valve, their position being clearly shown in the sectional and end views.

Sliding on a cast iron guide *B* threaded over the center portion of the main valve body are two high carbon steel rings *G* which, when the throttle is open and steam pressure in the chests, are held to a seating over the ½ in. holes.

If at any time the pressure in the cylinders should rise higher than that in the steam chest, due to excessive compression or any other cause, the rings are forced from their seatings and the pressure relieved through the holes in the packing rings before mentioned, and via the ring valves into the steam chest. Further, when the engine is running with steam shut off the ring valves easily may leave their seatings and the piston valve then will act as a cylinder by-pass valve, thus functioning as mentioned in paragraph (c). Stops are provided on the valve guides by which they are limited to ⅛ in. lift. Originally, the ring valves were held to their seatings by means of four coil springs arranged between the rings, but in the latest design as shown, the springs have been omitted.

An interesting fitting used on the Great Central is what is called an Intensifore lubricator which works in much the same manner as a hydraulic intensifier. Briefly, the arrangement consists of a container filled with oil upon which pressure is applied by means of steam acting on a plunger. Oil is led from the lubricator by suitable piping to distributors mounted on the foot plate, usually on the back head of the boiler. The distributors consist of sight-feed glasses fitted with suitable controls, from which the oil is led to the valves, pistons and also the driving boxes.

The continuous brake used on the Great Central is the automatic vacuum and the engines are fitted with a steam brake which may be worked separately or automatically with the train brake as desired.

The boiler is fitted with a flue tube Robinson superheater of 28 elements which are expanded directly into the cast iron header of the front cover type. The boiler is a standard type, and interchanges with two classes of 4-6-0 engines, having two inside cylinders, and with the large four-cylinder express locomotives previously mentioned. The working steam pressure is 180 lb., the combined evaporative and superheating surface is 2,387 sq. ft., and the grate area 26 sq. ft. The maximum tractive force is 29,950 lb., so that with 131,000 lb. on the coupled axles the adhesive factor is 4.45. The total weight of the engine is 178,000 lb., and with the tender fully loaded the total weight is 286,000 lb.

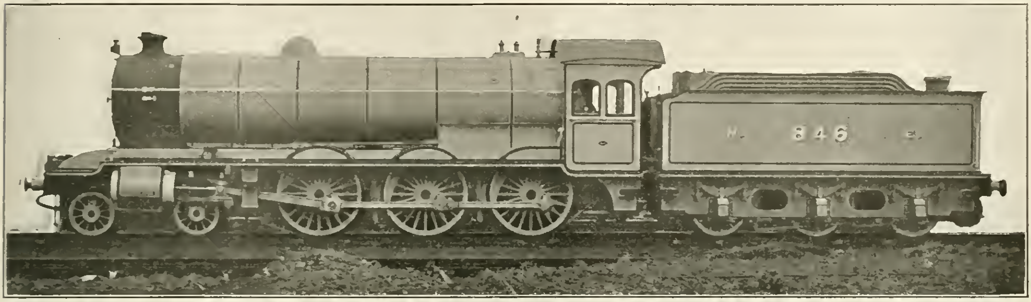


Fig. 3—North Eastern, Three-Cylinder, 4-6-0 Type Fast Freight Locomotive

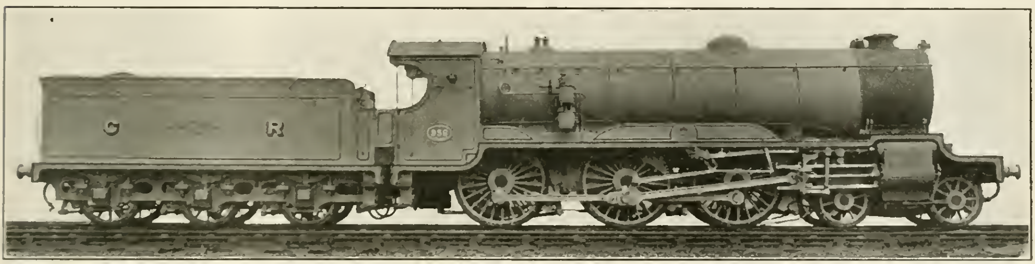


Fig. 4—Caledonian, Three-Cylinder, 4-6-0 Type Express Passenger Locomotive

Three-Cylinder Locomotives for North Eastern and Caledonian

Fig. 3 illustrates a class of 4-6-0 type fast freight engines introduced on the North Eastern some two years ago, and built at the Darlington shops from the designs of the chief mechanical engineer Sir V. L. Raven, who kindly supplied the photograph.

In common with all modern North Eastern locomotives, they have three cylinders which are formed in one casting. They are in line transversely, and all drive on one axle, the cranks being at 120 deg. to each other. The cylinders are 18½ in. by 26 in. and the three piston valves are each worked by separate sets of link motion. Reversing is effected by a steam gear. The coupled wheels are 68 in. in diameter, and the tractive force is 30,032 lb. The boiler carries a steam pressure of 180 lb. and interchanges with those fitted to the 4-4-2 passenger and the 0-8-0 type freight engines. The 0-8-0 type three-cylinder locomotives were described and illustrated in the *Railway Mechanical Engineer* for August, 1920, and as in general the new 4-6-0 locomotives follow closely the mineral traffic engines both in construction and design, a further detailed description is unnecessary.

The engines weigh 174,100 lb. in working order, of which 131,488 lb. are available for adhesion. The standard North Eastern self-trimming tender fitted with water scoop is used, the capacity of which is 5.25 tons (11,770 lb.) of coal, and 4,125 gal. (Imp.) of water. The Westinghouse brake acts on the engine and tender, and an ejector is also provided so that vacuum brake fitted cars may be handled.

Particulars of some trials made on the North British railway with a North Eastern 0-8-0 type three-cylinder mineral traffic engine may be of interest. The tests were made in August, 1921, and consisted in hauling loaded coal trains up a grade 6.7 miles long, the average gradient being one in 75 (1.33 per cent). The total length of the run was 8¾ miles. Three trips were made, the loads behind the tender being 31, 36 and 39 four-wheeled wagons, and on each occasion two 20-ton brake vans; the trailing loads were 617, 703 and 755 tons, and the start to stop times were respectively 35.5, 30 and 33 minutes.

On the first trip the engine was worked with a 53 per cent cut off, and on the second in full gear (cut off 75 per cent) till after passing a point about 3½ miles from the start, when the engine was pulled back to 65 per cent cut off, and on the third trip the engine was run in full gear throughout. For each trial the throttle was full open. A full boiler pressure was maintained throughout the first and second runs, and on the third it only dropped to 195 lb. during the last mile, when the second injector was started. There are 15 curves on this length of road, ranging from about 1 to 3 deg. With a steam pressure of 200 lb., these engines exert a maximum tractive force of 41,070 lb. It was considered an excellent performance to haul 755 tons at 12.1 m. p. h. up a grade of 1 in 75.

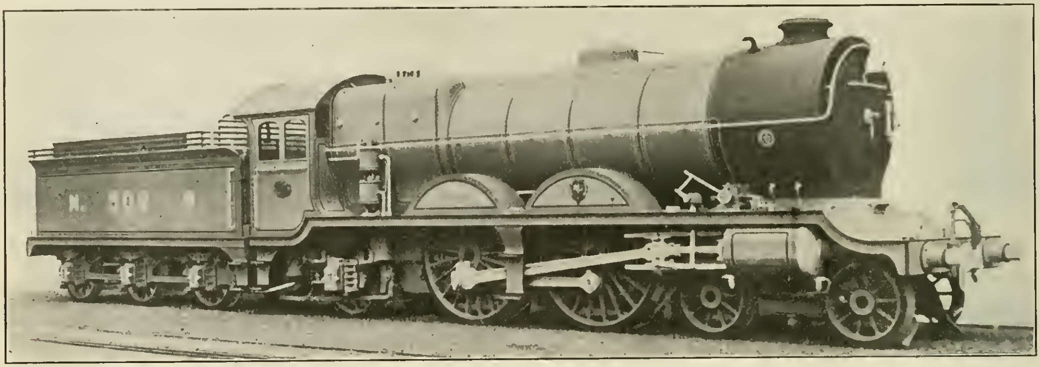


Fig. 5—North British, Two-Cylinder, 4-4-2 Type Express Passenger Locomotive

The Caledonian locomotive shown in Fig. 4 was completed at the St. Rollox (Glasgow) shops of the company last year. The engine is the first of a new class built from the designs of W. Pickersgill, the locomotive superintendent who kindly supplied the photograph. The engine is one of the most powerful 4-6-0 type built for express passenger traffic; in fact, there is only one class running having a greater tractive force. They are the four-cylinder engines of the 4-6-0 type on the London & North Western (Lancashire & Yorkshire section) having 75 in. wheels and 29,000 lb. tractive force as against 28,000 lb. for the new Caledonian locomotive.

The engine illustrated has three cylinders. They are all in line and drive on separate axles in contradiction to the plan adopted on the North Eastern. The center cylinder drives the leading wheels through a crank axle and those outside the center coupled wheels through connecting rods 11 ft. long as against 6 ft. 6 in. for the inside rod.

Steam distribution is effected by piston valves and two sets of Waschaert gear, the necessary motion for the valve for the center cylinder being obtained from the combined movement of the two sets of valve gear through a system of levers. Steam reversing gear is fitted which is standard practice on the Caledonian. The cylinders are each 18½ in. by 26 in., and the piston valves are 8 in. diameter. Automatic by-pass valves are fitted to each cylinder and large air valves are provided on the superheater header which open on the throttle being shut, thus allowing air to circulate through the elements, valve chests, and cylinders when the engine is drifting. The boiler which carries a working pressure of 180 lb. has a total evaporative heating surface of 2,370 sq. ft. and a superheating surface of 270 sq. ft. The grate area is 28.5 sq. ft. There are 24 5-in. flues for the superheater units, and in addition 203 2-in. tubes all of steel. The distance between the tube sheets is 16 ft. The Robinson superheater is used. The driving wheels are 73 in. and the truck wheels 42 in. in diameter. The total weight of the engine is 181,500 lb., of which 134,500 lb. are carried on the coupled axles. The adhesive factor is therefore 4.8 and with the tender fully loaded with 12,500 lb. of fuel and 4,500 gal. of water, the total weight of the locomotive is 276,000 lb.

The standard brake on the Caledonian is the Westinghouse, which acts on the engine and tender, but an ejector is provided as only the vacuum brake is used on many of the through trains between the London & North Western and Caledonian systems, and the arrangement is such that the application of the vacuum brake on the train operates the air brake on the locomotive.

Mention may be made of the fact that the valves, pistons, piston rods and the driving boxes for the leading and center axles are lubricated from an eight-feed mechanical lubricator, which is mounted on the running board, and receives its driving motion from a point in the valve gear where the return crank connection joins the link.

North British Atlantic Type Locomotive

The Atlantic type passenger locomotive, Fig. 5, is one of a series lately delivered to the North British railway by the North British Locomotive Co., Ltd., and constructed at the Hyde Park works, Glasgow. These engines have been built to the requirements of W. Chalmers, chief mechanical engineer, to whom the writer is indebted for the photograph, and are employed on important express services, particularly those forming part of the East Coast Route between Edinburgh and the North, which trains travel from London (King's Cross) over the Great Northern and North Eastern railways. These engines follow in general design those introduced some years ago, but differ in that they are superheated, and have larger cylinders. The tractive force is 23,400 lb. The cylinders are 21 in. by 28 in. and the valve motion between the frames is the ordinary link gear, piston valves being used. The boiler working pressure is 180 lb. The earlier engines of this type were introduced in 1906 and worked with saturated steam at 200 lb. and had 20 in. by 28 in. cylinders, so that the tractive force was 23,700 lb. Both lots have 81 in. drivers.

The saturated steam locomotive had 2,256 sq. ft. of heating surface, and the total combined evaporative and superheating surface of the superheated engines is 2,188 sq. ft. The grate surface in each design is 28.5 sq. ft. The overall dimensions of the boilers are the same in each case. The engines in both series carry the same weight, 89,600 lb. on the drivers. The new engines weigh 171,800 lb. against 166,800 for the earlier design, and the standard tender when loaded with 15,700 lb. of coal and 4,240 gal. of water weighs 102,700 lb. The brake used is the Westinghouse, and an ejector for the vacuum brake is fitted. The superheated engines have also mechanical lubricators for the valves and pistons.

2-8-0 Type Fast Freight Locomotive

The locomotive illustrated by Fig. 6 represents a new class introduced for working fast freight trains on the Great Western which are noteworthy for the fact that they are the first of the 2-8-0 type to be used for such work on a British railway. In general, these engines follow current Swindon practice, and existing standards were closely adhered to in their construction. The cylinders are 19 in. by 30 in. and outside steam pipes are used. Piston valves distribute the steam and are operated by the ordinary link motion placed between the frames, the four eccentrics being mounted on the second or driving axle. The coupled wheels are 68 in. in diameter. The first engine when built was equipped with the standard boiler as fitted to previous 2-8-0 freight engines having 56 in. wheels, but has since been returned to the shops and supplied with a new and larger boiler. The following tabulation shows the changes made consequent to this alteration.

COMPARATIVE HEATING SURFACES

	Original boiler	New boiler
Tubes	1,686.6 sq. ft.	2,062.35 sq. ft.
Fire-box	154.7 sq. ft.	169.75 sq. ft.
Total	1,841.3 sq. ft.	2,132.10 sq. ft.
Superheater	330.05 sq. ft.	323.90 sq. ft.
Grate area	27.07 sq. ft.	30.28 sq. ft.
Total weight	174,100 lb.	183,700 lb.

Fig. 6 shows the engine as fitted with the new boiler, the working pressure of which is 225 lb., which is the pressure used for all the larger classes of Great Western locomotives.

Ordinary underhung laminated or leaf springs take the weight and equalizing gear is used. The truck and two leading axle springs are joined, as are also those of the third and fourth axles. The Great Western is the only British line which systematically adopts equalizing arrangements, and in this and other respects, more particularly in truck and boiler design, and in the use of combined cylinder and saddle castings, Great Western locomotives resemble American practice.

The tender is fitted with a water scoop, has a tank capacity of 3,500 gal., and space for about 11,000 lb. of coal, and weighs full 89,600 lb. The vacuum brake operates on the engine and tender.

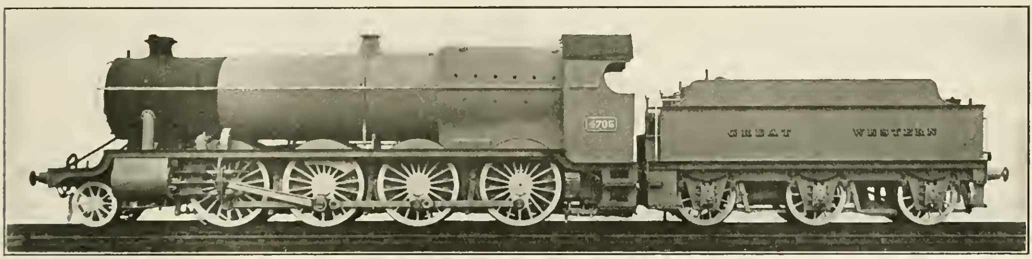


Fig. 6—Great Western, 2-8-0 Type, Fast Freight Locomotive

Great Eastern Passenger and Freight Locomotives

A. J. Hill, chief mechanical engineer of the Great Eastern Railway, has courteously supplied the writer with the photograph from which Fig. 7 has been prepared. The 4-6-0 type express locomotive, not illustrated, is the standard type used for working the heavier services on the line; originally engines of this design were introduced some years ago, but the new locomotives differ in certain details. In two respects these engines are distinctly novel, one is the unique length of the piston stroke, which is 28 in., being longer than that used for any other inside cylinder engines, except the 0-6-0 freight engines, Fig. 7; and secondly, in the position of the coupling rod pins which are on the same centers as the corresponding inside crank, instead of being placed at 180 deg., as is the usual practice.

It is well known to readers of the *Railway Mechanical Engineer* that exhaust steam injectors are widely used in British practice, and these engines form no exception to this rule. The cylinders are 20 in. by 28 in. and piston valves placed above are worked by link motion through the medium of rockers. Extended piston rods are used.

The Belpaire boiler, which carries a working pressure of 180 lb., has a combined heating surface, evaporative and superheater, of 1,896 sq. ft.; the area of the grate is 26.5 sq. ft. The coupled wheels are 78 in. and those of the truck are 39 in. diameter. The engines weigh 143,600 lb. in working order, of which 97,560 lb. are carried on the coupled axles, and as the tractive force at 85 per cent is 22,000 lb., the factor of adhesion is 4.4. The tender carries 3,700 gal. of water and 8,960 lb. of coal, and the total weight of the engine and tender loaded is 227,000 lb.

The 0-6-0 type locomotives, Fig. 7, of which a number have been built at the company's shops at Stratford, Essex, are especially interesting because they are the most powerful 0-6-0 locomotives in Britain, the tractive force being 29,044 lb. The boilers with which these engines are fitted are the same as those used for the 4-6-0 type. The cylinders are 20 in. by 28 in., and have piston valves. The valve gear is the ordinary link motion with rockers and reversal is effected by a wheel and screw, which is the most usual arrangement in British practice. Like the passenger engines they have superheater headers fitted with two automatic air valves, which can be seen just behind the smokestack. The coupled wheels are 59 in. in diameter and ordinary gravity sanding gear is fitted to each for forward running. The engine weight is 122,700 lb., and the total weight of the engine and tender, with the latter loaded with 11,200 lb. of coal and 3,500 gal. of water, is 208,000 lb.

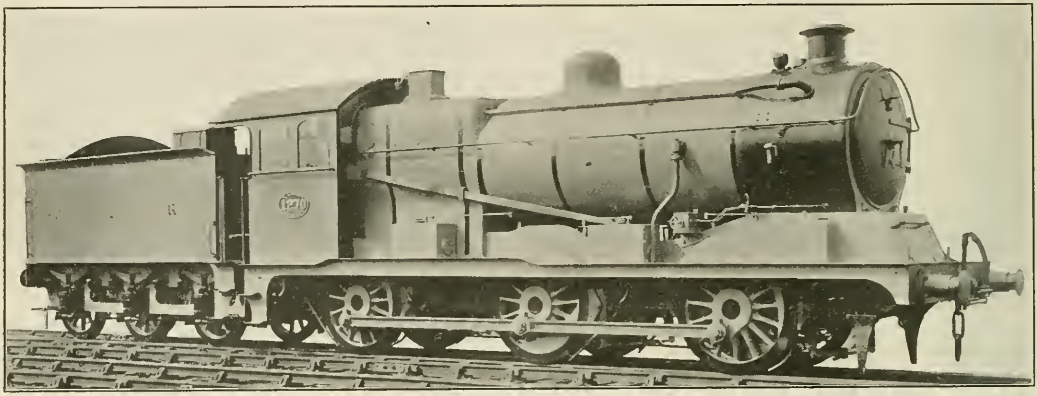


Fig. 7—Great Eastern, 0-6-0 Type, Inside Connected, Freight Locomotive

Valve Gear for Three-Cylinder Locomotives

In 1919 H. N. Gresley, locomotive superintendent of the Great Northern Railway, built at the Doncaster shops the first of a very interesting class of locomotives for fast freight service. The engines, which embody several novel features, and of which several have now been built, have three cylinders, and are of the 2-6-0 type. All three cylinders drive onto the center axle, that between the frames through a balanced built up crank axle, the cylinder center line being inclined at 1 in 8 in order that the main rod may clear the leading coupled axle.

Piston valves having inside admission distribute the steam, the three valves being operated by two sets of Walschaert gear applied to the outside motion. The manner in which this is accomplished is as follows: A lever of the first order rocking about a pivot in the horizontal plane is attached to the valve spindle, on one side of the engine. The free end of this lever has fulcrumed on it an equal armed rocking lever, also vibrated on the horizontal plane by being coupled to the valve spindle for the outside cylinder on the opposite side of the engine. The opposite or free end of the second named lever is coupled to the valve spindle for the center cylinder. The first lever is quite long, as it extends across the front of the engine, and the pivot is so placed that the travel at the end where it receives the equal armed lever is half the travel of the valve from which it derives its motion. The center cylinder valve in this way receives its motion from the movement of the other two valves combined. Through the equal armed lever it obtains a valve travel equal to those of the outside cylinders, and as the pivot of the equal armed lever is on the free end of the long lever, the position of the shorter lever fulcrum relatively to the cylinders is altered by the vibration of the longer lever.

The boiler is large for an eight-wheeled locomotive. The barrel is 72 in. diameter outside, and 11 ft. 5½ in long, and is made from a single plate ⅝ in. thick. The total heating surface of the boiler and superheater is 2,308 sq. ft. The grate area is 28 sq. ft. The cylinders are each 18½ in. by 26 in., the steam pressure carried is 180 lb., and the coupled wheels are 68 in. in diameter. This combination gives a tractive force of 30,030 lb. Great care has been exercised in the design of these engines with a view of keeping down weight, especially in the motion parts, which are made from chrome-nickel steel heat treated.

The crossheads work in guides of the three-bar type, and the crank pins for the return cranks of the valve gears are fitted with ball bearings. The total weight of the engine in working order is 160,800 lb., of which 134,400 lb. are carried on the coupled axles. The engine weight per square foot of combined heating surface is very low, being only 69 lb. as against 74.6 lb. and 103 lb. for two preceding classes of two cylinder engines of the same wheel arrangement. One of the engines of the three-cylinder design was illustrated in the *Railway Mechanical Engineer* for September, 1921, and the connecting rods were described in the May issue of the same year.

(To be continued)

Luminous Fixed Signals—letters showing on the front of a box—for use of air brake inspectors, at night, in signaling between the front end and the rear end, of a train standing at a station, are in use at Magdeburg, Germany, according to a note in one of the late numbers of the Bulletin of the International Railway Association, the data having been taken from a German paper. The letters, composed of dots formed by small electric lights, are energized through a circuit with push buttons (for closing the circuit and illuminating the signal) distributed along the platform in positions convenient for use with trains of different lengths. The letters are only three; F for applying brakes (Festlegen); L for releasing (Losen); E for finished (Erledigt). The arrangement is similar to that used at theatres and other public places for calling carriages by displaying numbers, different combinations of light being shown to form different letters.

Some Properties of Materials and Their Use

Influence of Investigations on Design; Allowable Stresses Should Be Based on True Elastic Limit

By J. M. Lessells

Railway Equipment Engineering Department
Westinghouse Electric and Manufacturing Company

THE importance of the designer being acquainted with his materials cannot be too strongly emphasized, and sufficient has been said elsewhere by others to give permanence to this idea. Usually the engineer has not the opportunity to compile comparative data for himself; consequently, this must be supplied him so that all the characteristics of the materials used in construction can be seen at a glance. Such is the method of some industrial companies who do applied research work. Another point requiring emphasis, because it is too often neglected, is the wealth of information which can accrue to the designer from a complete knowledge of the behavior of parts in service. In cases of failure the data forthcoming should render recurrence unlikely. Unfortunately, it is not always possible to conduct such investigations.

This work, however, demands the full co-operation of the designer, the metallurgist, the steel founder and the application engineer before success can be achieved, since all parties are involved. Therefore, in design work, if full advantage is to be obtained from experience in making the future product better, a searching after the truth is desirable, and a co-ordination of effort must be a necessary foreword.

In any structural member undergoing stress, failure to withstand the straining action may be due to one or a combination of causes: (1) Bad design due to a lack of appreciation of service conditions. (2) Material not according to specification. (3) Material not suitable.

Failure Due to Bad Design

There are three principal kinds of stresses encountered in service: (a) Stress due to dead loads. (b) Stress due to live loads. (c) Stress due to alternating loads.

Furthermore, these stresses may be either normal or tangential to a principal plane in the section under stress and, in certain cases, may act together. The problem in design, therefore, is always to reduce to an equivalent single load.

In conditions where normal and tangential stresses occur there are three theories as to when elastic failure takes place:
(1) A certain value of the maximum principal stress.
(2) A certain value of the maximum principal strain.
(3) A certain value of the maximum tangential stress, and if

p = maximum principal stress on a given section
p1 = maximum normal stress on the same section
q = maximum tangential stress on the same section
$\frac{1}{m}$ = Poisson's ratio

then the first condition will give

$$p = \tfrac{1}{2} p1 + \sqrt{\tfrac{1}{4} p1^2 + q^2} \qquad (1)$$

and the second condition will give when $\frac{1}{m} = \frac{1}{4}$

$$p = \tfrac{3}{8} p1 + 5/4 \sqrt{\tfrac{1}{4} p1^2 + q^2} \qquad (2)$$

and the third condition will give

$$p = \sqrt{\tfrac{1}{4} p1^2 + q^2} \qquad (3)$$

The value given in (2) is the one generally adopted.

Omitting, for the present the case of alternating loads, the attainment of a satisfactory design hinges on the question of whether the working stress is based on the ultimate stress or on the elastic limit stress of the material. This question has always led to controversies and it seems to warrant examination in detail.

In Tables I, II and III are given the physical test results on a .48 carbon steel of the following analysis:
C. — .48; Mn. — .62; P. — .06; S. — .037; Si. — .22

as forged, annealed and oil-treated, respectively.

TABLE I—PROPERTIES OF STEEL AS FORGED

Ult. stress lb. per sq. in.	Yield stress lb. per sq. in.	Elastic limit lb. per sq. in.	Elong. per cent	Red. per cent	Izod. ft. lb.
78,500	43,000	27,600	25	51	3
79,600	47,400	32,900	23.5	51.8	3
85,000	36,200	30,600	22.8	45	3
81,000 Av.		30,300 Av.			

TABLE II—PROPERTIES OF STEEL AS ANNEALED

Ult. stress lb. per sq. in.	Yield stress lb. per sq. in.	Elastic limit lb. per sq. in.	Elong. per cent	Red. per cent	Izod. ft. lb.
80,900	41,325	39,000	24.5	43.2	13
85,200	40,750	32,000	25.7	42.8	10
86,000	40,600	31,000	25.5	41.9	11
84,000 Av.		34,000 Av.			

TABLE III—PROPERTIES OF STEEL AS OIL-TREATED

Ult. stress lb. per sq. in.	Yield stress lb. per sq. in.	Elastic limit lb. per sq. in.	Elong. per cent	Red. per cent	Izod. ft. lb.
100,000	59,200	43,000	19	56	9
102,000	58,700	44,600	19.5	59	9
100,000	60,700	54,700	19	60	8½
100,700 Av.		47,400 Av.			

Let us suppose for the sake of argument that the working stress for this particular material is based on the ultimate stress rather than on the elastic limit stress; then supposing that the same material is being applied under similar conditions of service and let x, the factor of safety, sometimes called the factor of ignorance, be 3.

$$x = \frac{\text{Ultimate stress}}{\text{Working stress}} = \frac{ft}{fw} \text{ say}$$

then the working stresses for this material in these states become as follows:

Material as forged	f w = 27,000 lb. per sq. in.
Material as annealed	f w = 28,000 lb. per sq. in.
Material as heat-treated	f w = 33,000 lb. per sq. in.

and expressing these as a percentage of the elastic limit stress for the respective state—

Material as forged	f w = .89 of elastic limit stress
Material as annealed	f w = .82 of elastic limit stress
Material as heat-treated	f w = .69 of elastic limit stress

Referring to the micro-photographs Figs. 1, 2 and 3, which represent, respectively, these different states of this material—as forged, as annealed, as heat-treated—it will be seen that the material as forged, which has a very coarse grain structure, would have the highest ratio of working stress to elastic limit.

With the case of alloy steels, the conditions may be much worse, for taking the case of a 3½ per cent nickel steel in the annealed and heat-treated condition, the following divergence is usually obtained between the ultimate and elastic limit stresses:

Ultimate Stress	Elastic Limit	
74,000 lb. per sq. in.	26,000 lb. per sq. in.	Before treatment.
100,000 lb. per sq. in.	80,000 lb. per sq. in.	After treatment

If the working stress is as before based on one-third of the ultimate stress, then the material as forged will be overstressed, and permanent deformation will sooner or later occur. It is, therefore, evident that this condition of affairs is wrong and working stresses must be based on the elastic limit of the material if grave errors are to be avoided.

Coming now to the question of alternating loads, a new field is opened up. To the locomotive designer it is an important one because many of the structural members which combine to form the design are subjected to stress reversals. Typical examples are: (1) The reversal of tension and compression stresses in main and side rods. (2) The reversal of bending stresses in the axles.

Considerable attention already has been given to the elastic limit stress. It was understood, of course, that this was the stress determined by a tension testing machine. It will be known here as the "apparent" elastic limit for experiments on alternating stresses demonstrate the fact that there is a second elastic limit and that material can be made to fail although stressed to a degree less than the apparent elastic limit.

Quoting from the recent paper by Prof. H. F. Moore of the University of Illinois who found that for a .49 carbon material in a sorbitic state, the "true elastic limit," or as called by him the "endurance limit," was 48,000 lb. per

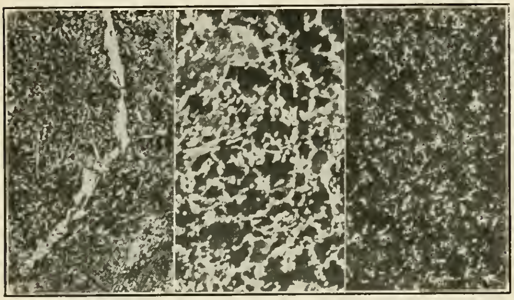


Fig. 1—Left—Material as Forged
Fig. 2—Center—Material as Annealed
Fig. 3—Right—Material as Heat Treated
Magnification 100 diameters

sq. in., while the "apparent elastic limit" was 67,700 lb. per sq. in., it will be seen that due consideration of these changes must be given in design work.

The author recently has been conducting a series of fatigue tests on axle material 6 in. in diameter in which it has been revealed that when a section of this size is properly annealed, there is no difference between the outer layer and the inner layers as far as resistance to fatigue propagation is concerned. The material was of the following analysis:

C. — 44; *Mn.* — .56; *P.* — .010; *S.* — .038; *Si.* — .16

This material was heated to 850 deg. C., held for three hours, and cooled in the furnace. The various test pieces were cut as shown in Fig. 4:

It will be noted that three tensile and Izod tests were taken at different distances from the outside. Each group of fatigue tests was formed into the following series: 1, 6, 7, 12; 2, 5, 8, 11; 3, 4, 9, 10 and 13, 14, 15, 16. The results of a few of these tests are given in Table IV:

Table IV—Tests of Annealed Axle Steel

Ultimate stress lb. per sq. in.	Yield stress lb. per sq. in.	Elastic limit lb. per sq. in.	Elong. per cent	Red. per cent	Izod. ft. lb.	Brin. No.
77,625	37,000	35,500	31.8	41.9	7	149
79,625	37,759	35,500	27.5	37.3	7	156
80,625	37,625	34,000	24.5	35	8	149

The outer layer, comprising the series of fatigue test pieces 1, 6, 7 and 12, gave an "endurance," or "true elastic" limit of 32,000 lb. per sq. in.

The inner layer, comprising the series of fatigue test pieces 3, 4, 9 and 10, gave an "endurance," or "true elastic" limit of 31,500 lb. per sq. in.

These points have been mentioned because in all good designs, these various characteristics have to be predetermined.

Material Not in Accordance with Specification

In view of the requirements of modern specifications, the

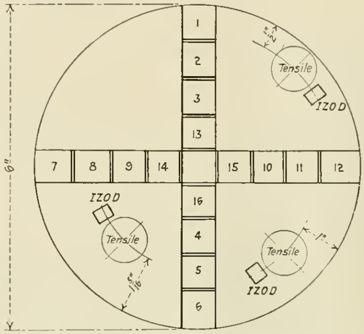


Fig. 4—Location of Test Specimens

case of a material not being in accord with these should be of rare occurrence, but is, of course, possible and, therefore, must be considered.

Material Not Suitable

This phase of the subject is important because many failures in service have been due to ignorance as regards the

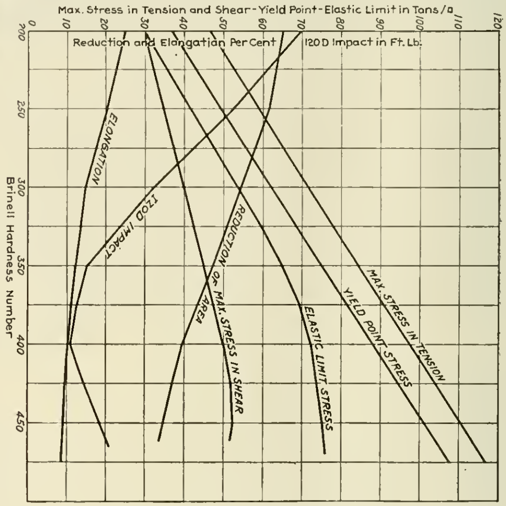


Fig. 5—Diagram Showing Results of Physical Tests

materials used. Two cases will be given. (a) Application of non-ductile alloys, such as those of aluminum for high-speed pistons without considering the effects of temperature change. (b) Application of ferrous material in a coarse crystalline condition for a part subjected to shock.

To eliminate such mal-applications therefore, it is necessary for the designer to become better acquainted with the materials he uses. It is an excellent practice to have all salient points brought to the attention of designers by means of charts, an example of which is shown in Fig. 5.

It would be interesting to discuss the question of material specification tests, as a knowledge of materials is worthless unless used to secure correct material as well as correct design. However, this is beyond the scope of this paper.

Sufficient has been said to show that in addition to a good design a better knowledge of materials is important. When it is generally realized what the physical interpretation of the elastic limit represents and the conditions under which it may vary, working stresses will never be based on any other physical value.

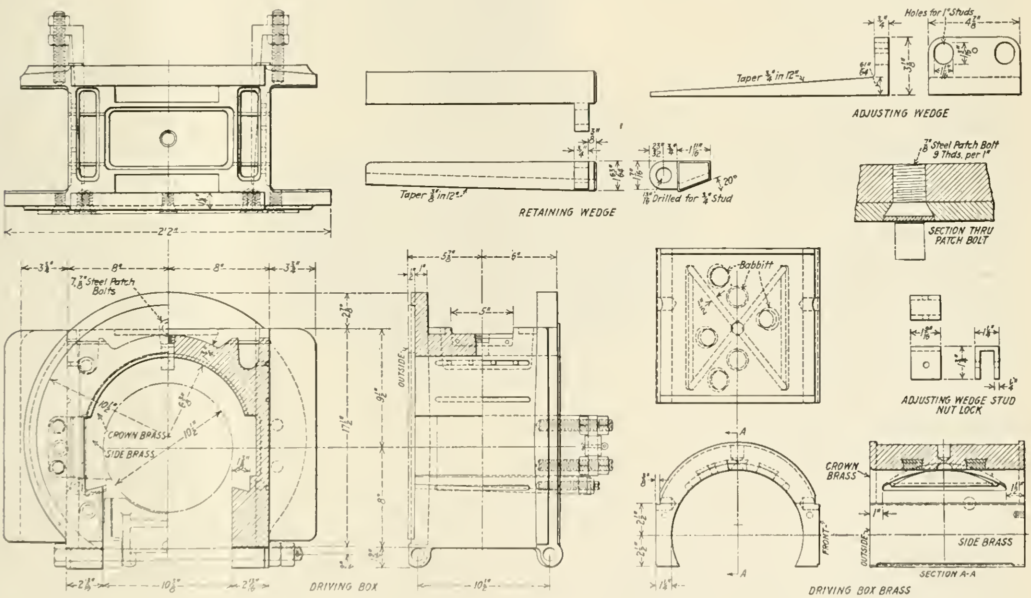
Locomotive Driving Box with Adjustable Bearing

WHILE the heavy modern locomotive presents a very different appearance from one designed 20 or 25 years ago, many of the details have remained of the same general design. The locomotive driving box, for example, has been changed from cast-iron to cast-steel and its size and weight have been increased, but in other respects the modifications have been but slight. The bearing area of design has the merit of simplicity and its faults have been tolerated, it can hardly be claimed that it is satisfactory.

In an endeavor to improve the situation, J. Murrin, superintendent of shops, and E. J. Brewster, general foreman of the Chicago & North Western, have designed a driving box which has adjustable side bearing brasses and which permits of the removal and renewal of the crown and side brasses without dropping the wheels.

This driving box, as will be noted from the accompanying drawing, consists of a cast-steel body tied together at the bottom legs by two 1-in. heat-treated bolts, instead of the usual cellar bolts, pulled tightly against the cellar to keep the box parallel. The brasses are in three pieces, the top or crown piece and two side or quarter brasses, located equally above and below a horizontal line drawn through the center of the axle. These three brasses are held solidly in position in the box by two taper retaining keys exerting pressure upwardly. The side brasses, which are about 5 in. wide and 1¼ in. thick when new, are adjusted by means of two taper wedges of ample width and thickness to give a solid bearing on the box and also to withstand the heavy thrusts imposed on them through the brasses.

To take up wear at front and back, it is only necessary to loosen the retaining keys and force in the adjusting wedges, which move the quarter brasses forward toward the journal. The wedges and retaining keys are held in place by studs, nuts, lock nuts and cotters. The adjusting wedges have a



Construction of Locomotive Driving Box With Adjustable Brasses

the crown brass is proportioned to the weight carried, but little provision is made to care for the enormous thrusts produced by the large pistons, high steam pressure, increased spread of cylinders and closer spacing of frames now commonly employed. Owing to the limited bearing surface on which the horizontal forces act, the wear is rapid and a pound soon develops. Furthermore, the usual method of securing the crown brass in the box, which has been retained from early days, makes it necessary to drop the wheels to remove the box for renewals of the brass. While the present movement of 1½ in. each and, as these wedges are tapered ¾ in. per foot, this provides for a take-up of 3/16 in. for wear. When the brasses have become worn to such an extent that the adjusting wedges cannot travel further, a liner may be applied to the back faces of the quarter brasses, which will bring the wedges out to the original position and permit a further movement of the brasses toward the journal.

The complete brass may be removed from the box without dropping the wheels by first pulling the retaining keys and the adjusting wedges and removing the quarter brasses, then raising the driving box off the journal and removing the crown brass.

The crown brass is held in place by a 1-in. dowel pin, which projects from the inside of the box into a hole drilled in the top brass to receive it. It also has a flange on each side and these flanges, interlocking over the sides of the box-prevent the brass from moving endways. The quarter brasses are locked by a dowel, half on the edge of the quarter brass and half on the edge of the crown brass, which prevents them from moving endways. Boxes of this design can be bored on a boring mill to accurate dimensions and brasses can be finished and carried in stock for immediate use. This type of bearing provides about 30 per cent more bearing surface on the brass in line with the piston thrusts forward and back than the ordinary design.

The first box of this design was applied to a left main journal of a Pacific type passenger locomotive and the right main journal equipped with an old-style box in October, 1920. Since this time the right main box has had three new brasses applied and the left main brass of the new design is still in service. The locomotive has made approximately 25,000 miles between adjustments. The Chicago & North Western now has 25 locomotives in service with this style of driving box and 80 more under construction. It is stated that there has been no more trouble in regard to hot boxes or lubrication with these boxes than with those of the old style, as would be anticipated from the increased bearing area at the point of thrust which decreases the pressure per square inch on the bearing.

Water Treatment on the St. Paul

IN many places the available water supply is very unsatisfactory for use in boilers. The country traversed by the Chicago, Milwaukee & St. Paul east of the Missouri river in South Dakota presents conditions which may be taken as typical of those under which railroads are frequently obliged to operate.

The few streams run slowly through lands so rich in the soluble salts of calcium and magnesium that the river waters are always hard, and the more the rainfall on adjoining lands and the higher the rivers, the harder the water. Because of the scarcity at or near the surface, most railroad supplies are derived from drilled wells, which vary in depth from 50 ft. to 1,500 ft. and in which the character of the water varies as widely. In the ground are two layers of sandstone whose horizontal cracks furnish the supply, the water from the lower sandstone being very hard (80 to 90 grains per gallon) and carrying also 20 to 60 grains of sodium sulphate or chloride, while the water from the upper sandstone so closely resembles the lower water after softening that it is presumed to be the same water softened in the ground; that is, by zeolitic action. This soft water is available, however, only in sections near the Missouri river.

The problem through a considerable district was one of securing an increased amount of water, as bad as it was, and of accomplishing something in the way of improving it. Additional wells were drilled at a number of points and the use of boiler compounds was resorted to. Results were not sufficiently satisfactory and it was decided to install a series of water treating plants. Seventeen plants are now in operation and they cover every water station in a district which includes about 400 miles of line.

The new plants are continuous in operation. All of the main line plants with the exception of those at two points, are designed to treat 15,000 gal. of water per hour continuously and consist each of a hard water pump; a 40-min. reaction tank within which the mixture of hard water and the necessary chemicals (all fed in continuous streams) is slowly stirred by mechanical means; a three-hour settling tank; a treated water pump which delivers to the track tank, and a chemical storage room; all strongly housed and heated.

The plant at Scotland, S. D., is typical of the main line plants. Everything is of wood except the machinery and pipe. The drilled well, 12 in. by 168 ft., under the pump room furnished water to a double-stroke deep-well pump which delivers it through a 6-in. pipe to the water wheel which does the stirring. The water, after passing the wheel, flows to the bottom of the mixing tank where, as it rises, it meets in succession the continuous streams of milk-of-lime, sodium carbonate and ferrous sulphate solutions.

Hydrated lime is used in water treating to extract the carbonic acid, which brings about the precipitation of the scale-making limestone carbonates down to three grains per gallon or less. Sodium carbonate (soda ash) is used to replace completely the scale-making limestone sulphates by non-scaling sodium sulphate. Ferrous sulphate (green sulphate of iron) is used for the treatment of the last three grains of calcium carbonate so that it will not clog the injector or branch-pipe; this, by converting half of the calcium carbonate into calcium sulphate.

In these plants, these reagents are all fed by regulated streams of water from the pipe which supplies the water wheel. The milk-of-lime box holds 480 gals. of water for a five-hours' supply (at Scotland 400 lb.) and this is fed continuously by a small stream of water entering at the bottom of the lime box and overflowing near the top through a 2-in. pipe to near the bottom of the mixing tank.

Once every hour, an hour's supply of dry hydrated lime is added to the supply in the box. This method produces an hourly variation in the rate of lime feeding, but the stirring in the mixing tank is so thorough and so prolonged (45 min.) that only a slight variation is found in the water as it overflows from the top of the mixing tank to the bottom of the settling tank.

The dry soda ash rests on a shelf in the soda box and is fed to the mixing tank by a spray. The supply on the shelf is replenished hourly. The sulphate of iron is fed in solution from its box by a small stream which enters at the bottom and overflows near the top.

The best method of feeding any reagent to a treating plant is determined principally by its solubility in water and in all cases the thinner the solution or mixture the better. The arrangement of feeding devices described above is not theoretically perfect, but has been adopted as the result of experience in handling railroad plants which are frequently miles from a repair snop and are seldom operated by skilled mechanics. The uniformity of results is the best proof of the wisdom of the design and method.

The water, with its chemical reactions practically complete and its precipitate ready to settle, arrives at the bottom of the settling tank and there commences to leave its precipitate as the water slowly rises to overflow through the perforated collecting pipe to the treated water pump in the pump room, whence it is delivered to the track tank.

The settling tank is freed of its accumulated sludge once daily by opening for 30 seconds the valves controlling the system of perforated sludge pipes lying in the bottom of the settling tank. The perforations are in the bottom of the sludge pipes, and the branch pipes are connected to the main pipes by street-ells so that they are close to the floor of the tank.

The treating plants were built by company forces at an expenditure of approximately $18,000 for each of the larger plants and $7,000 for the smaller ones. Since their installation boilers have been free from scale and from leaking, and almost free from foaming. Boiler repairs are now almost nothing and during the entire strike period no boiler troubles attributable to water were reported on this district.

Traveling Engineers Hold Thirtieth Convention

W. O. Thompson, Secretary, Honored; Papers on Oil-Burning Locomotives, Power Distribution and Air Brake Defects

A REMARKABLE tribute to his constant service in behalf of the Traveling Engineers' Association throughout the 30 years since the organization had its inception, was paid by the members and friends of the association to W. O. Thompson, the secretary and only living charter member, at the opening session of the 1922 convention, held at the Hotel Sherman, Chicago, October 31 to November 3, inclusive. A three-quarter length portrait of Mr. Thompson, in oil, was presented to the association. In accepting, the association voted to have the portrait hung in the convention hall at all future meetings. The presentation was a complete surprise to Mr. Thompson.

The convention was called to order by the president, J. H. De Salis (N. Y. C.), who, after the invocation addressed the association in part as follows:

President De Salis' Address

"The greater part of our members serve as instructors of locomotive engine crews, and personally observe the performance of the locomotives and the crews operating them. Their responsibilities cover all parts of the locomotive and its proper operation, both from a mechanical and transportation standpoint. The traveling engineer is required to be a specialist on the many devices that go to make up the successful and economical operation of a train.

"Education for the men holding these positions is necessary. Their duties place them in a position where mistakes cannot be corrected; they must act right the first time. If the train is not started in the proper manner the mistake means broken draft rigging or broken cars. If the train is not stopped properly it may mean derailment or collision, and if a train is not properly operated when running it may not make the schedule time or will cause a loss of fuel. At these conventions are brought out the best methods of educating engine crews. In the proceedings is found the best practice for the successful operation of trains, and a book published by this association entitled 'Standard Form of Examination for Firemen' is being used by many railroads for the examination of new men and of candidates for promotion."

W. O. Thompson—New York Central
Secretary

Early History of the Association

Following Mr. De Salis' address, a brief resumé of the early history of the association, prepared at the request of the executive committee, was presented by Mr Thompson, of which the following is an abstract.

A short time after the adjournment of the Master Mechanics' and Master Car Builders' convention in 1892, a road foreman of engines of one of the lines running into Chicago listened to a conversation between his master mechanic and a representative of the Westinghouse Air Brake Company relative to the good work accomplished at the convention and how beneficial it was for a man engaged in the railroad business to meet with other men in the same branch of the business from all parts of the country for the purpose of exchanging their views and experiences.

The conversation led the listener to think that if the Master Mechanics' Association was of such inestimable value, why would not an association of traveling engineers be of even more importance, not only to the traveling engineers, but to all departments of the railroad.

Acting on the thought, he started out to find traveling engineers enough to form an association, and, strange as it may seem with our membership of over 1,500 in the United States, Canada and Mexico, he was over three months in getting the names of 14 traveling engineers who were in favor of the idea.

After the 14 traveling engineers had been heard from, a meeting was held at Chicago, November 14, 1892. The result of that meeting was the forming of a temporary organization. During the meeting an invitation was received from Sinclair and Hill, of Railway & Locomotive Engineering, to meet in their office in New York City to perfect a permanent organization. This meeting was held on January 9, 1893, and 53 members were enrolled.

During the first few years of the association's existence its condition was rather precarious. At that time the newly created position of traveling engineer was not looked upon as an actual necessity by the managements of many railroads. In the panic of 1894 and 1895 approximately 70 per cent of our membership was set back to running engines and had it not been for the hard, painstaking work of a number of our members, the almost immediate popularity of reports and researches of our committees, the loyalty of a few of the higher railroad officials, the press and a few of the railway supply firms, the association would have died in its infancy.

The benefits to the traveling engineer have also been great. Thirty years ago he was considered nothing more than an engine-tamer and trouble-doctor, but today he is considered an indispensable adjunct of any well-organized railroad.

The association has grown from a membership of 53 to 1,536. During its life 575 members have been selected to fill higher positions on railroads or in other businesses. In all of the 30 years there has never been a decrease in membership. Nearly all of the members who have been promoted to higher positions continue their membership, thus giving

J. H. DeSalis—New York Central
President

Frederick Kerby—Baltimore & Ohio
1st Vice-President

T. F. Howley—Erie
2nd Vice-President

W. J. Fee—Grand Trunk
3rd Vice-President

the association their moral and financial support. Considering these facts, the pride which the traveling engineers feel in their association is pardonable.

Portrait of Secretary Thompson Presented

At the close of the paper, D. L. Eubank (Galena Signal Oil Company) unveiled and presented Mr. Thompson's portrait to the association. In his remarks leading up to the presentation he brought out the fact not mentioned by Mr. Thompson in his paper that the author was in large measure responsible for the organization of the association and for its healthy growth during the early years of its existence.

On behalf of the members, tributes were paid to Mr. Thompson's service to the association by L. D. Gillett (Dominion Railway Commission of Canada) and D. R. McBain. Members of the Traveling Engineers' Association, of the Railway Equipment Manufacturers' Association, and the Hotel Sherman participated in providing the portrait.

Operation and Maintenance of Oil Burning Locomotives

In the operation of an oil-burning locomotive attention should be given to avoiding sudden and great change in fire-box temperatures. The fireman, by inattention in letting the steam drop back and then forcing the fire to bring the steam up again, not only wastes fuel, but works a great hardship on the boiler. Owing to the rapidity with which the temperature can be dropped by cutting down the fire it is of utmost importance to have the engine crew give special attention to the use of the dampers and handling of injectors or feedwater heaters and the blower to prevent abuse of the boiler. In starting a train, the locomotive burning oil can develop its maximum power without fear of holes being torn in the fire by heavy exhaust at long cut-offs, as in a coal-burning locomotive; but if careful judgment is not used in handling, this feature will adversely affect fuel economy by producing uneconomical acceleration.

The fuel oil should be heated to about 100 deg. F. in the tank to give the best results, although with the use of very heavy oils it has been necessary to heat the oil to 150 or 180 deg. F. Excessive heating damages the oil by driving off the lighter gases and causing the asphaltum to separate from the lighter oil. This makes the flow irregular and it is difficult to carry a light fire when drifting or standing.

Frequent sanding of the flues to prevent accumulation of soot promotes economy. Sanding should be done where there is no hazard of starting fires and when the engine is working under heavy conditions at a long cut-off. The intervals between sanding depend upon conditions of operation.

The operation of the firing valve and atomizer require close attention to take care of the varying boiler load, due to changing cut-off. Careful attention in the use of the atomizer and firing valve will eliminate black smoke, except where mechanical defects interfere. Heavy black smoke is not only a direct fuel loss, but rapidly deposits soot on the flues which interferes with the heat transfer to the boiler. A clear stack is deceiving. It may mean only a small amount of air, or it may mean as much as 300 per cent excess. Under operating conditions, it is good practice to regulate the supply of air until a very light brown haze is shown at the stack, which will reduce the amount of excess air and thereby produce economy in the use of fuel. The presence of smoke does not always mean insufficient air. Poor atomization, poor mixture of air and oil, unconsumed oil striking cooling surface and poorly designed or bricked fire-pan frequently cause smoke when the air supply is far in excess of that required.

Burners should have sufficient air admitted around them to prevent them from becoming heated to a temperature causing carbonization of the fuel at the mouth of the burner, resulting in deflecting the oil spray. The best results have been obtained with a burner located at a point from six to nine inches above the floor of the fire-pan. Burners should be properly alined with the fire-pan to strike the center of the flash-wall and should be inspected frequently, by inserting a hack-saw blade in the oil port to insure that there is no foreign matter to prevent the maximum amount of fuel being delivered when required.

The fire-pan should be free from all leaks, except the air openings provided for the combustion of fuel. Leaks, in many cases, cause the brick work to become loose. If bricks fall into the bottom of the fire-pan they deflect the oil spray.

Fire clay, asbestos and fine sand should be used in lining brick work of the fire-box and fire-pan. These should be mixed in proportion of two parts clay, one part of sand and one of asbestos, and stirred to the consistency of a thin paste. The brick should be placed as closely together as possible. Large quantities of fire clay mixture should not be used at any one point or depended upon entirely as a heat-resistance surface. After the brick setting has been completed, all exposed surfaces should be coated with a solution of soda ash and water, mixed until it will flow freely. This glazes and makes a very satisfactory fire-resisting surface.

Much can be accomplished in maintaining the brick work by having the fire-pan properly braced.

Should any carbon be found on the flash-wall, this should be removed to permit the oil spray to come in contact with a reasonably clean wall.

The formation of carbon is oil striking the brick work or some obstruction in the fire-pan before it had time to burn. There is a noticeable increase in the amount of carbon formed when very heavy asphaltic base oils are used. This is probably due to the fact that these are heavy and slow-burning. Decreasing the openings in the fire-pan and thereby increasing the velocity of air entering the fire-pan has reduced carbon formation, as it hastens combustion.

Both small and superheater flues should be inspected frequently, as there is a possibility of sand collecting in the large flues when there are leaks in the front end. Any restriction in the flues will affect superheating and evaporating efficiency.

If an oil-burning engine is properly drafted and the firebox properly bricked to prevent the localization of high temperatures, the cost of maintenance is about the same as that of a coal-burning engine.

In comparing the operation of an oil-burning locomotive with a coal burner, the locomotive burning oil has a number of distinct advantages: (1) Reduction in the amount of smoke; (2) absence of cinders; (3) largest type of power can be operated without the mechanical stoker; (4) less loss of fuel at the stack; (5) the hazard of starting fires along the right-of-way is reduced; (6) with careful handling the steam can be kept closer to the maximum boiler pressure without frequent or prolonged openings of the pop valve; (7) it permits the fireman at all times to observe signal indications and operating rules; (8) the use of oil permits a more accurate check of the fuel consumption, which is of great value in compiling individual performance records of enginemen, firemen and locomotives; (9) quicker turning of the power may be accomplished with the use of oil and terminal charges reduced because of the reduction in hostler service and the elimination of ash-pit service; (10) it permits a better system and lower cost of fuel distribution through the use of pipe lines.

The use of oil is also conducive to longer locomotive runs, as for equal heat valve oil occupies much less space than coal. Furthermore, oil when stored does not lose its heating value as does coal, nor are there any difficulties arising from disintegration as with coal.

The report is signed by J. N. Clark (Sou. Pac.), chairman; J. C. Simino (Sou. Pac.); J. C. Brennan (N. Y. C.); E. F. Boyle; W. G. Tawse (Superheater Co.), and Dumont Love (F. E. C.).

Discussion

The principal points brought out by the discussion, were the necessity for care in firing up the oil burning locomotive to avoid the risk of gas explosions in the firebox, the value of the stack cover for retaining heat in the boiler when the locomotive is in the terminal and a doubt as to whether the risk of roadway fires is entirely eliminated.

The practice outlined to avoid explosions in firing up oil burning locomotives, particularly when the fire is to be lighted in a hot firebox, is first to open the blower valve, open the fire door, then turn on the atomizer and finally open the oil valve after a piece of burning waste for igniting the oil has been placed in the firebox. The blower and the open door permit a sufficient volume of air to pass through the firebox to prevent the accumulation of gas which may be formed in the hot firebox should the oil be slow in igniting.

The use of stack covers does not seem to be general practice although a number of roads use them to some extent. Instances were cited where, by the use of the stack cover, it has been possible to retain sufficient steam pressure in the boiler after from 8 to 12 hours to permit the engine to be fired up with its own steam in the atomizer.

L. D. Gillett (Dominion Railroad Commission of Canada), raised the question as to the fire hazard of oil burning locomotives, stating that in Canada an investigation of fires in oil burning territory had developed the fact that burning tar has been thrown from the stack in quantities sufficient to set fire under favorable conditions, and that a change in the refinery process has eliminated the trouble. The discussion thus started brought out the need of supervision to insure that cigarettes or cigar stubs, pieces of waste, etc., be not thrown into the sand box, and thence into the firebox and out the stack only partially consumed, to set fire along the right-of-way and on the adjoining property. Through certain agricultural districts where considerable grain is grown, the Southern Pacific uses netting in the front ends of its locomotives during the dry season as a precautionary measure against the small sparks thrown out when sanding the tubes. Although it is evident that fires can be set from oil burning locomotives, the consensus of opinion of the members who have had experience, is that the risk is incomparably less than with coal burning locomotives.

Poor Distribution of Power Increases Operating Costs

At more or less frequently recurring periods, every railroad is confronted with a situation where its ability to earn revenue is controlled by its ability to move the traffic offered. Likewise periods occur when surplus equipment represents a large overhead investment producing no revenue. Any plans that will contribute toward improving these conditions will help greatly in reducing the general cost of operation.

A study of the power situation with a view to conserving tractive effort on the railroad system as a whole, without reference to particular conveniences or economies on a single division, is of paramount importance. Records of fuel and locomotive maintenance cost will show that, generally speaking, where the size of the train is limited, the smallest type of engine that will comfortably handle the train will give the lowest annual operating cost for fuel, wages and repairs, and in turn will release the heavier type of power for trains where the loading is controlled only by the tractive effort of the engine. Investigation has shown instances of comparatively heavy engines handling very light local passenger trains, with lighter engines handling tonnage freight trains on other divisions, perhaps for the reason that the engineman returned on a heavier run, or because that particular division inherited that particular class of power as a result of some changes in the power distribution on the district as a whole. Changes in power distribution or extending the run of locomotives over two divisions have in such cases brought about considerable saving in tractive effort and as a result decreased the cost of operation.

Locomotives having a large reserve of power for the trains they are required to handle, or more modern in design, can be in less than average good condition and yet make the time without failure. Furthermore, small types of more or less antiquated power are not popular at the general shops for overhauling, for the reason that the more modern types are usually in demand, and it is easier to figure on what they will require in repair parts. The motive power officer on the division has for his yardstick man hours per locomotive despatchment and engine failures, rather than the total cost of operation per 1,000 gross ton miles or per passenger car mile, and naturally is not vitally interested in the question as to whether some other type of locomotive would do the work more economically.

It has been stated by eminent authority that the loss to the farmers of the United States, through not being able to move their crops when markets are favorable, amounts to about $400,000,000 annually, and yet railroad officers find themselves at certain periods with considerable surplus of power. These considerations, together with the fact that the average miles per locomotive day for freight locomotives in 1920 was 59.3, gives to the subject of power utilization a compelling interest, any discussion of which will naturally resolve itself into consideration as to the merits of pooled vs. regular engines, of long runs vs. division runs, and many other things.

J. N. Clark—Southern Pacific
4th Vice-President

J. B. Hurley—Wabash
5th Vice-President

D. Meadows—Michigan Central
Treasurer

One feature to consider in engine assignment is that engines having a large reserve of power for the trains assigned to them do not call for the same refinement in the handling and firing that will obtain where it is necessary to have skillful handling in order to deliver the desired service. This absolutely works out in practice. The fuel used at terminals and in stand-by losses represents probably 30 to 35 per cent of the total and increases with larger power on light trains.

The cost of locomotive operation for a representative mid-western road for the year 1920, which will also be fairly representative of 1922 conditions, was as follows:

	Total cost for year	Cost per loco. owned per annum
Fuel	$28,789,756	$13,158
Repairs	26,462,086	12,094
Wages—enginemen, firemen and enginehouse employees	18,442,173	8,429
Lubricants	424,917	194
Other supplies	335,696	153
Total of selected items	$74,454,628	$34,029

This represents average costs applied to all locomotives owned. If this were shown only for the locomotives in actual service or for the heavy freight locomotives in service, the average cost would be much higher.

The St. L.-S. F. has for some time made up a daily cost sheet for each freight train operated. This shows the cost per 1,000 G. T. M. for fuel and wages, including overtime. This information reaches all division operating officers, including the road foremen of engines, daily, and is very valuable in keeping individual fuel and wage costs before all concerned, including enginemen and trainmen.

On the majority of roads the operating or transportation department distributes the power, working with the motive power department, which usually approves of the individual engines to be assigned to divisions or runs, but this is not always the case in transfers of power between divisions or districts. A very close working arrangement is necessary if the best results are to be obtained. Transfers of power are sometimes, if not usually, made at times of rush business when new men are entering the service, both in the shops and on the road. A transportation officer without training in locomotive matters cannot fully appreciate all that is involved in introducing new types of locomotives into new territory. The experience of men with the training of the traveling engineer is very valuable in such times and should be utilized. The traveling engineer so advising should be thoroughly familiar with the operating conditions on the railroad as a whole and make his recommendations accordingly, without reference to division economies which disregard the general good to be accomplished. Compound engines or engines equipped with certain special devices, while giving excellent service where regularly used, may prove of negative benefit when thrown into a group of engines of similar tractive power perhaps, but unlike in design or equipment. This is especially true where there are many new men not entirely familiar with the types of locomotives or devices.

A number of roads have increased the available power supply through lengthening locomotive runs. This will not apply equally on all roads, but has great possibilities under certain conditions. This practice has been very much extended since our 1921 meeting, and the experience of the members is invited in the discussion to follow. Local conditions, as to train schedules, conveniences for taking coal and water, the grade of fuel used and facilities for caring for the fire and ash-pan enroute, must be considered. It is a fact that enginemen and firemen are assigned to runs rather than to engines and the difficulty in actually having regular crews on engines has increased, thus making it difficult to secure satisfactory mileage from regularly assigned engines to runs. It is safe to predict that where the character of the fuel used will permit, the tendency of operating departments of railroads will be to develop the fullest information as to the desirability of extending the length of runs for locomotives in passenger and fast freight service, but particularly in passenger service. The experience of the New York Central Lines, with which two members of your committee are connected, has been that to date the average monthly mileage of all passenger locomotives has not increased as a result of running certain engines over two divisions, although individual engines will make large mileage for a period. There is a saving in fuel due to decreased terminal consumption and the supervision given toward maintaining good condition of fires enroute to avoid delays for steam. We suggest the possibilities of extended runs for locomotives be made a subject for next year's convention.

Segregating certain types of engines to one district or division, instead of mixing up different classes in one territory, has its advantages. This may appear to impose a hardship at first if the engines are new to the district and somewhat more difficult to maintain and to operate than the engines regularly or previously used, but if done at a time when business is not too heavy and when experienced men are on both sides of the engine, and a high standard of inspection and repairs can be built up, it is a paying proposition. It is the practice, also, on some roads to work fairly close on power at all times. The motive power officers themselves insist on this, thus keeping the largest possible reserve of power laid up in good order for rush periods. It costs money to take engines out of storage, and it should not be done without knowing that they are actually needed.

The roads referred to also maintain pooled freight engines throughout the year rather than assigning regular crews to engines during slack periods and then having to pool them when a rush comes on. The principle involved is that of maintaining a more rigid average year round system of inspection and repairs at terminals than would obtain with regularly assigned engines for certain seasons of slack business, and when we more or less depend on the engineer's report and personal interest to help maintain the power than when running pooled engines. However, when forced to return to pooling it is hardly possible to build up quickly the inspection and the method of caring for repairs or to keep the same degree of interest alive among the engine crews that obtains with regularly assigned engines or with a highly developed plan of pooled service. The advent of newly promoted enginemen and new firemen is an important point to consider and it is always to be remembered that the period of rush business is when the earning capacity of the locomotive is the greatest and when we should be able to get the best possible use from it.

The report is signed by Robert Collett (N. Y. C.), chairman; David Meadows (M. C.); W. R. Garber (K. & M.); J. E. Ingling (Erie), and C. A. Fisher (G. N.).

Discussion

The discussion of this report centered very largely around the subject of long engine runs, in which it is evident that the members of the association are taking a deep interest. Several cases of passenger runs of from 250 miles to over 600 miles were cited, and a number of cases were also cited where freight locomotives were running over two districts. The longer runs mentioned were in oil-burning territory on the Southern Pacific and the Missouri, Kansas & Texas. It developed that in several cases the extension of the length of the locomotive run has required an increase in the size of the cylinder lubricator. The four-pint lubricator has been found too small for large passenger power and in some cases six pint lubricators are being installed. This matter has offered no real obstacle, however, as extra oil is placed on the engine for use in case the original filling may not be sufficient to carry the locomotive over the entire run.

On the New York Central passenger locomotives are being run through from Harmon, N. Y., to Syracuse. This has saved turning 40 locomotives a day at the Rensselaer terminal (Albany, N. Y.), at an average cost of from $6 to $9 each, with a corresponding reduction in the number of movements between the roundhouse and the station, a distance of one mile over a busy double track bridge. Car department employees fill the main pin grease cups and shovel the coal forward at the Albany station in an average of from five to seven minutes. The locomotives have a short layover at Syracuse and return to Harmon in less than 24 hours. This practice has not necessitated any increase in the engine house force either at Harmon or Syracuse. On the two divisions, trains which formerly required 21 locomotives to handle are now being taken care of with 16 locomotives. No case was cited in the discussion where the practice, once established, had been discontinued because of the inability to overcome any of the difficulties encountered, although the shopmen's strike has interfered with the development of the practice in some cases. Although numerous difficulties have been encountered, the consensus of opinion of those members of the association who have had experience with it, indicates that some increase in locomotive mileage may be expected, that train miles per locomotive failure need not be decreased by the longer runs and that engine house expense will be reduced. Definite opinions as to what effect the long runs will have on fuel consumption and locomotive maintenance were not brought out. It was suggested, however, that where the long runs include more than one division the responsibility for maintenance would be divided and that the long runs would tend toward pooling of the passenger power.

The Baltimore & Ohio has had considerable experience with assigned locomotives in freight service. Prior to the strike mikado locomotives were assigned to regular crews on one division and mallets on another, with good results in both cases. It has been found that regularly assigned engines spend less time at the terminals than pooled engines. To save time and insure despatching without delay to the crew, machinists are assigned to the inspection pits to do as much repair work as possible while the inspection is being made and the engine is awaiting movement to the house.

Some Defects of the Air Brake System

The fundamental purpose of the railroad is to save time. The starting and stopping of trains are complementary factors in the problem of time saving, and it is evident that the best results can be obtained where both factors are given due consideration. Unfortunately, the brake is usually looked upon as a safety device only and, because of this idea, its maintenance does not receive the consideration it merits.

Insufficient consideration is given to the importance of correcting defects before trains leave the terminal. It is far better from every standpoint to spend a few minutes in the yard correcting defects than it is to spend hours in delays on the road. When a train leaves the yard, it should be in condition to go through to the next terminal without delay, due to improper brake action. Proper time for this work should be allowed, not while the train is being made up, but after the make-up is completed.

The business of the railroad is to move trains. Trains cannot be moved unless they can be controlled. The effectiveness of the control will determine the speed and number of trains. It will determine the number of cars which may be successfully operated in each train, as well as their weight and variation in weight from the empty to loaded condition.

The importance of brake pipe leakage, as it affects the operation of the brakes and fuel consumption, is generally underestimated.

When the engineman makes a brake pipe reduction and places the brake valve on lap, he is powerless to prevent the effect of break pipe leakage on the train. It is important that this point receive more attention on long and heavy trains than on the shorter ones, not only to avoid trouble during the application of the brake, but also to decrease compressor wear and steam consumption, to insure the ability to release all brakes in the train and to shorten the time of release.

It is customary to determine the amount of air leakage from the brake pipe by making a 10-lb. reduction, lapping the brake valve and noting the rate of drop of brake pipe pressure. Knowing the volume of the brake pipe, it is possible to calculate the cubic feet of free air lost from the brake pipe during the first minute after the brake valve is placed in lap position. This figure is commonly accepted as a measure of the relative condition of trains on the road with respect to leakage from the air brake system.

An extended investigation of long freight trains has developed the fact that the information so obtained may be rather misleading than otherwise. Trains are frequently encountered on which the brake pipe leakage, as noted above, may not be excessive, the indication being that the locomotive compressor capacity is ample to supply the air required for maintaining the pressure in the brake system, but subsequent observation on the road demonstrates that the compressor capacity is insufficient to supply the air lost.

Attempts to measure the amount of air leaking from the entire system (including brake pipe and auxiliary reservoirs) by charging the brakes to 70 lb. and then placing the brake valve handle in lap position does not give satisfactory results, because where there is considerable leakage some brakes will apply while the brake valve is in lap position and the leakage then observed is from the brake pipe and only those reservoirs on cars where the brakes do not apply. This uncertainty makes tests of this character of no value.

In order to avoid the difficulties encountered in attempting to observe the leakage from the system by noting the drop in pressure on the brake pipe gage, such leakage is now determined by measuring the amount of air passing into the brake pipe to supply the leakage.

The permissible amount of leakage from the entire brake system is a question each individual road will have to decide. Too much leakage must not be allowed or an undesirably large compressor capacity or high degree of compressor maintenance will be necessary. An exceedingly low amount of leakage must not be insisted on or traffic will be interfered with on account of the time required to stop the leaks.

For instance, a 5-lb. pressure drop from the brake system, which would mean about 20-lb. pressure drop from the brake pipe volume alone, will not materially interfere with the application and release of the brakes, yet 5 lb. of air leakage from a 100-car train will amount to 65 cu. ft. of free air per minute. This amount of air leaking from the system of a 100-car train in one minute would not interfere with the operation of the brakes, as far as application is concerned, but it might seriously interfere with the release of the brakes, since it reduces the ability of the compressor by 65 cu. ft. of air per minute to raise the pressure in the brake pipe at the rate required to insure release. In fact, the compressor may have but little, if any, margin above that required to replenish the leakage. The time required to release the brakes on a freight train is a variable quantity. It can be said, however, that the time is usually underestimated, and the time the brake valve is left in release position is overestimated. Instruct an engineman, when releasing brakes, to place the brake valve in release position and leave it there 15 sec., and it will usually be found nearer 10 sec. than 15. The natural tendency to hasten the movement of the train makes the time seem longer than it really is, and an effort is made to start the train before all brakes have had time to release. This places great strain on the draft gear, frequently severe enough to cause parting of the train.

At how low speed brakes can be released without liability of damage depends on how heavily they are then applied, the amount of excess pressure, the length of the train, whether slack is in or out, and whether track conditions are favorable for releasing. Where retaining valves are in use, it is practicable to release at somewhat lower speeds than where they are not. While the head brakes always start to release before the rear ones, the retaining valves cause a much slower fall of brake cylinder pressure than when they are not in use, and this causes the slack to run out more smoothly. The most favorable conditions for releasing the brakes are when the train is standing, with maximum excess pressure and the brakes almost fully applied. The difficult release is when the brake pipe pressure is very low, as when the engine has been cut off for some time, or after a burst hose, train parting or an emergency application, because of the large amount of air required to raise the pressure in the brake pipe and in the auxiliary reservoirs of all early releasing brakes above the pressure in the auxiliary reservoirs of the late releasing brakes, particularly those at the rear. To insure release, a quick and considerable rise of brake pipe above auxiliary reservoir pressure must be had. In trying to get this to the rear after a light application, the head brakes are sure to be overcharged, so that some will reapply. Where a light application is made, the excess pressure should be increased before attempting to release.

No attempt should be made to release the brakes on a long freight train while running following an emergency application, no matter how high the speed may be. In case the brakes are applied from the train, place the automatic brake valve in emergency position, shut off steam and ascertain the cause. A hose may have burst, the train may have parted, or the conductor's valve may have been opened.

It may be of interest here to state that it requires to apply the brakes on a 100-car train of 10-in. equipment with a full service application approximately 205 cu. ft. of free air. Assuming the average leakage from the brake system at 40 cu. ft. of free air per minute, then every five minutes as much air is consumed by leakage as is required to apply the brakes with a full service application. If this train of 100 cars be kept charged while on the road 12 hours, it will consume in leakage alone about 28,800 cu. ft. of free air, or enough to apply the brakes with a full service application 144 times. From this we can see that the actual amount of air used in operating the brakes as compared with that wasted by leakage is very small, indeed. Furthermore, when we begin to appreciate more fully the expense entailed in unnecessary fuel consumption, compressor wear, poor train control and delay to train movement on account of air leakage from the brake system, then, and then only, will proper attention be given to overcome this leakage. We avoid the cost of a good tight pipe job, of close inspection and competent repairing, but burn more coal and waste much time. We must do more than make rules about these things. We must have the right kind of men, enough of them, and encourage them by giving them the right kind of tools, the materials and a proper place to do work.

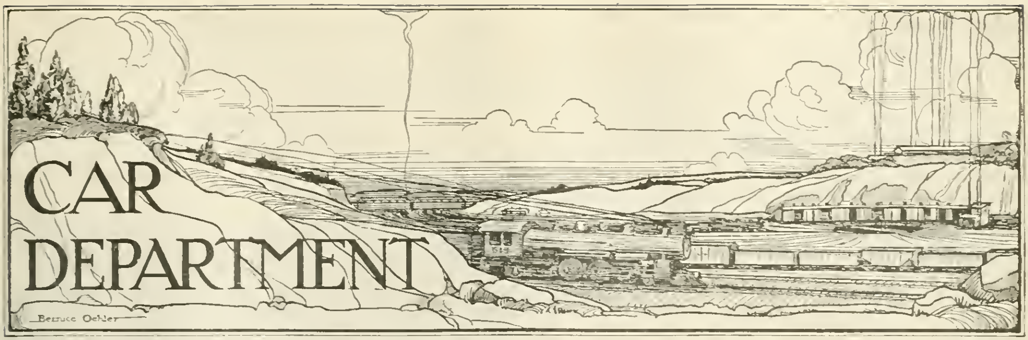
The report is signed by B. J. Feeny (Illinois Central), chairman; T. F. Lyons (N. Y. C.), L. M. Carlton (Westinghouse Air Brake Co.), W. W. Rush (D. & R. G. W.) and Wm. Owens (New York Air Brake Co.).

Discussion

In discussing the methods of testing for brake pipe leakage in transportation yards, several exceptions were taken to measuring the air required to supply the leakage rather than noting the drop in gage pressure with the brake valve lapped. The point was made that any means of measuring the air supplied to the brake pipe was likely to be too complicated to be practicable in the transportation yard, although such a test would be desirable where it could be made before the locomotive is attached to the train. Attention was also called to the fact that, as stated in the paper, a reduction of 5 lb. per sq. in. from the entire brake system, including the auxiliary reservoir volume, would be equivalent to a reduction of 20 lb. in the brake pipe pressure with the brake pipe volume alone, and that since most of the leakage is in the brake pipe, it is important to know the rate of pressure reduction with the brakes applied and the engineer's valve in the lap position, since this rate of leakage determines the extent to which the engineer can control the brake cylinder pressure. For this reason the Air Brake Association test, in which the brake-pipe leakage is noted with the brake valve lapped following a 10-lb. brake pipe reduction, was advocated.

There was considerable discussion as to the proper handling of the brake valve following the application of the brakes from the train. Cases were cited in which, by the prompt release of the locomotive brakes through the independent brake valve following the emergency application caused by a break in two, it has been possible to keep the locomotive and 10 or 15 cars which had broken away, out of the way of the rear end of the train. Generally speaking, about the only variation from the practice recommended in the report is the lapping of the brake valve instead of putting it into emergency position, which is the rule on several roads.

(Abstracts of other reports will be given in future issues.)



Recent Developments in Use of Container Cars*

Saving in Manual Handling by Container System—Application to Transportation of Milk in Bulk

By F. S. Gallagher
Engineer of Rolling Stock, New York Central

THE container system of handling L. C. L. freight is too young to enable any definite or concrete figures in connection with costs to be given, but I will endeavor to draw a word picture that will show the economy and

Loading a 600 Gal. Milk Tank Container

safety effected through the handling of less than car load freight by the container system.

The L. C. L. method of handling less than car load freight, permitting the unloading of a car in a few minutes, will be very far reaching, taking into consideration the railroad equipment of the country and the inability of the railroads to control this equipment during the peak load of business, when, in some cases, it is known the shippers use the car as a temporary storage place, tying up equipment that is badly needed. This results in a loss to the railroad company for car revenue which it would have had if the car had been unloaded promptly and returned to service, and an expense to the public at large due to the inability of the railroads to handle promptly shipments because of the lack of equipment.

With the use of the L. C. L. containers, this condition should be greatly reduced, if not altogether eliminated, because the containers can be removed from the car, immediately taken to the shipper's warehouse, and while there might some day be a demurrage charge for holding the containers, it would not keep the rolling stock out of service. In other words, the container methods of handling freight permits the quick unloading, and, of course, the quick unloading permits the quick return to service of the car, and during periods when there is a shortage of cars, which is almost chronic, the quick unloading of the freight car is a benefit to all concerned—the railroads, the shipper and the public.

Thirteen Manual Handlings for Each L. C. L. Shipment

Few people realize the number of times that L. C. L. freight must be handled from the shipper to the consignee. Following one package from start to destination, we will find it is manually handled as follows: (First) From the packing room to the warehouse platform; (second) from the warehouse platform to the wagon by hand truck; (third) from the hand truck into the wagon. The wagon then proceeds to the freight house, and the next manual handling (fourth) is from the wagon to the freight house platform; (fifth) from the freight house platform to the hand truck. The individual package must be weighed and proper record made, and then taken into the car (making the sixth movement). The seventh handling would be the stowing into the car. The car is then sealed and moved to destination.

The next handling (eighth) is the unloader lifting the freight to the floor of the car for the hand trucker; (ninth) the hand trucker carries this freight to a designated place in the freight house. When the consignee calls for the goods the hand trucker takes the shipment to the wagon for loading (tenth handling). When the package is delivered by the hand trucker to the wagon loading platform, it is dumped at the tail gate of the wagon (eleventh handling), and must be handled the twelfth time to place it into the wagon. At the consignee's receiving platform the goods must be un-

*Address delivered before the Society of Terminal Engineers, New York, October 10, 1922 loaded from the wagon, making the thirteenth time that this package has been handled.

Assuming that a car load of L. C. L. freight is 20,000 lb., this means that it must be handled manually lifted 13 times, or man power must be provided to lift 260,000 lb. in order to transfer one car load of 20,000 lb. of freight. This does not include the numerous checkings and records that must be made of this freight, which in itself is a big item of expense. By the container system the container is delivered to the shipper, who will have a light overhead crane or some other means of carrying the container into his warehouse, so that one handling of the original package into the container is all that is necessary. The expense of crating is eliminated.

Gondola Cars with Slight Modifications Are Well Adapted for Holding Containers

Being loaded with one handling of the freight, the container is lifted by hoist from the floor of the shipper's warehouse to the truck and is lifted by hoist from the truck to the car.

At destination, the operation is just the opposite. The container is lifted from the car onto the truck and then from truck to the consignee's platform, where it is unloaded and is ready for return shipment, or the container is ready to be picked up by the truck for the use of some other shipper. While the container is being unloaded the truck is released.

Instead of having to handle this container shipment of L. C. L. freight thirteen times by man power, it is handled twice, saving on the same basis as before; that is, on a car load of L. C. L. freight weighing 20,000 lb., the man power lifting of 220,000 lb. This is an economy that we cannot lose sight of, and while it would be said, of course, that there will be an expense incident to the installation of equipment for handling these containers at shippers' and consignees' plants, when this equipment is once in, the expense ceases.

Saving on Loss and Damage

We are all familiar with the enormous amount of money returned to the shippers by the railroads and by the express companies on account of loss and damage to freight. In L. C. L. freight it amounts to more than 8½ per cent of the revenue. The express companies pay claims to the amount of $25,000,000 a year for loss and damage. A great portion of this can be saved by the container system, because there is no chance of damage if the goods are properly packed in the container unless there is a disastrous smash-up, and no chance of loss en route from the shipper's platform to the consignee's platform.

Containers for Shipping Liquids

There are other commodities handled by the railroads beside L. C. L. freight, express and mail where the container should play a big part; that is, in the handling of liquids, especially milk, fruit juices, edible oils, acids, etc., where the temperature is an important factor. The New York Central now has containers arranged for the transportation of milk in bulk.

The container and tank for milk or other liquids is shown in Fig. 1. A glass lined tank built by the Pfaudler Company of Rochester, N. Y., is used, but is encased in an insulated container. Time saving and labor saving is accomplished in every operation of handling milk or liquid by the use of the container car tank. The liquid being placed in the tanks at the proper temperature and the container being properly insulated, eliminates the use of ice.

These tanks may be made as large as may be transferred over the highways. In actual service all of the containers from the car will be hoisted and placed on a motor truck regularly in about a minute or a minute and a half per container. To transfer the same amount of milk between truck and railway car in the standard ten-gallon cans would

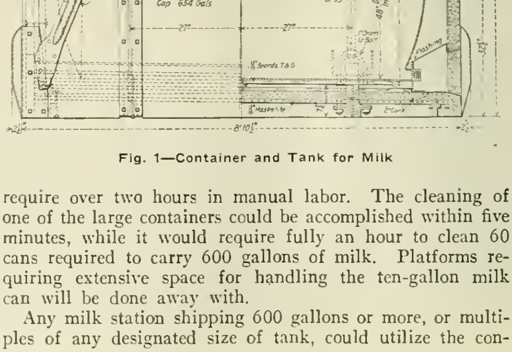
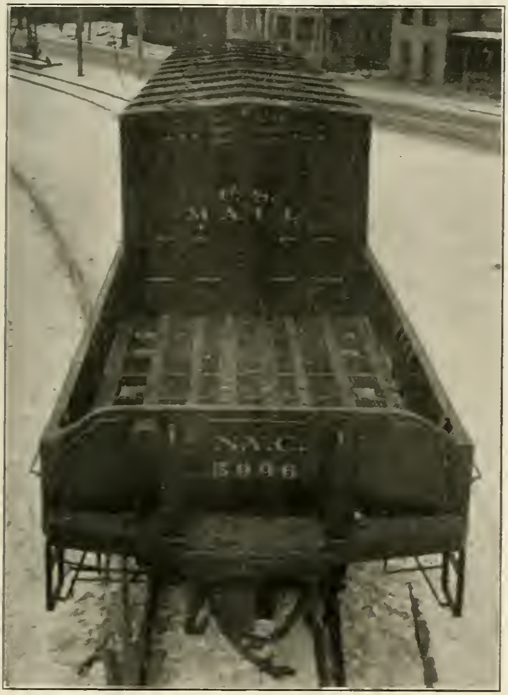


Fig. 1—Container and Tank for Milk

require over two hours in manual labor. The cleaning of one of the large containers could be accomplished within five minutes, while it would require fully an hour to clean 60 cans required to carry 600 gallons of milk. Platforms requiring extensive space for handling the ten-gallon milk can will be done away with.

Any milk station shipping 600 gallons or more, or multiples of any designated size of tank, could utilize the container car tank service and lessen the handling at the shipping point and at the receiving point. The limiting feature of a liquid container would simply mean the capacity of the truck for transferring over the highways. The tank can be made to carry in bulk any amount: 600, 1,000, 1,500 or more gallons of milk.

There is no chance of getting water into the container, because the top of the Pfaudler glass-lined tank is sealed and locked, and in addition a regulation refrigerator car ice



Container Cars for Mail Service Have a Wire-Mesh Floor

hatch plug is used for insulating purposes. This plug is dropped into the opening and then the container cover is fastened down and sealed.

With regard to the actual handling of L. C. L. freight by the container method, a tariff was arranged for between Chicago and Cleveland, and the container system of handling freight put into regular service. The containers were handled as I described, thus making a store door delivery, or in proper words, from store door to store door delivery. This system of handling L. C. L. freight is now in operation between New York and Buffalo and intermediate points, where the "from store door to store door" handling of L. C. L. freight is made possible, and all the equipment that is necessary to put this system in operation is the crane for lifting the container from the car, and at the shipping or consignee's plant the container can be left on the truck and unloaded, but if they have lifting means it would be quicker and cheaper to lift the container from the truck and place it on the shipping or receiving platform, releasing the truck for other work while the container is being loaded or unloaded, as the case may be.

These containers are 7 ft. wide, 9 ft. long and 8 ft. high, and they have a carrying capacity of 7,000 lb. This keeps the gross weight within the carrying capacity of a five-ton truck. They are made of steel throughout, except the floor, which is made of laminated wood. The containers are well braced, and there is very little chance of damage with ordinary handling.

By the container system, when we can arrange for the proper equipment for handling the containers, a car can be unloaded and released for service in a very few minutes; also it will permit the shipper and consignee to transfer or haul their goods from their warehouse or to their warehouse, as the case may be, by auto truck, without waiting at the freight house and without the loss of time necessary to load the truck with individual packages, because it will take only about a minute to load the truck when goods are shipped in an L. C. L. container, thereby saving an hour or two in getting the goods from or to the railroad.

Protecting Draft Gear from Solid Impact

By Wendel J. Meyer

In his paper on the design of steel freight cars before the Railway Club of Pittsburgh* John A. Pilcher, mechanical engineer, Norfolk and Western, stressed his opinion that cars receive their greatest damage from impacts in switching service and advocated limiting the switching speeds rather than attempting to design a car to meet any speed the trainmen might use. According to the speaker, the switching speed should be limited to the capacity of the draft gear in order that it should never be allowed to go solid. Each time the gear goes solid, it sustains damage, making it less efficient for its next impact, and so on until it is so badly damaged that it ceases to protect the car.

From tests conducted by the Inspection and Test Section of the United States Railroad Administration, speeds at which two commercial gears will go solid when applied to cars of 143,000 lb. gross weight each, vary from 1.87 m.p.h. to 5.09 m.p.h. (see Fig. 61 of "Report of Draft Gear Tests"). The report shows that the closing capacities were as follows: One type at 5 m.p.h., six between 4 and 5 m.p.h., six between 3 and 4 m.p.h. and four under 3 m.p.h. From this might be deduced a limiting speed of about 4.5 m.p.h. but since the gears tested were new and in excellent condition and moreover, since the most widely used types were closed at from 3 to 4 m.p.h., the limit would need to be reduced to at least 3.5 m.p.h. if not to 3 m.p.h.

Observers have agreed that impact speeds of from 5 to 10 m.p.h. are common in switching service. To enforce a speed limit as low as 3 m.p.h. would require an army of supervisors and even the supervisors would wink at this low speed limit if it were a question of speed limit or time limit to make up a train. A practical limit, one which could be adhered to and enforced, would need to be around 6 m.p.h. This speed is greater than the capacity of any commercial gear. Therefore, it is necessary to protect the draft gear from solid impacts and to design the car to withstand these. It should not be difficult to design the car to meet such service, for in the draft gear tests two 70-ton cars, equipped with dummy couplers and with solid steel blocks instead of draft gears, seemed to have withstood impact at 8 m.p.h. without excessive damage.

The coupler horn was devised originally to protect the draft gear and attachments by delivering the solid impact to the striking plate, buffer block and end sill and so to the ends of the center sills. The transition from wood to steel construction brought about the application of the draft gear

* *Railway Mechanical Engineer*, October, 1922, page 633.

attachments directly to the center sills. With the advent of the friction draft gear came the idea that the coupler horn was no longer needed and so its function and design were neglected. It was considered that the solid impact should be taken by the coupler shank and draft gear and delivered by the rear follower to the rear lugs and so to the center sills. Indeed, this opinion is still held by many to be correct; the statement is often made that the coupler horn never meets the striking plate because ¼ in. clearance is provided between them. Such a statement is not true to fact.

It is true that on new cars it is customary to apply the draft gear attachments so that there is an initial clearance between coupler horn and striking plate, but this clearance is not maintained long after the cars are in service. A little

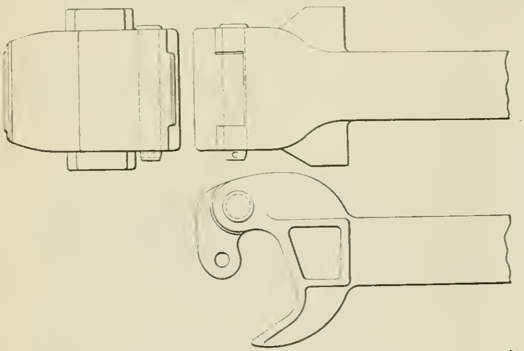


Fig. 1—Coupler with Horn at Top and Bottom

observation in any railroad yard will verify this. Almost every car will show evidence that the horn and plate have been in contact. The writer knows of a repair order of 2,000 cars, 80 per cent of which had broken striking plates. Mr. Pilcher stated that he had measured 16 couplers taken at random and had found that the shanks had been upset from ¼ in. to 1 in. Add this upsetting or shortening to the deformation of draft gears, followers, draft lugs and rivets and it is obvious that the clearance between horn and plate cannot exist very long. Moreover, by referring to the "Report of Draft Gear Tests," we find that in the drop tests the gears

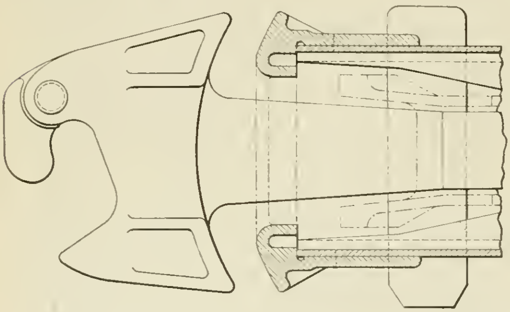


Fig. 2—Coupler with Curved Horn at Each Side of the Head

began to show signs of failure when the 9,000 lb. tup fell just a few inches more than the height which closed the gears (see Fig. 38 of "Report of Draft Gear Tests")—a positive proof that the draft gear is incapable of taking the solid impact.

From the above evidence it is obvious that the draft gear and coupler shank must be protected so that they cannot be subjected to solid impact and the only logical protection is a properly designed coupler horn. The present horn is improperly designed for use on modern steel cars.

In recent years, importance has been laid upon the area and stress ratio of the center sills. This stress ratio is based on the area and section modulus of the sill and the distance from the center line of the coupler to the neutral axis of the sill section. No account is taken of the distance from the neutral axis to the center line of impact between horn and striking plate and so the present stress ratio requirement is without basis or logic while the coupler horn is in its present location. The present horn causes the force due to solid impact to act along a line about 4½ in. above the center line of the force acting on the resilient draft gear. The stress ratio should therefore be based on the resultant of these forces, but a sill properly designed to meet such a requirement would need be of unusually large section.

Therefore, the only logical remedy is the re-location of the coupler horn so that its impact shall take place on the line of action of the draft gear force. If this should be done the present stress ratio and its method of calculation would then be correct.

The proper location of the coupler horn could be accomplished in a number of ways: (a) by providing a coupler carrier iron cast integral with the striking plate and adding another horn at the bottom of the present head as shown in Fig. 1; (b) by placing a curved horn at each side of the head as shown in Fig. 2, or (c) by making the horn in the

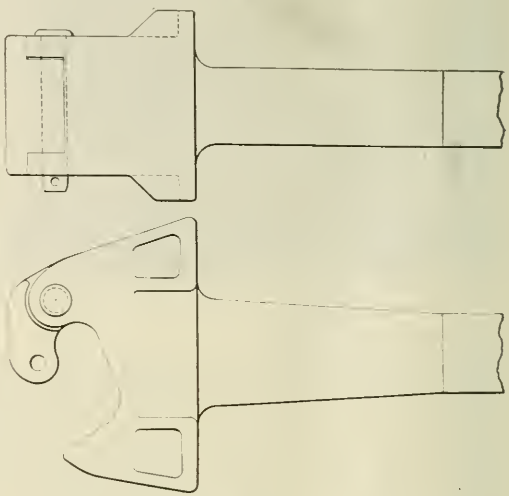
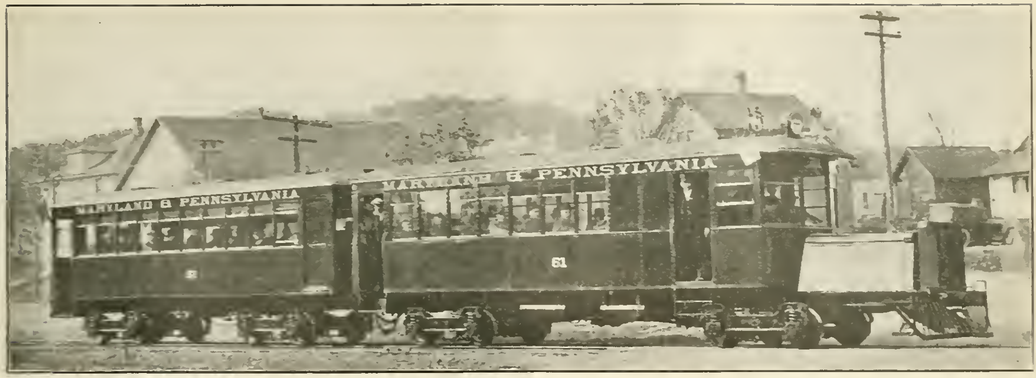


Fig. 3—Coupler with Shoulder All Around the Head

shape of a shoulder all around the shank as in Fig. 3. The latter arrangement, however, would not be efficient for impacts on curved tracks.

The material needed for forming such coupler horns would not be great because they are merely slight extensions to the wing webs which reinforce the present heads. Furthermore, this material could be taken from the shank which would be relieved from all solid impacts and so could be made lighter without decreasing the life of the coupler.

Such a change in coupler design would present less difficulty than was caused by the change from the 5 in. by 7 in. to the 6 in. by 8 in. coupler because the striking plate could be designed to suit the old type of horn as well as the new.



Motor and Trailer Car Driven by 120 h.p. Gasoline Motor

Motor Driven Rail Car with High Power Unit

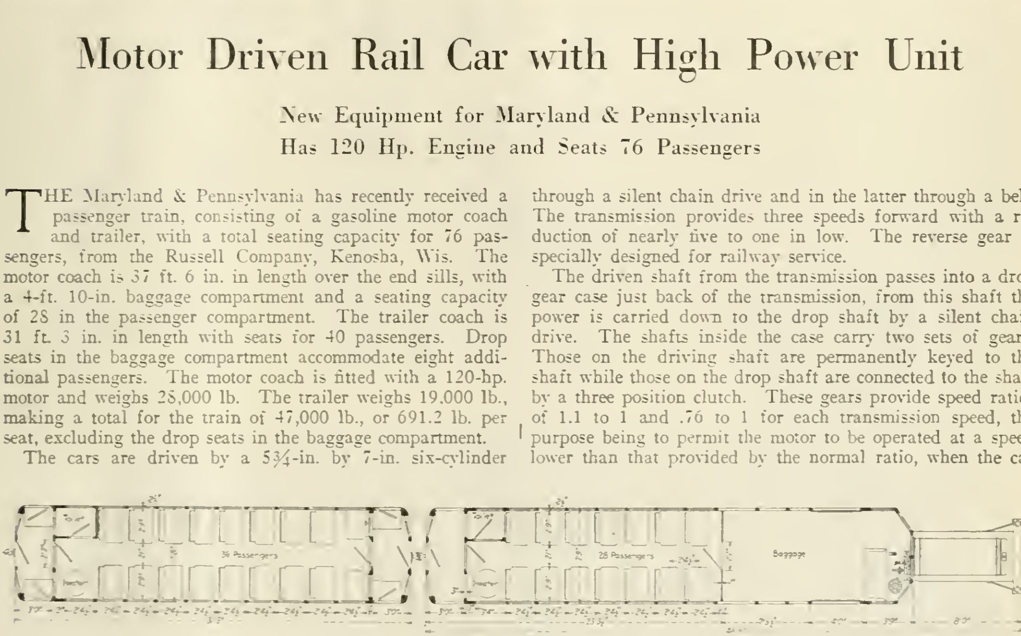
New Equipment for Maryland & Pennsylvania Has 120 Hp. Engine and Seats 76 Passengers

THE Maryland & Pennsylvania has recently received a passenger train, consisting of a gasoline motor coach and trailer, with a total seating capacity for 76 passengers, from the Russell Company, Kenosha, Wis. The motor coach is 37 ft. 6 in. in length over the end sills, with a 4-ft. 10-in. baggage compartment and a seating capacity of 28 in the passenger compartment. The trailer coach is 31 ft. 3 in. in length with seats for 40 passengers. Drop seats in the baggage compartment accommodate eight additional passengers. The motor coach is fitted with a 120-hp. motor and weighs 28,000 lb. The trailer weighs 19,000 lb., making a total for the train of 47,000 lb., or 691.2 lb. per seat, excluding the drop seats in the baggage compartment.

The cars are driven by a 5¾-in. by 7-in. six-cylinder

through a silent chain drive and in the latter through a belt. The transmission provides three speeds forward with a reduction of nearly five to one in low. The reverse gear is specially designed for railway service.

The driven shaft from the transmission passes into a drop gear case just back of the transmission, from this shaft the power is carried down to the drop shaft by a silent chain drive. The shafts inside the case carry two sets of gears. Those on the driving shaft are permanently keyed to the shaft while those on the drop shaft are connected to the shaft by a three position clutch. These gears provide speed ratios of 1.1 to 1 and .76 to 1 for each transmission speed, the purpose being to permit the motor to be operated at a speed lower than that provided by the normal ratio, when the car



Maximum Size Floor Plan of the Russell Motor and Trailer Cars

Wisconsin gasoline motor, which weighs 1,275 lb. and develops approximately 120 hp. at 1,200 r. p. m. This motor, handling the motor car and trailer, averages 3.8 miles per gallon of gasoline. It is mounted on the underframe in front of the forward truck center and is equipped with an Eismann dual magneto ignition system, Stromberg carburetor and Leece-Neville generator and starting units. A separate 32-volt generator, with a 16-cell storage battery of 70 hours' capacity, furnishes power for the headlight and train lighting. Fuel is carried in two supply tanks with a total capacity of 52 gallons and is fed to the carburetor by the vacuum system, supplemented by air pressure.

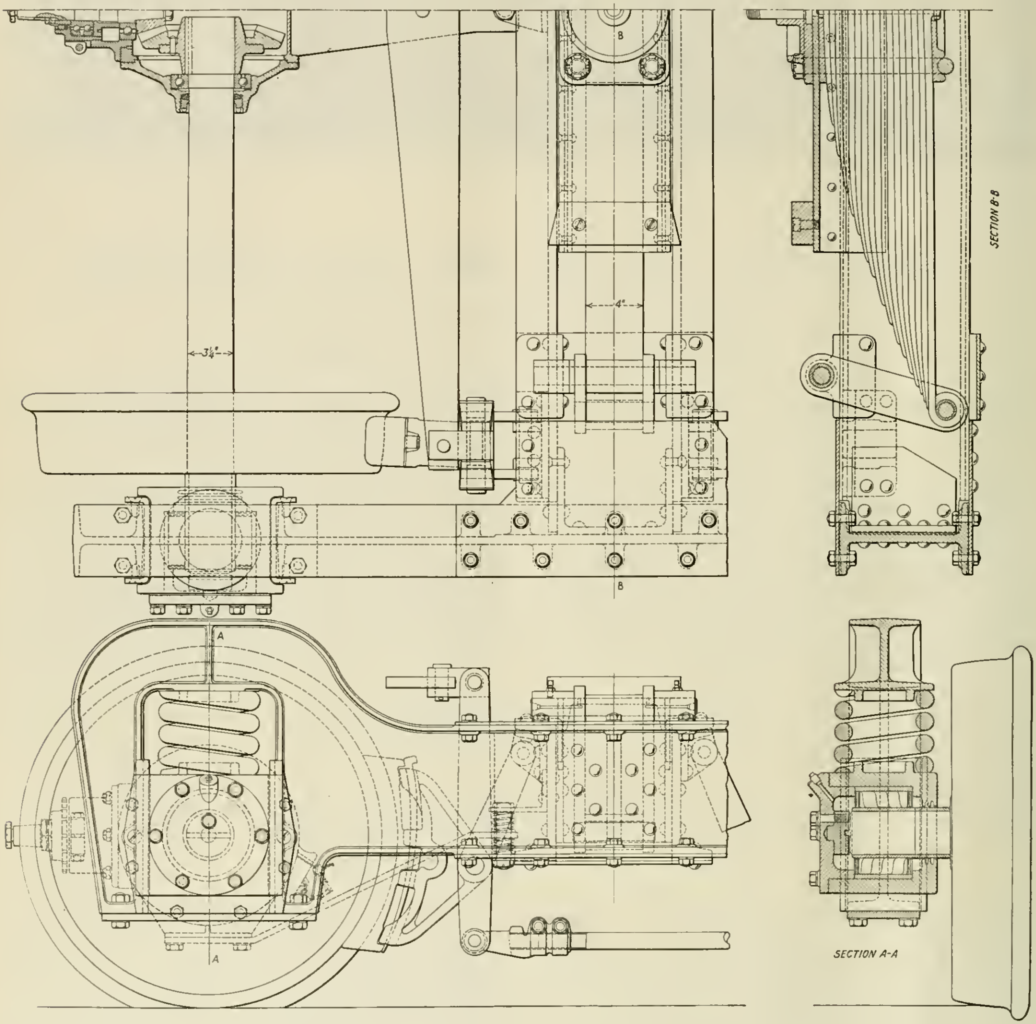
The underframe consists of two 9-in. 25-lb. steel channels spaced 33 in. apart over the outside faces. The drive shaft is carried back through universal joints to the clutch and transmission, which are located under the middle of the underframe. Power for the air compressor and electric light generator are taken off this shaft, in the former case

is traveling at high speed under conditions which do not require heavy duty from the motor.

The drop shaft extends through the case in both directions and from it flexible drive shafts are carried forward and backward to a gear case on the inside axle of each truck. This gear case contains a bevel pinion, supported on ball bearings, which meshes with a bevel gear attached to the axle. The gear case is carried on the axle itself, but attached to it is a torsion arm which is spring supported on a bracket attached to the truck crossframe.

The trucks have a wheelbase of 4 ft. 8 in. They are built up of cast steel pedestal frames of 9-in. I section, connected by structural steel cross members of channel section, and weigh 3,750 lb. each. The side and cross members are joined by top and bottom gusset plates which are riveted to the channels and bolted to finished surfaces on the top and bottom of the sideframe castings. Davis cast steel wheels 24 in. in diameter are mounted on 3¼-in. solid steel axles. The outside journals are 3 in. in diameter and are fitted with ¼-in. steel sleeves and Hyatt roller bearings. The bearings are designed to carry a vehicle with a maximum weight of 40,000 lb. and run in oil. They are mounted in removable cages and are carried in a cast steel journal box on which the truck frames are supported through single coil springs. The truck bolster is made up of a 4-in. semi-elliptic spring the ends of which are supported by swing links from the truck cross frame. To the top of this spring a short channel for the above the rail. The bodies are of wood frame construction with steel sheathing. The trailer of the Maryland & Pennsylvania train is fitted with a blind vestibule at the front end, in which the heater is located; the steps at the rear end of the motor car serve the front end of this car. The regular arrangement of the builder, however, provides for vestibule entrances at both ends of the trailer car and at the rear end of the motor car. The vestibules are fitted with trap doors.

Each car is fitted with a toilet and the trailer car carries

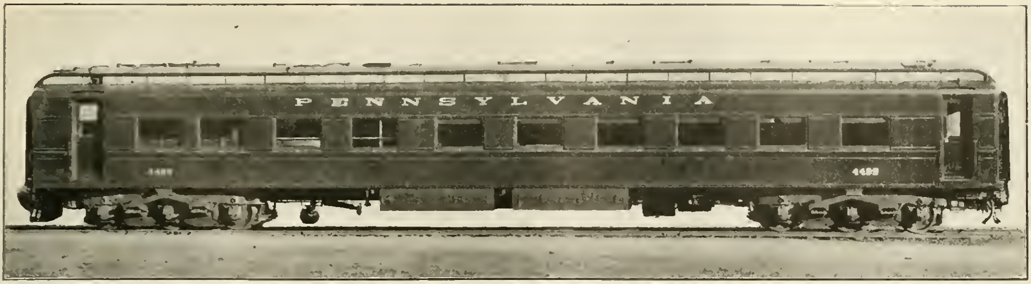


Motor Car Truck Developed by the Russell Company

support of the center and side bearings is attached by two U-bolts which also serve as the spring band.

Except for the shorter baggage compartment and the location of the toilet and heater in the trailer car, the floor plans of the Maryland & Pennsylvania coaches are similar to those shown in the drawings, which are the arrangements of the builder's full size car bodies. The bodies of the Maryland & Pennsylvania cars are built separate from the underframes, to which they are securely bolted. The overall height is 11 ft. 4 in. above the rail and the floor is approximately 42 in. a small Arco Ideal hot water heater. The motor car is heated by the motor exhaust, a portion of which may be diverted through metal ducts carried along the sides of the car just above the floor.

The cars are fitted with Westinghouse self-equalizing automatic brakes. The brake heads and shoes are of the M. C. B. type and the couplers are Van Dorn vertical plane type, one-half M. C. B. size. The motor car is fitted with a pilot, an electric headlight, a bell, air operated whistle, and marker brackets.



Latest Type of Dining Car for the Pennsylvania

Pennsylvania System Dining Cars Built at Altoona

Attractive Interior Finish, Kitchen Equipment, and Cast-Steel Truck Side Frames Features of Design

TWENTY new steel dining cars for the Pennsylvania System have just been completed in the car shops at the company's Altoona works.

Structurally, these cars are the same as others now in service, having a center sill built up of two 18-in. channels with ½-in. by 24-in. top and bottom cover plates and four cantilevers, two attached to each side of the center sills, spaced 18 ft. 9 in. from the transverse center line of the car, supporting the superstructure. No bolsters are used.

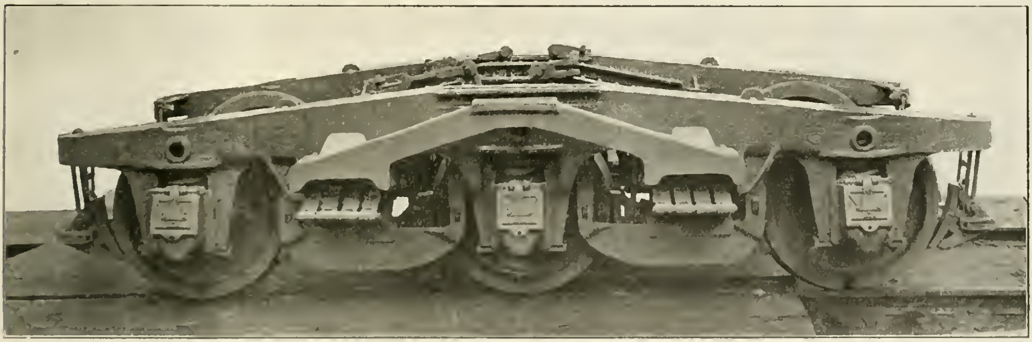
The side truss below the window sills consists of a bottom angle 9/16 in. by 3½ in. by 5 in., a belt rail of special section having an area of about 4 sq. in. and web plates ⅛ in. thick. The posts, of the cantilever type, are made of ⅛-in. pressed steel and extend from the bottom side angle to the deck plate, the lower deck roof, 1/16 in. thick, being riveted directly to the posts. The deck plate is ⅛ in. thick and the upper deck roof sheets are 3/32 in. thick. The roof sheet joints are welded.

Vestibules have been omitted since passengers enter the dining cars only from adjoining cars. End protection against collapse is of the same strong construction used in all Pennsylvania System steel passenger equipment cars, which for non-vestibule cars consists of one 12-in. I-beam on each side of the doorway and two Z-bars, one 4 in. by 8.2 lb. and one 3 in. by 6.7 lb., at each corner, with pressed steel diagonals between corner and door posts. Standard diaphragms are attached to the I-beams.

The general dimensions are as follows:

Length over buffers	82 ft. 3⅜ in.
Distance between centers of trucks	56 ft. 3 in.
Distance between centers of crossbearers	37 ft. 6 in.
Width over sides	9 ft. 10⅛ in.
Width over roof	9 ft. 11½ in.
Width over upper deck	7 ft. 7 in.
Height from rail to center line of coupler	34½ in.
Height from rail to top of paltform	50 in.
Height from rail to car floor	52 in.
Height from rail to eaves, lower deck	11 ft. 2⅝ in.
Height from rail to eaves, upper deck	13 ft. 3½ in.
Height from rail to top of roof	14 ft. ½ in.
Seating capacity	36 persons
Weight when fully equipped with ice, coal, water and supplies	160,000 lb.

Some of the fundamental features of the design are: area of center sill 50 sq. in.; ratio of ratio unit stress to end load 0.024; draft gear travel 2¾ in.; maximum coupler side motion travel, total, 18 in.; thickness of draft follower plate 2¼ in., section modulus all vertical end members 100, and for those either forming or adjacent to door posts 76.



Cast Steel Side Frames Reduce the Weight of the Truck and Decrease the Number of Parts

The air brake is the Westinghouse type UC-1812, without the electro-pneumatic attachments, although this feature can be readily applied, as the wiring has been installed. The cars are heated with vapor, having a thermostatic control and may also be operated manually, the thermostat being located at the center of the car between windows.

The lighting effect in these cars is very satisfactory, semi-indirect lights being used, one over each pair of tables. Each fixture contains a 100-watt lamp, which makes a very efficient light. Between each pair of lamps is an electric fan with an air deflector or distributor, which produce a movement of air at intervals of about 20 times per minute. This feature of intermittent breeze eliminates the steady gust of air common to many types of electric fans.

The draft gear is the Westinghouse type N-11 with attachments for cheek castings at least 25 per cent stronger than the A.R.A. requirements for freight cars. The cheek castings are riveted directly to the webs of the center sill channels and the tail yoke is cast steel with quadruple shear attachment to the stem, which has the latest A.R.A. type D head.

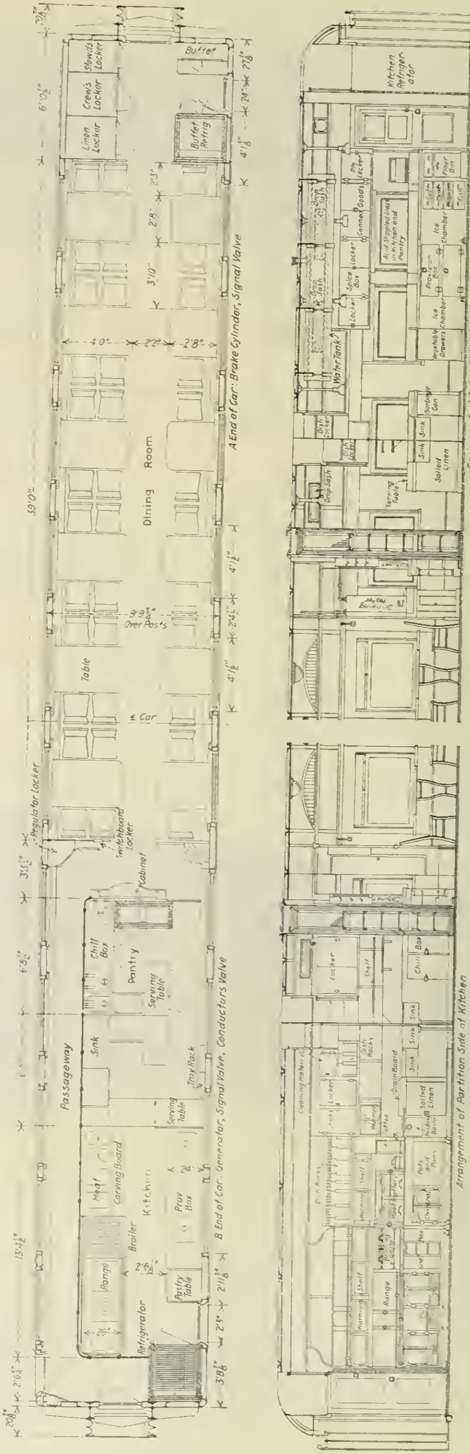
The trucks are of the six-wheel clasp brake type and have a wheel base of 11 ft. 0 in. The axles are of the special Pennsylvania System type with 5½-in. by 11-in. journals, and the wheels are rolled steel, 36 in. in diameter. The general scheme of the trucks is the same as used on all former Pennsylvania System cars, the bolster being of riveted plate construction, which has been exceedingly satisfactory

The Interior Is Finished in Olive Green

on previous cars. It was designed to flex readily in a horizontal plane, but is rigid against transverse and longitudinal strains.

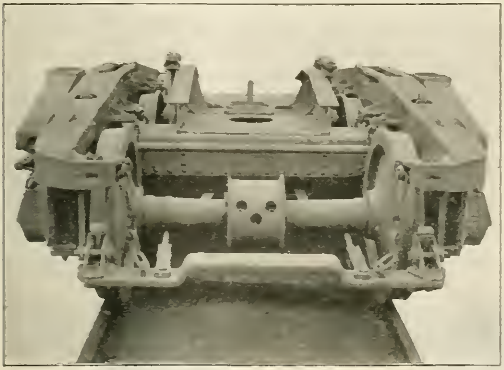
The truck bolster is supported on sets of quadruple elliptic springs, one set under each end of each spring beam. The equalizers supporting the elliptic springs have one end hung from the truck frame, the other being attached to an inverted U-shaped equalizer and hanger combined, which rests on the helical spring located over the center journal box. These trucks have exactly the same characteristics as the two axle passenger trucks, but with increased wheel base and a third or floating axle placed between the other two. The helical springs are supported directly on the journal boxes, which in turn are guided as usual in pedestals. It will be noted that this arrangement results in having the least possible non-spring-supported weight and, therefore, the least possible kinetic effect on rails. The features which differ from the old trucks are the journal boxes and side frames.

The journal boxes are of cast iron of a special mixture sometimes called semi-steel and also cylinder iron. The faces which bear against the pedestal legs are chilled and



Plan of Pennsylvania Diner and Elevation, Showing Kitchen Arrangement the pedestals have renewable [illegible]-in. plate steel wearing shoes riveted thereto.

The older trucks had side frames built up of channels, cast steel pedestals, spacing pieces, cross braces, etc. In the new truck all of these parts are combined into two cast steel frames, one on each side, connected flexibly by only two 2-in. transverse rods located respectively between the center and each end axle. Each frame can, therefore, readily adjust itself, independent of the other frame, to meet track irregularities. Also, since the bolster is flexible in a horizontal plane, it in turn can adjust itself to the various positions taken by the side frames and, being rigid longitudinally, holds the side frames in correct transverse alinement. The cast-steel side frames were designed to be interchangeable with the old built-up side frames so that when repairs are necessary to old trucks the cast-steel frames, which weigh less than the built-up frames, can be substituted. The total weight of each truck is 23,000 lb.



End View of the Truck

The interior of these dining cars is arranged so that there is a large dining room, seating 36 persons. They are finished in plain mission style of architecture, the walls being painted a medium shade of olive green with striping of a darker shade of green edged with gold. The ceiling is cream color striped with dark green. The carpet and curtains are of a green shade. The color of the side walls is very unique and has been the subject of many complimentary remarks from passengers.

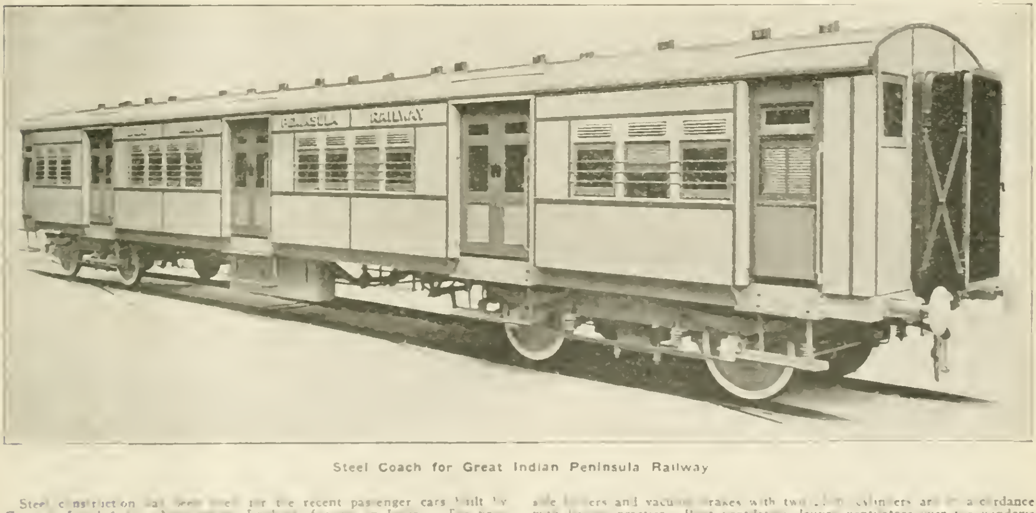
At one end of the dining room are located the linen lockers, crew's lockers and steward's lockers, while on the opposite side of the passageway there is a large refrigerator used by the steward for mineral waters, etc. A humidor is built into the refrigerator, but is made so that moisture from the refrigerator cannot enter the humidor. There is also at this end of the car a buffet for the use of the steward.

At the other end of the dining room the pantry and kitchen are located. These are arranged especially for quick service, the kitchen and pantry being in one without a partition between them as is usually the case, which permits the waiters to enter the kitchen and allows more freedom for the men.

The kitchen and pantry have a number of special features, such as a water filter for filtering all water used on the tables, separate coolers for milk, cheese, butter, meats and fish.

The refrigerators are of special design, being constructed as two separate steel boxes as nearly air tight as possible, one inside the other, with three layers of 1-in. cork board and two layers of paper between. The only connection between the outside and inside walls of the refrigerator is the aluminum door frame and this is separated from the steel plates by fibre insulation. The chill boxes in the pantry and kitchen are similarly constructed.

The table tops, sinks and splash boards are of monel metal, which, being rust proof, gives very satisfactory service for such parts.



Steel Coach for Great Indian Peninsula Railway

Steel construction [illegible] for the recent passenger cars built by Cammell, Laird & Co. [illegible], England, for [illegible] India. The [illegible] class vestibuled [illegible] shown [illegible] 67 ft. 10½ in. long over end sills, [illegible] ft. wide and of 5 ft. 6 in. gage. The trucks, spaced [illegible] 48 ft. centers, are of the swing bolster type [illegible] springs under the bolster and semi-elliptic springs over the journal boxes. The wheels are of 43 in. diameter, the journals 4[illegible] in. [illegible] 9 in. and the truck wheel base 10 ft. Screw couplers, side [illegible] and vacuum brakes with two [illegible] cylinders are in accordance with [illegible] practice. Roof ventilators, louvre ventilators over the windows and [illegible] insulation are provided on account of the tropical climate. The interior wood finish, the transverse seats, the electric lights and other fixtures were applied in India, the cars being dismantled and shipped in sections. Seats are of the longitudinal type. Side doors and vestibules provide for quick loading and inter-communication.

Car Inspectors and Foremen Hold Live Convention

Large Attendance for Discussion of New Rules of Interchange to Effect Common Understanding

A LARGE attendance of interchange inspectors, car foremen, and M. C. B. bill clerks marked the twenty-first annual convention of the Chief Interchange Car Inspectors' and Car Foremen's Association of America, which was held at the Hotel Sherman on November 9 and 10. In addition to the discussion of the changes in the interchange rules, which become effective January 1, 1923, the program included papers on the maintenance of tank cars, by S. F. Beasley, master car builder, Sinclair Refining Company; apprentices in the car department, by H. L. Shipman, engineer of tests, Atchison, Topeka & Santa Fe; the broad question of lubrication, by W. J. O'Connor, New York Central, and the loading of certain steel products, by W. R. Rogers, Youngstown, Ohio. The convention also listened to addresses by Joe Marshall, representing the freight claim division of the American Railway Association, and Charles M. Dillon, representing the Association of Railway Executives, and a talk on scheduling of equipment through repair shops, by E. H. Hall, Pere Marquette. As the new rules of interchange become effective on January 1, 1923, the discussion of the charges is included complete in this issue. The papers and addresses will appear in succeeding issues.


E. Pendleton
President


A. Armstrong
1st Vice President


W. T. Westall
2nd Vice President

Discussion of Changes in Interchange Rules

President Pendleton: It is the purpose to arrive at the uniform interpretation of the changes submitted by the Arbitration Committee, and not at this time to make any recommendation. The rules are not effective until January 1. No doubt the Executive Committee will meet the latter part of February or March, at which time any recommendations desired will be made for changes in the rules next year.

Rule 2

In order to eliminate conflict between Car Service Rules and Interchange Rule 2, it is recommended that the second paragraph and sections (i) and (j) of this rule be modified to read as follows:

PROPOSED FORM—Second Paragraph. Empty cars offered in interchange must be accepted if in safe condition and serviceable for some commodity that can be loaded in the car, the receiving road to be the judge.

Owners must receive their own cars, when offered home for repairs, at any point on their line, subject to the provisions of these rules.

Empty cars furnished on orders for specific lading must be in serviceable condition for such lading, the receiving road to be the judge.

Section (i)—A bad order foreign car delivered under load, if load is transferred or unloaded within switching district, may be returned to delivering line properly side-carded on both sides with a bad order transfer, or return when empty card, showing the defects for which the car was transferred or returned, in which case it must be accepted, unless the receiving line has a direct physical connection with the car owner at that point or where delivery can be made to the car owner at that point through an intermediate switching line, car ferry or float.

Section (j)—Eliminated.

T. J. O'Donnell (Buffalo, N. Y.): Is the switching district (section i) to be designated definitely by our Association? Supposing the car goes 25 miles outside the terminal, I would say that car ought to be taken back.

President Pendleton: It would make no difference what the distance was, as long as it was confined to the switching district. In many terminals we have switching districts that extend beyond 25 miles.

T. J. O'Donnell: If a car went seven miles beyond the switching district, would you compel the receiving line, that had to handle that car or unload it, to handle the car 500 miles to get rid of it, rather than return it to the road that gave the receiving line the load?

President Pendleton: I would say not.

T. S. Cheadle (Richmond, Va.): The old second paragraph specifies, "A foreign bad order car previously delivered under load must be received back by the delivering line, providing it has the same defects which existed when it was delivered under load, and is moving empty on its home route. Owners must receive their own cars, when offered home for repairs, at any point on their lines, subject to the provisions of these rules." I believe under the new ruling the car can be sent back for defects arising after the car has been delivered.

G. P. Zachritz (M., St. P. & S. S. M.): If we are not to deliver the cars back, in many cases how are we going to get rid of them? Suppose we may take a car outside of the Chicago switching district, unload it and save the delivering line the cost of transfer. According to this rule, unless it is inside the switching district, the delivering line does not have to take it back from us. Suppose the car belongs in the south, and we cannot make a direct connection. If we do not have a direct connection, either at Chicago or some other point, we must deliver that car back to Chicago to get rid of it. A strict interpretation of this rule would place us many times in the position of having to make a very heavy repair and we might have to haul the car 300 or 400 miles to put it in a shop where we could handle it.

A fair agreement would be that when a car comes back to the place where it was received the line that originally delivered it should accept it back, no matter what the defects are, so long as it is properly defect carded for any defects which we may have added to the car.

President Pendleton: We are not going to hang upon a strict interpretation of the rule. It is reciprocal and we are not going to have trouble.

The words "some commodity" in paragraph 2 will mean a great deal.

Mr. Zachritz: I think that means if the car can handle any commodity, it should be accepted.

Rule 3

The Committee recommends that a new paragraph be added to Section (b) as follows:

After January 1, 1924, cars equipped with couplers having riveted yoke without lugs will not be accepted in interchange.

REASON—The use of coupler yokes with pull depending entirely on the rivets should be prohibited.

A. Armstrong (Atlanta, Ga.): I move that the changes of the rules which are merely extensions of time, be not considered.

The motion was seconded and carried.

The Committee recommends that Section (f) be modified to read in accordance with proposed form shown below, the effective date being extended to January 1, 1923:

PROPOSED FORM—After January 1, 1923, *no refrigerator car* equipped with brine tanks will be accepted in interchange, unless provided with suitable device for retaining the brine between icing stations.

F. W. Trapnell (Kansas City, Mo.): I am of the opinion that we will have to have another extension on that.

Mr. Cheadle: You would not call January 1, 1923, an extension. How can a change be effected by that time? How are we going to tell when a car is equipped with brine tanks? I asked that question in 1907, and nobody has answered me yet.

President Pendleton: Isn't it a fact that some of the refrigerators that are equipped with brine tanks are so stenciled?

Mr. Cheadle: Some cars are equipped but not stenciled "equipped with brine tank." Some inspectors will say such a car has a brine tank and others will say it has not.

Mr. Zachritz: Isn't it a fact that you can tell the brine tank cars by the valves in the icebox?

T. J. O'Donnell: There are a large number of refrigerators that the owners tell us they are not going to equip with brine containers; there are a lot that do not need them; we have a lot of them stenciled.

Mr. Cheadle: There are cars that are not intended to be used for brine that are used for brine. It seems to me that the rules should say that brine cars not equipped with brine tanks should not be accepted.

Mr. Trapnell: I do not think we would be justified in refusing a load because it is not equipped with a brine tank. If we should spoil a car of fresh meat, we would hear from it. There should be an extension on that, because we have lots of cars that are not so equipped, that are used for fresh meat service.

The Committee recommends that the effective date of Section (g) be extended to January 1, 1923, and the section modified in accordance with proposed form shown below:

PROPOSED FORM—(g) After January 1, 1923, cars will not be accepted *from owners* unless stenciled, showing month and year built, or bearing a badge plate giving this information. Cars built prior to 1895 may be stenciled "Built prior to 1895," or bear a badge plate giving this information.

Mr. Zachritz: There is a very good idea in that change. You will note the car will not be received after January 1, 1923, from the owner. The committee should go further in all these exceptions, and, instead of using the term "not accepted in interchange," they should say, "not accepted from the owner." Then the originating line, that accepts that car from the owner is not penalized for having accepted it.

There are lots of instances in perishable freight service where we must violate these rules in order to get the freight going. If it is safe for the first line to handle, it is safe for the last line to handle.

B. F. Jamison (Southern): Does this paragraph mean that we would reject from the owner a loaded as well as an empty car that was not stenciled date built? Many cars are running today that have no date when built new stenciled on them. It would be impossible to stencil all those cars before January 1, 1923.

T. J. O'Donnell: The rule means a car, whether loaded or empty, but a man would not absolutely refuse it. Two years ago we held up about 700 cars and were told to let them go very quickly, when the rule became effective. Nobody would hold up a loaded car, but you should wire the owner.

Mr. Cheadle: Interpretation No. 6 under this rule says: "Cars, whether loaded or empty, must not be offered in interchange if not equipped with an efficient hand brake, per section (a); and United States Safety Appliances or United States Safety Appliances Standard, per section (k), in good order. Tank cars, whether loaded or empty, must comply with the requirements of sections (e) and (p). None of the other objections referred to would permit rejection of lading."

Mr. Zachritz: Our understanding is that we cannot refuse the lading, but we can ask for transfer orders for these conditions, which it says will not be accepted in interchange. We have to use our judgment; we have to violate the rules. All through the rules we have these exceptions which say, "will not be accepted in interchange." A great many cars are being refused and transfer orders asked for merely on these exceptions, and the railroad company should be relieved of this charge.

C. J. Wymer (C. & E. I.): The only loaded cars you can refuse are the ones mentioned in Rule 2. Neither do I believe that you can get a transfer order on a car that is not stenciled. You can find nothing in Car Service Rule 14 that would permit a transfer, because no one would say a car is defective because the date is not stenciled.

Mr. Straub: I do not think we should have any further discussion on (g) or (h); it says "from owners," and any head of a car department who is wide-awake will at once notify his inspectors at interchange points to telegraph at once to headquarters. In a few hours they will get the information they want, and the car will go on without any trouble.

Mr. Overton (Southern): Suppose the owner of a car not stenciled with the date built is on the Atlantic seaboard and the car is on the Pacific coast, the car goes to interchange and it is not stenciled the date built; what are you going to do with that car?

Mr. Straub: Interchange it until it gets back to the owner.

Mr. Jamison: I believe I am in order to ask for an interpretation on this rule, because I know it is going to be misunderstood. Section (h) following is also worded just exactly the same, that cars will not be accepted from owners. I move that under Rule 3, sections (g) and (h) apply only to empty cars offered in interchange by the owner.

G. Lynch (Cleveland, Ohio): I think the better way would be to ask for an extension of time. The time is too short to have these proposals complied with. Stenciling the date and year built is an unwise proposal for the reason that it is impossible to maintain, distinctly, the stencil on most equipment for any length of time, especially on steel equipment that may be a mill trade. It is very often scaled off from heat, and it will be an impossibility to maintain the date distinctly. I do not see the benefit derived from that information on the car to the foreign lines.

Mr. Hays (N. Y. C.): My belief is that the object of the time limit is to bring pressure to bear on the railroads to meet the requirements the Arbitration Committee thinks necessary. When they issue a ruling, they place a certain date. The time limit is extended from year to year until the time has arrived when the date should be closed up. Evidently the Arbitration Committee believes the railroads have had ample time to carry out these requirements.

Now, a motion was made that cars should be accepted from the owner under load, but not empty. It is my understanding that ordinarily the owners' cars are moving home empty, and then he should take action to carry out these requirements before they are loaded and again sent off the line. In the event a car is received by the owner that his inspector does not catch and properly stencil and is reloaded and moving off his line, it is up to the receiving line to use good judgment as to whether it wants to reject the car or accept it. That policy can be arrived at between the two lines, and the rule will work no hardship.

The motion was lost.

T. J. O'Donnell: Did I understand Mr. Hays to say that would apply to loaded cars as well as empty?

Mr. Hays: My opinion is that this is something that should be mutually arranged between the receiving line and car owner. If they elect to accept the car it would be all right; if the receiving line did wish to reject a car, he would have that privilege, but he could not reject the load. He would have to accept the load and transfer at the expense of the car owner. The car owner then understands he is penalized for not living up to the requirements of this rule, which has been in effect for some time.

S. Skidmore (Big Four): I do not think we should encourage any transferring of cars, under such circumstances. We have had the claim department man here this morning telling us we should avoid, as much as possible, the transferring of cars. We are anticipating trouble that will not arise, except in a few cases. It is up to the lines to give all connection points these instructions. The stencils should be put on, it is only a few minutes' work, and to continue deferring this from year to year, you will never get them stenciled. I think that is the reason they have set the time limit at January 1.

Mr. Overton: For many years we have been trying to get all the equipment stenciled when built new, and we have arrived at a time when the thing should be closed out and stop those cars from rolling. If you are going to let cars leave the owner's lines they will keep on going. It may be a year or two before they get back, and we never will get our cars stenciled when built new.

Rule 4

The Committee recommends that the second paragraph of this rule be modified in accordance with proposed form shown below:

PROPOSED FORM—(second paragraph). Defect cards shall not be required for any slight damage (new or old) that of itself does not require repairs before reloading of car. Defect card shall not be required for raked or cornered sheathing, roof boards, fascia, bent or cornered end sills, if defects are old.

REASON—It is felt that the rewording of this rule will bring about the desired improvement in avoiding the issuance of unnecessary defect cards.

Mr. Hays: If it is not permissible to obtain a defect card for those items, suppose the car should arrive on the repair track for repairs to wheels, and the car foreman elects to repair them at the same time, what is the general understanding of the bill clerks? Would they accept a bill from the repairing line for the repairs to sheathing, roofing or end sill, when the billing repair card shows clearly that it was rather old?

W. M. Pyle (Southern Pacific): I would not be in favor of accepting a bill for such a repair. This would let down the gates for sharp practice. If the car is in such a condition that it is safe and serviceable to handle in interchange with this defect and it does not impair the loading of the car, then why not let the defect remain until the car reaches the owner and let him make the repairs? Then we do not open up the way for discussion.

Mr. Straub: A car can be raked and still remain in service a long time. It might get a commodity that is not damaged by the weather. For weeks or months the car owner might receive the revenue out of that car and he should bear the expense of any repairs made to a car that is raked, the billing repair card for which shows an old defect.

I, therefore, move that this Association go on record to that effect, that this should be a car owner's defect, so there would be no misunderstanding, in connection with the billing.

The motion was seconded.

E. H. Mattingley (B. & O.): Why should it be necessary to make a motion of this kind, when the rule says if it is so slight as not to require repairs it is not cardable; that in itself makes it an owner's defect.

T. J. O'Donnell: I do not think you can charge it to the owner. It is either a cardable repair or nothing.

Mr. Hays: When a car is placed on the repair track for some other defect, it would not be a good idea to let that car go with a few boards raked, simply because the road cannot collect for it. If we interpret the rule like that the foreman will probably let it go, and it will only be good for rough freight; after a while, you will have nothing but rough freight cars running. The object should be for all roads to put cars in good condition where they only require a few sheathing boards that are raked old.

A. Herbster (N. Y. C.): Interpretation No. 7, on page 65 of the 1921 code, reads: "If car is cornered, derailed, or sideswiped, and damage is not caused by any of the five conditions named in Section (d), is it handling company's responsibility?" And the answer is, "Yes." In the new rules Interpretation No. 7 is eliminated.

T. J. O'Donnell: Let us analyze this rule. The first part says: "Defect cards shall not be required for any slight damage (new or old) that of itself does not require repairs before reloading of car." That is definite. We would not card for it if it did not endanger loading of the car. If the first damage, when new, did not require repairs, why would the same identical damage, when old, require repairs?

Mr. Hays: I had in mind a car with raked sheathing boards that was shopped because it had an end sill or broken side sill broken in fair usage. Those sheathing boards had to come off; naturally, they would not let the old sheathing boards, all raked up, remain on. That is an exceptional case but it is the exception that causes the trouble.

Mr. Wymer: There are only two classes of defects: delivering line and owner's responsibility; there is no half way place, and when you take this defect out of the delivering line responsibility class it has no home unless you put it in the owner's responsibility class. It must have a home in one or the other.

President Pendleton: We do want to determine the proper interpretation of the rule. The motion is proper that it is the sense of this body that it is owner's responsibility.

The motion was carried.

Rule 9

The Committee recommends that the item showing information required on billing repair card under the heading "Air Brakes Cleaned," be modified in accordance with proposed form shown below:

PROPOSED FORM—R. & R. K-1 or K-2, convertible or non-convertible.

Name of road and date of last previous cleaning.

Work performed, per Rule 60.

The Committee recommends that a new item be added under heading of "General Information," to be shown on billing repair card as follows:

Size of bolts and nuts.

REASON—In order to make it possible to check the weight of such material.

The Committee recommends the following interpretation of this rule:

Q. Is it necessary to specify dimensions of forgings and springs on billing repair card in addition to weight?

A. No.

REASON—This interpretation seems necessary on account of certain railroads insisting that this information be furnished, although not specified in the Rules.

Mr. Hays: It is peculiar that the size of the bolts and nuts should be shown for the purpose of checking, when the interpretation says the size of the spring should not be shown. The ordinary bolt on a car weighs from two to four or five pounds; a 6-in. by 8-in. draft spring ordinarily weighs 35 lb. and an 8-in. by 8-in. draft spring 54 lb. If 54 lb. is charged on a billing repair card, unless the bill clerks are familiar with the type of equipment and type of draft gear, they must accept that charge without question. There is a difference of 19 lb. Possibly 6-in. by 8-in. is the standard and 8-in. by 8-in. was applied. There would be no means of checking that; and yet when it comes to a bolt, a size must be given so he can check.

Rule 12

The Committee recommends that the following be added as the second paragraph of Rule 12:

At points where it is impracticable for a railroad company to obtain joint evidence, the evidence of car owner shall be sufficient, provided it is furnished by a competent representative of the railroad company after actual inspection has been made by him.

REASON—The car owner should be afforded the means of establishing the existence of wrong repairs in the many instances when it is impracticable to secure joint evidence.

Mr. Jamison: What is the meaning of "impracticable" in the sense in which it is used here? Who is going to be considered a "competent representative"? At Memphis, Tenn., it is seven miles from our shop to the nearest car inspector, and it is not often we can induce him to come over and look at something. I would like to know whether it is the sense of this body that the rule would cover such situations as that.

Mr. Armstrong: Have you a car foreman at this point?

Mr. Jamison: We have.

Mr. Armstrong: He is your accredited representative.

President Pendleton: He has no other line.

Mr. Armstrong: He does not need any.

T. J. O'Donnell: Would it be impracticable to get the inspector where he is within seven miles of a car? I should think you would get the inspector.

Mr. Jamison: It is almost impossible. We have loaded cars on which we want joint evidence. It is one of the points where we get a lot of joint evidence.

Mr. O'Donnell: Your own inspector or foreman would be just as well on cars you do not want to hold up.

Mr. Jamison: Would you consider that an ordinary car inspector would be competent, where there were no car foremen?

President Pendleton: I would think so.

Rule 17

The Committee recommends that Section (e) of this rule be modified in accordance with proposed form shown below:

PROPOSED FORM—A. R. A. No. 2, or A. R. A. No. 2 plus brake beams may be used in repairs to all freight equipment cars equipped with non A. R. A., A. R. A., No. 1, A. R. A. No. 2 or A. R. A. No. 2 plus brake beams; charges and credits to be on basis of beams applied and removed. A. R. A No. 3 brake beam must be replaced in kind.

REASON—To permit the use of No. 2 or No. 2 plus brake beams as recommended by the committees on Brake Shoe and Brake Beam Equipment, Train Brake and Signal Equipment and Car Construction.

The Committee recommends that Interpretation No. 11 of Rule 17 be modified to read in accordance with the proposed form shown below:

PROPOSED FORM—Q. Owing to the great demand for equipment, it has become necessary in a number of cases to repair truck bolsters and pressed steel side frames by riveting patches, which makes a reasonably substantial job. Is it proper to bill car owner for this work?

A.—The patching of bolsters and truck side frames generally is not considered good practice. However, in the case of pressed or structural steel bolsters and pressed or structural steel side frames, patching of flat surfaces or tension side by riveting on plates, in a substantial manner, is permissible, and may be considered permanent repairs, provided this patching restores original strength of bolster or side frame.

In order to clarify the matter of exchanges of various types of triple valves, the Committee recommends the following interpretations to be added to this rule.

Q.—What types of triple valves are standard? What types convertible and what types non-convertible?

A.—The only A. R. A standard triple valves are the K-1 and K-2.. The only triple valves that are convertible to the "K" type are those having removable check valve case. Triple valves having check valves case cast integral with triple valve body and not removable are non-convertible to the "K" type.

Q.—Is it considered wrong repairs, to substitute one type of non-convertible triple valve for another non-convertible type?

A.—No. Provided car was built prior to January 1, 1919, and is stenciled, showing a non-convertible type valve as standard, or where car is not stenciled showing what type of valve is standard. Cars built after January 1, 1919, must have "K" type of triple valve applied.

Mr. Jamison: A question has arisen under that last clause, last question and answer. If I have a car built after January 1, 1919, carrying a non-convertible valve, will I be perpetuating improper repairs if I supply the same type of valves, the car not being stenciled?

Mr. Leonard: He would not be making wrong repairs.

Mr. Hays: In my opinion, wrong repairs would be made in such a case, because it says there very clearly, "Cars built after January 1, 1919, must have 'K' type of triple valve applied." If you find it necessary to give the triple valve attention where the car is not stenciled, then you would have to apply a "K" type valve, regardless of the type on the car, or you would be perpetuating wrong repairs.

Mr. Schroder (M. C.): Arbitration Case No. 1232 will cover the question. I think in this case you would be held responsible for wrong repairs.

Rule 58

The Committee recommends that the words "Cars offered in interchange with" in the first line of this rule be eliminated from the rule.

REASON—As these parts are frequently reclaimed for further use, they should be replaced at the expense of the handling line.

T. A. Eyman (E. J. & E.): If you lose an air hose or angle cock on your own line, you have the air hose and angle cock; but if you deliver the car, then the road that repairs it is out.

Mr. Zachritz: Mr. President, the way I interpret that rule, under Rule 58, cars offered in interchange with this material missing were carded—they were considered delivering line responsibility. Under the new rule, by removing the words "Cars offered in interchange with," it makes missing brake cylinders, reservoirs, angle cocks or air hose, each or all complete, delivering line responsibility, no matter where. If you lose any of these items and make the repair, you can charge that to profit and loss, the Committee says, because you would pick up that material and use it some other time. The handling line must assume responsibility.

Mr. Trapnell: If you deliver it with those things missing?

Mr. Zachritz: You would have to card it.

Mr. Cheadle: A member said there would be no necessity of a defect card. Some of these items do not constitute penalty defects. If the defect card is issued at a large number of points in the United States, where a line receiving the car is making repairs for the line delivering the car the bill clerk would possibly get those defect cards and will question them.

Mr. O'Donnell: What is the use of a defect card when you are doing the work jointly? Why don't you use the material? I should think you would arrange with the division officers to give you sufficient material to repair for both roads.

Mr. Cheadle: The management of the roads do not want to do that.

President Pendleton: As I understand the change in Rule 58, it makes the handling line responsible for replacing material lost on his line, and if he delivers it in interchange missing, it penalizes him for his failure to make repairs.

Rule 59

The Committee recommends that the words "Cars offered in interchange with" in the first line of this rule be eliminated from this rule.

REASON—As these items are frequently reclaimed for further use, they should be replaced at the expense of the handling line.

The Committee recommends the addition of a new paragraph to this rule under the bracket "Delivering company responsible," as follows:

Missing steam heat hose or air signal hose, complete, where cars are stenciled that they are so equipped.

REASON—It was felt that the car owner should be protected for such missing hose when car is so stenciled.

T. J. O'Donnell: I am wondering if the reinsertion of that provision was requested by many roads. We have had it out of the rules for about five years. There are only a few high class cars used in freight service. They go one way in passenger and express trains, and then return in freight, and you always have to watch the hose. Some inspectors say the cars were not stenciled and the owners says, "they were stenciled and we want the money." There are only three or four roads in the country that are following those things up closely. It is always a question of correspondence; we all have a pile of correspondence that high.

Mr. Cheadle: Mr. Lynch spoke of the cars going into steel plants and coming out with the stencils burned off. If the car passes one inspection point where the inspector is not familiar with it, it goes to another point where the inspector is familiar with it, and he will find a tail end of a letter on it and he will say it is stenciled. We have the same thing with steel wheels and air hose.

Mr. Lynch: Most car owners remove the steam hose during the summer months. Would we be obliged, during the months of the absence of the hose, to issue defect cards, if they are missing, removed by the owners, usually? It would complicate matters a great deal, in my opinion. The owner will accumulate a number of steam hose unless he removes the stenciling.

Mr. Schroder: In case the owner removes the hose, wouldn't he be carded in the first place, and that card removed when it came home?

President Pendleton: There is a possibility of the wrong road being penalized. If it is the practice of the owner to remove the hose, he should eliminate the stenciling, or stencil it that the hose was removed by the owner.

Mr. O'Donnell: Or report it to the division officers without issuing a card.

Mr. Zachritz: Or the line that accepted the car from the owner should accept it, owner's responsibility, because when he did not protect himself he has to protect the receiving line with a defect card when he is called on.

T. J. O'Donnell: It would be fine if they had in the rule: "For the steam hose, between the months of May and October, no cards are applied."

Mr. Armstrong: Mr. President, we have a mutual understanding in our gateway that defect cards will not be issued during the months of May to October.

J. J. Gainey (Cincinnati, Ohio): If the owner takes the hose off that car and does not take the stenciling off, he is bound to card that car when it goes through interchange, and it makes him responsible for it.

President Pendleton: But suppose he does not card it or the receiving line accepts it without a card; he would be penalized for not protecting himself.

Mr. Gainey: He should be.

Rule 60

The Committee recommends the addition of the following new paragraphs to this rule, to follow the present first paragraph, and read as follows:

Charge is not permissible for cleaning triple valve or cylinder unless the triple valve, cylinder, retaining valve, dirt collector (or pipe strainer) are all cleaned at same time.

If either the retaining valve or dirt collector (or pipe strainer) are cleaned, charge may be made therefor, even though cylinder and triple valve are not cleaned at same time. The cleaning of these items must be shown separately and bill rendered in accordance with Rule 111.

REASON—To insure a higher maintenance standard for retaining valves, dirt collectors and pipe strainers.

Mr. Jamison: If the car is not equipped with a dirt collector, what are you going to do? I am going to instruct our write-up men and regional record men to show on their original record, "Not equipped with a dirt collector."

It says, "dirt collector (or pipe strainer)," referring to the brake pipe strainer. You have no charge in Rule 111 for that. Is it the opinion of those present that we should use the same charges as for the dirt collector? It is practically the same job.

Mr. Cheadle: I would like to ask to which strainer you refer, the one at the center or the one at the triple valve?

Mr. Zachritz: The one at the triple valve, as we have always worked, is part of the repairs to the triple. I think the Committee should give us the price on this other strainer for next year, which I think would be the same as the cleaning of the dirt collector, as it is practically the same job.

Rule 70

The Committee recommends that the following note be added to this rule.

NOTE—Defect card should be attached to car at time and place wrong wheels are applied. Failure to do this obligates the road delivering car in interchange to issue its defect card. Before rendering bill on authority of such defect card, however the car owners must investigate their records to ascertain, if possible, the road on which wrong wheels were applied. If by such investigation the owner fails to locate application, a statement to that effect must accompany bill on the defect card. In the event the application is located by car owner, settlement must be made by the road responsible, in which case the defect card issued under Rule 70 must be canceled. Subsequent receipt of repair card by owner after bill has been rendered on authority of defect card carries the same obligation.

REASON—It was felt by the Committee that car owners should be protected as far as possible against the substitution of cast iron wheels for wrought steel or cast steel wheels, and that the penalty should be assessed wherever possible against the line making wrong repairs, instead of against delivering line.

Mr. Zachritz: The bill clerks should be proud that the Arbitration Committee gave them the nice little job of hunting up this information.

Mr. Lynch: This note will make confusion worse confused. You will note that it is very mild toward the repairing line; it simply says that "the repairing line *should* attach a defect card," but that it is imperative on the owner that he "*must* investigate" to protect the line that failed utterly to properly protect itself. I think an addition to Rule 70 would be preferable to the note, reading: "The Company making such wrong repairs must place upon the car, at the time and place the wrong repairs are made, an M. C. B. defect card covering the wrong material used." This would make it compulsory on the part of the repairing line to attach defect card, and use the word "must" instead of "should," and write it out in capital letters, so they might see it. In Rule 87 there is an exception which relieves the repairing line from being responsible to the car owners, and I cannot understand why this hardship and inconvenience is imposed on the car owners because of the failure of the repairing line to apply a defect card.

Mr. Straub: This note is going to entail a great deal of work on record keeping and investigation. It would seem that the matter could be helped along a great deal when a defect card is issued at an interchange point for such wrong repairs, that defect card should show the wheel record of the wrong wheels so that you can have something to trace those particular wheels and who applied them. Sometimes the railway company's initials will be on the wheel and give you some clue.

F. C. Schultz (Chicago): I used to feel, or claim, that I could always locate the party who put in the wrong wheels—get his wife's name and his children's names—but I have gotten that out of my head. They are put in and not a word said about it. But in view of the fact that there are not many cases where the car owner is not billed for anything, this matter should be handled as wrong repairs.

Mr. Schroder: The road making wrong repairs should be penalized; but as far as the expression of the rule is concerned, I think it is understood by every car man that Rule 4 is forcible enough. Defect card must be applied when wrong repairs are made, but it is not being done and, as far as Rule 70 goes, we all know that the car should be carded. It is up to the American Railway Association to get the roads to pay more attention to issuing defect cards.

President Pendleton: In the past, all of the objectionable features of the rules that we found we have recommended for change and have gotten a long ways with the Arbitration Committee with our recommendations. But this is not the time to make recommendations. We are going to discuss the application of the rules now and probably in the next 60 or 90 days the Executive Committee will have a session and that will be the proper time to make recommendations for changes.

Rule 91

The Committee recommends that Rule 91 be modified in accordance with the proposed form shown below:

PROPOSED FORM—Instructions for billing.

Bills may be rendered for work done under Rule 16, except in cases where owners are not responsible and the car bears no defect card covering the defects repaired, stating upon the bill the date and place where the repairs were made; the billing repair card or defect card to accompany the bill.

Billing repair cards returned for correction, or on account of exceptions, must not be defaced in any manner on the face of the card.

NOTE—The following provisions must be observed when rendering or correcting bills:

(a) Bills should not be rendered for amounts less than 25 cents in aggregate, but charges for items less than 25 cents may be held until they amount to that sum.

All bills should be rendered promptly. Bills rendered after one year from date of repairs may be declined. No bill should be rendered for repairs to cars after the time limit has expired, even though previous attempts have been made to ascertain proper ownership.

(b) No bills should be returned for correction on account of incorrect car numbers, but shall be passed for payment at once, and the alleged errors in car numbers brought to the attention of the company rendering same, within 60 days from date bill is passed for payment, but in no case exceeding six months after first receipt of bill.

The billing company shall furnish correct car reference, or shall issue, within 30 days, countercharge authority as per form shown on page 176. If it is alleged car was not on repairing road on date claimed, the car owner must show location of car on such date.

(c) No bills shall be returned for correction on account of other error or questionable charges unless the net amount involved exceeds 10 per cent of the total amount of bill, but shall be passed for payment at once and the alleged error brought to the attention of the billing company within 60 days from date bill is passed for payment, but in no case exceeding six months after first receipt of bill. The billing road must furnish proper explanation or shall issue within 30 days countercharge authority on form shown on page 176. If objections to bill do not amount to 25 cents in aggregate, no exception shall be taken; but bill shall be passed for payment as rendered.

REASON—There should be a time limit on exceptions on car repair bills where there has been an unusual delay in payment of same.

W. M. Pyle (Southern Pacific): Mr. President, the Railway Accounting Officers' Association has passed a mandatory rule effective January 1, 1923, that there shall be no bill rendered for an amount less than one dollar. They make an exception, however, to bills rendered by the American Railway Association, and make the recommendation that the bills shall be rendered for amounts not less than 50 cents. While these proposed revisions have already been adopted and will be incorporated in the rules as of January 1, 1923, it would appear that some consideration and thought should be given them.

I recently received a bill from a certain railroad for four cents. Now, it costs us four cents postage, two cents down and two cents back, to get that bill approved by our operating officers. Then the company used two cents more to mail the voucher, besides the clerical work in preparing it. So I returned it to them and asked them to cancel it, in accordance with the rules. We should take into consideration the recommendations of the Railroad Accounting Officers' Association, and a limit of the minimum of 50 cents for bills should be adopted.

Topical Discussions

In the course of the discussion of the changes in the interchange rules several questions not bearing directly on the changes were raised and discussed. In order not to break the continuity of the discussion of these rules, these questions have been grouped together below.

Mr. O'Donnell: I wrote Mr. Hawthorne, secretary of the mechanical division, and asked him if it would not be agreeable to put the number of the rules on the margin of the page instead of between the lines. Mr. Hawthorne replied immediately, and stated that the set up for this reprint is retained until the whole book is changed; they only reset the changes and the new matter. But he said that if at any time in the future the type was all reset again, he thought the suggestion was a good one and would be adopted by the Arbitration Committee.

Mr. Straub: It is only within the last year that they omitted the number from the top of the page, and any busy car foreman knows how difficult it is to hunt through his book of rules.

President Pendleton: The suggestion is a very good one and, no doubt, will be taken care of at the time the reprint is made.

Perpetuation of Wrong Repairs

W. M. Pyle (Southern Pacific): I am called upon at the present time to issue a defect card for a wrong triple. On June 16, 1921, we had a car in our Phoenix, Arizona, shops for light repairs, and at that time the triple was changed and a wrong triple applied, and although the car was stenciled "cylinder and triple oiled," with the date, June 21, 1921, still there was no repair card made for this work; in fact, there was not any work written up for the light repairs done on the car, through an oversight. My attention was called to it after June 23, 1922, when the car was repaired by the Southern; the air was cleaned and a standard triple applied. The Southern billed the owners for it. The owners come back now and ask for a defect card to cover the wrong triple.

Now, the rules provide that wrong repairs shall be detected within a certain time limit after the car is received on the owner's rails. We gave this car to the owners the day after it was repaired. That car bore our stamp showing that we made this wrong repair. Now, do you think that we should give the defect card for the wrong repairs? I do.

President Pendleton: There is no question but what you should.

Mr. Leonard (B. & O. C. T.): I think you should not issue a defect card for the wrong repairs. The owner did not take the opportunity when he had the car on the line the first time. He let it go to another connection and they made the proper repairs.

G. P. Zachritz (Soo Line): Is there any time limit as to when the repair card of the repairing line shall act as a joint evidence against the former repairing line? I know of none. We have had cases where the owner had the car in his possession in time to have taken advantage of the time limit, but he did not do so; yet if the repair card was furnished by the repairing line to him as joint evidence, I fail to find any limit on that in the rules and consequently you are in for a defect card.

Accounting for Salvage on Rebuilt Cars

T. A. Eyman (E. J. & E.): We are putting some new underframes under cars, building the body new, using the same repaired air brakes and using the trucks.

The accounting department, through the Government's interpretations, claims that if you renew over 51 per cent of this car it must go into capital account. On the other hand, if it is less than that, it goes into general repairs of the car. The rules have always stated that if a car is unfortunate enough to be destroyed on another line, and you have your second-hand trucks, it must go back to the old date the truck was built, rather than the body of the car.

In building these cars there was good second-hand material available from the car that was torn down, but instead of using this material in the new car, we used it in the repair of other cars. Is the car rebuilt entitled to this second-hand material? There is a difference of opinion on that matter, and I was wondering if any of you gentlemen had any experience on this matter.

E. H. Hall (Pere Marquette): I would state, Mr. President, that regardless of the rules of interchange, you have to follow the accounting rules laid down by the Interstate Commerce Commission. Those rules read to the effect that when the repairs exceed a major portion of the cost to replace in kind any unit of equipment, it shall be retired from your accounts and taken into your other accounts as new equipment.

Mr. Eyman: The only point is whether we can credit that car with the second-hand parts, for the reason we are using it on other cars. They say we cannot credit that second-hand material to the car we take it off of, unless we put it back on that car.

Mr. Hall: You scrap it.

Mr. Eyman: Yes, but it is not scrapped.

Mr. Hall: But you are taking it back as new material.

Electric Lights for Car Inspectors

Thomas O'Donnell (Bureau of Explosives): I was wondering if you had considered the recommendation to your officials of the use of electric lights in the yards instead of the present oil lights for inspection, particularly on dangerous commodities that we are up against more and more every day.

T. J. O'Donnell (Buffalo): My experience is that you are always safe with the present light if you have your wits with you, but the inspectors from time to time bring the subject up, and I am wondering if it would not be a topic that our officials could consider. Of course, if you use electric flashlights it would be an expense and might not be agreeable.

Mr. Lynch: Mr. President, I believe that many lines furnish inspectors with those flashlights for the inspection of tank cars, especially. I do not know whether it would be a good idea to use them exclusively or not; it would be rather expensive and they would be hard to get around with, because the battery would have to be so much larger.

Thomas O'Donnell (Bureau of Explosives): For some years we have been agitating the use of the electric lamp along with nearly all safety departments of the railroads. Recently, I made a survey in the St. Louis terminals, and I find that no road there has adopted the battery lamp, but many individual switchmen and yard men have them and are supplying the batteries themselves. After they become accumstomed to this lamp they will not use the oil lamp.

Recently the good points of the electric lamp were brought to my attention in a wreck involving several tank cars of gasoline, out on a single track, and we did not have any flashlight to work with. There isn't any oil lamp that can be considered as anything but an open flame light, which it is absolutely unsafe to bring anywhere near leaking tank cars because the vapor will come to the light. There is an impression among the inspectors in some places that a hood over the light renders it safe, but, of course, it does not, because if enough oxygen can enter to keep the light burning, the inflammable vapors can enter and they will flash back to the leak.

I think this body might well go on record as recommending some action be taken on eliminating the open flame lamp.

E. H. Mattingley (B. & O.): I think that question was talked of considerably at the Montreal convention (1920), and it was recommended that this Association or its members recommend to their railroads that the electric light be adopted as a standard car inspector's lamp.

A. Herbster (N. Y. C.): On the New York Central we have had electric lamps for what we call gasoline points for three or four years, and they are working out very satisfactorily. That, of course, only has reference to points where we handle gasoline as an everyday commodity. Additional lamps are also carried in the wrecking outfits, but they have not been adopted universally.

Mr. Cheadle: At the Montreal meeting the motion was that we take it up with their officers to see that lights were provided the inspectors to make inspection of tank cars, or in case of leaking tank cars. There was no action taken for placing electric lamps in the hands of inspectors for all classes of inspection.

President Pendleton: How many members have taken the matter up with your superiors, and how far have you gotten with it?

T. J. O'Donnell (Buffalo): I gave the data to our executive committee.

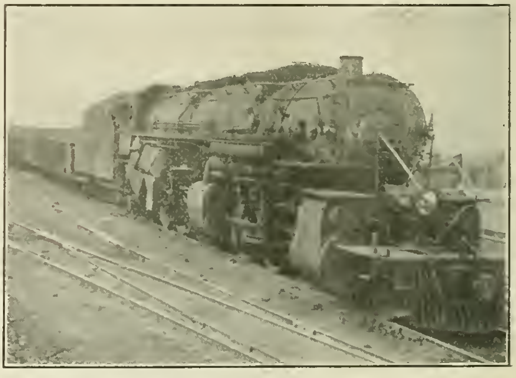
Mr. Cheadle: On our line electric lamps were placed with the inspectors for use in case of a leaking tank car or anything of that kind. Several inspectors have purchased various kinds of electric lights. Some of them have told me they are hard to use for the reason that they often suddenly go out and they have to go back to the point where they keep the batteries to replace it.

Thomas O'Donnell (Bureau of Explosives): There is scarcely a man in this room who does not admit that it is necessary to have this electric light. Colonel Dunn, in every speech he has ever made along safety lines, has recommended it; but there isn't any body of men in the business who are as practical along that line as you are here, and your recommendation would be the weightiest thing we can have behind it.

Election of Officers

In addition to the election of officers the association also voted to have the proceedings published in book form for wide distribution among the members and other railway officers and men interested in the work of the organization. The proceedings will be published by Bruce V. Crandall, without expense to the association.

At the closing session on November 10, the following officers were elected for the coming year: A. Armstrong, Atlanta, Ga., president; W. Westall, New York Central, first vice-president; C. M. Hitch, Baltimore & Ohio, second vice-president, and W. P. Elliott, Terminal Railroad Association of St. Louis, secretary-treasurer. The following new members were elected to the executive committee: W. M. Pyle, Southern Pacific of Mexico; B. F. Jamison, Southern; A. S. Sternberg, Belt Railway of Chicago, and J. A. Roberts, Chesapeake & Ohio. E. Pendleton (Chicago & Alton), the retiring president, becomes chairman of the executive committee, and the terms of J. E. Gordon (New York, Chicago & St. Louis), A. Herbster (New York Central) and W. H. Sherman (Grand Trunk) continue through the next year.



Mallet Locomotive on the Wheeling & Lake Erie

Methods of Repairing Walschaert Valve Gear Links

Operations Systematized to Permit Quantity Production of Parts: Jigs Insure Accuracy

THE links used on Walschaert valve gears are not easily handled in ordinary machines; consequently, when repairs are made, the parts are usually fitted on the bench with whatever equipment is available. In many cases little attention is given to the alinement of the trunnions with the result that the bearings bind unless they are given excessive clearance. Other errors are also likely to occur in fitting the parts. At one large locomotive repair shop an excellent method of repairing links has been developed, which insures accuracy and facilitates the work, as described and illustrated below.

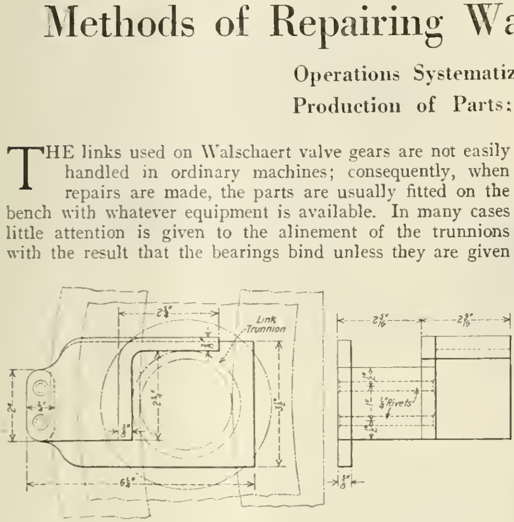


Fig. 1—Gage for Checking Alinement of Link Trunnions

When links are received in the shop, they are inspected to determine what repairs are needed. It is almost always necessary to grind the faces of the link slot and this is done on the usual type of vertical spindle radius link grinder. The trunnion bushings when defective are removed and replaced. The trunnions are checked with the gage shown in Fig. 1 to determine whether they are exactly at right angles with the sides of the link. If they are not alined accurately, or if they are not of the same diameter for their entire length, the trunnions are trued up with the hollow adjustable mill shown in Figs. 2 and 3.

In order to check the accuracy of trunnions and insure their being in line, as well as at right angles to the link, they are assembled in the fixture shown in Fig. 4. The lower member *A* is bored and carries a sliding sleeve. The inside of this sleeve is tapered at the upper end to fit the segmental bushings shown on the table in front of the fixture. The vertical movement of the sleeve is controlled by the lower hand wheel *C*. The ram *B*, which is in perfect alinement with the lower sleeve, works freely in the frame and is vertically controlled through a rack and pinion by handle *F*. A sliding sleeve, similar to the lower sleeve, is located in this ram which is controlled by upper hand wheel *C'*. The tapered outer surfaces of the segmental bushings fit either of the two sleeves, the bore of the different bushings being suitable for varying diameters of trunnions.

The fixture is set up so that the ram *B* and lower sleeve are plumb with each other. The weight of the link when assembling is borne by the vertically adjustable arms *EE*.

The method of setting up and adjusting a link and bridles is as follows: Suitable bushings are selected and placed on each trunnion. The lower bridle is placed in the lower support *A*. The link is placed on arms *EE* and vertically adjusted to a line with the bridle, the upper bridle is then applied and all members are loosely bolted. The ram *B* is lowered until the collars of the bushings are held tight, when the ram is held from movement by a set screw not shown, located on opposite side of the fixture. The hand wheels *CC'* are adjusted, thus centering the segmental bushings on the trunnions and in the fixture. This in turn brings the two trunnions in line.

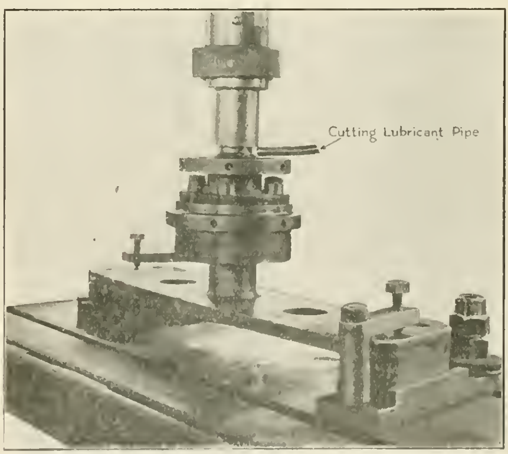


Fig. 2—Truing Link Trunnion with Hollow Adjustable Mill

In order to insure the link being square with the trunnion, a spirit level is placed on the upper surface of the link and, if the members are not level, they are shifted on each other to make them so. If the bolt holes are then in line, the link can be assembled. Should the bolt holes in the link and bridles not agree, the parts are held in position by temporary bolts and the holes are reamed to bring them in line.

It will be noted in the photograph that an arm projects from the top of the sliding ram *B* and a lug is placed on the frame of the jig directly below it. These parts are carefully located so that when the bushings are on the trunnions and the sliding sleeve is down, the distance between them is

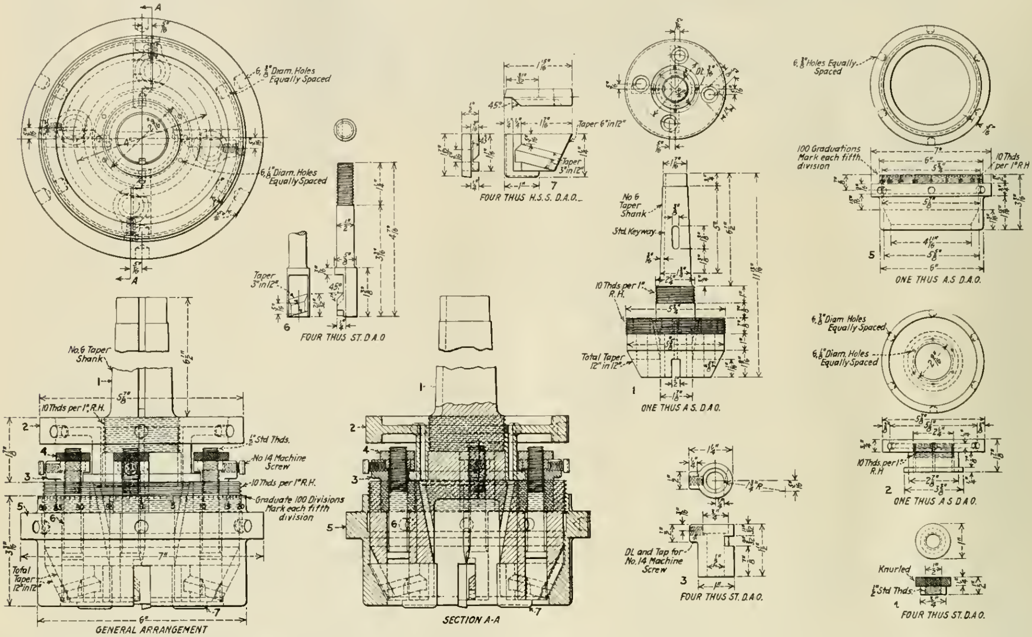


Fig. 3—Details of Hollow Adjustable Mill for Truing Link Trunnions

exactly equal to the distance between the shoulders at the inside of the trunnions. This measurement is taken with a micrometer as shown, and is recorded for reference when fitting the bushings on the trunnions.

The bushings on the trunnions are fitted to the bushings in the link supports. The bushings for these brackets, which are of the form shown at *A* in Fig. 5, are blanked out and

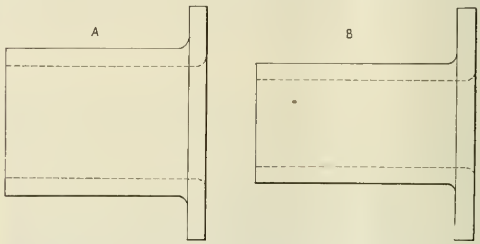


Fig. 5—Bushings for Link Supports and Trunnions

reamed on automatic machines and are then carbonized but not hardened. The bores of the bushings are then ground to a standard size. Before applying the bushings, they are turned outside to a press fit in the link supports; the flanges are faced to restore the original dimensions between them; they are hardened and pressed in, and the distance between the inside faces checked.

The trunnion bushings are also blanked out on automatic machines, the outside diameter being ground to a standard size to fit the bushings for the brackets, after which they

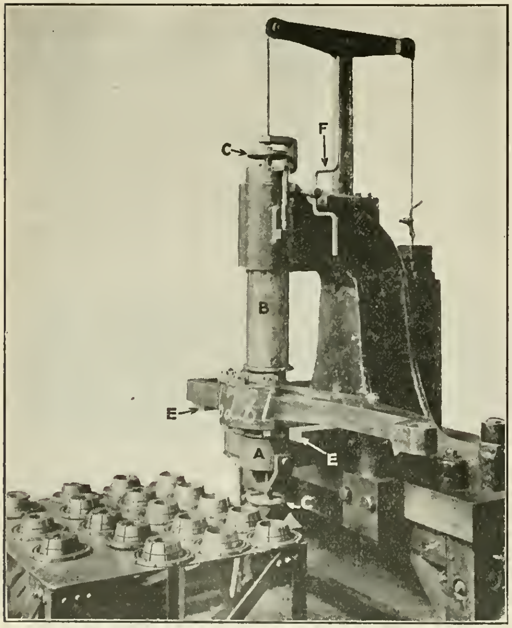


Fig. 4—Fixture for Assembling Links and Trunnions

are carbonized but not hardened. The bore is left small and the thickness of the flange somewhat oversize to compensate for irregularities. The diameter of the trunnion is measured with the micrometers and the bushings are bored to make a press fit and the thickness of flanges is made suitable to restore the standard dimensions and the bushings are then hardened and pressed in place.

This completes the work on the link, except renewing the bushing for the eccentric rod pin. These bushings are made in quantity, bored, case-hardened and internally ground to

Fig. 6—Gage for Checking Roundness, and Measuring Size of Holes

grade sizes to fit standard sizes of pins, the outside diameters being left oversize and ground to make a press fit in the holes.

In measuring the sizes of these holes, two interesting types of gages are used. The first type, shown in Fig. 6, consists of a triangular plate with two accurate straight edges. Along

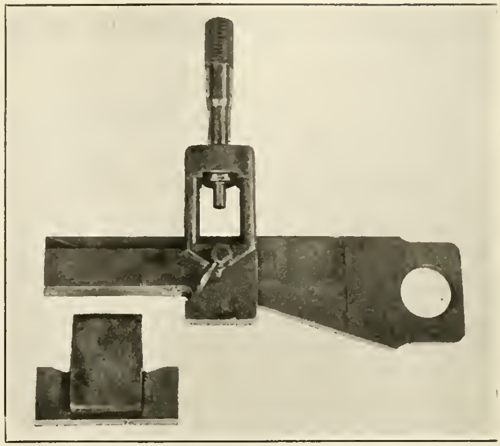


Fig. 7—Special Gage with Micrometer Attachment

one edge is a rib which holds a slider that can be clamped at any position along the side. The outside straight edge of the slider is parallel to the opposite side of the plate. By moving the slider, the distance between these parallel edges can be varied over a wide range.

In using the gage, it is inserted in the hole as shown, the slider being moved along the edge until the gage fits the hole. The slider is then clamped and the gage rotated to see whether the hole is round and not tapered. If any irregularity is found, the hole is ground on an internal planetary grinder. If the hole is true, the diameter is measured with a micrometer as shown in Fig. 6, or the slider may be clamped and the dimension taken after the gage is removed from the hole. A similar tool which has the micrometer permanently attached is shown in Figs. 7 and 8, being used principally when measuring holes at a distance from the machines where the bushings are ground. In this case the inspector reads and makes a memorandum of the sizes.

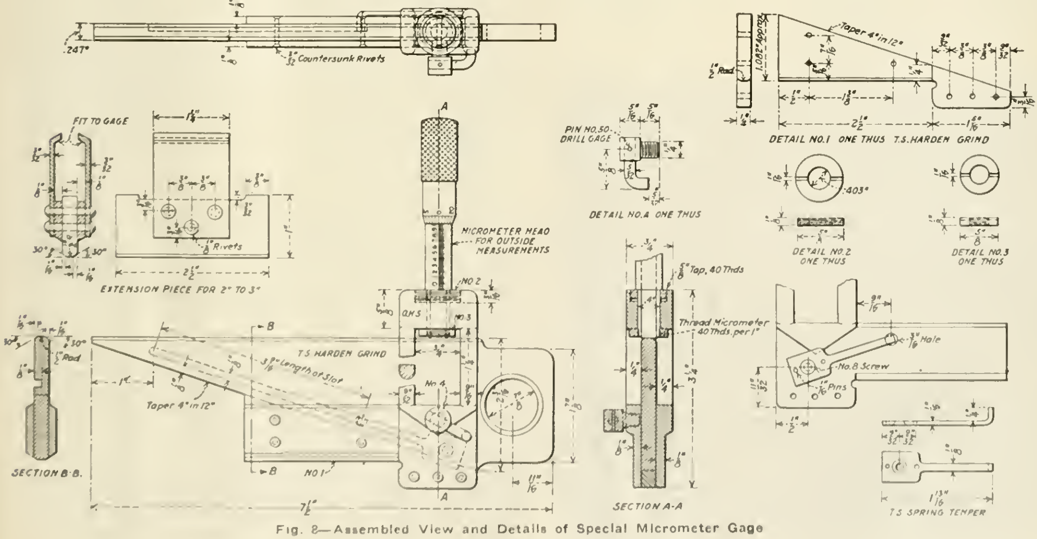


Fig. 8—Assembled View and Details of Special Micrometer Gage

Furnace Atmospheres and the Formation of Scale*

A Study of the Relation of Scale Formation to Carbon Content of Steel and Furnace Atmosphere

By G. C. McCormick

Assistant Metallurgist, Crompton & Knowles Loom Works, Worcester, Mass.

An important chemical property of metallic iron is its tendency to combine with oxygen. Under favorable conditions of atmospheric humidity and temperature, rust, a compound of iron and oxygen, forms with speed and facility. At the higher temperatures, commonly encountered in forging and heat treating, the activity of these two elements is greatly accelerated with the result that a compound very different from iron rust is formed. This compound is generally known as scale. The chemical composition of scale is variable and complex. It is sufficient for this discussion to bear in mind the signficant fact that scale is a compound of iron and oxygen, formed in the temperature ranges of thermal treatment. This experimental work was conducted for the purpose of determining, first, the temperature at which scale begins to form, and second, the extent of scaling at common heat treating temperatures.

Procedure

A series of blocks were cut from low, medium and high carbon steels. Special attention was devoted to the cutting of the blocks in order that they should possess as nearly as possible the same dimensions and weight. The specimens were polished on a fine wheel, cyanided for 10 min. at 1,450 deg. F., quenched in water and cleansed in a hot soda solution. This procedure served to remove the mill scale, rust, or grease, with which the surface of the bar stock may have been coated. The sample pieces were then calipered and weighed.

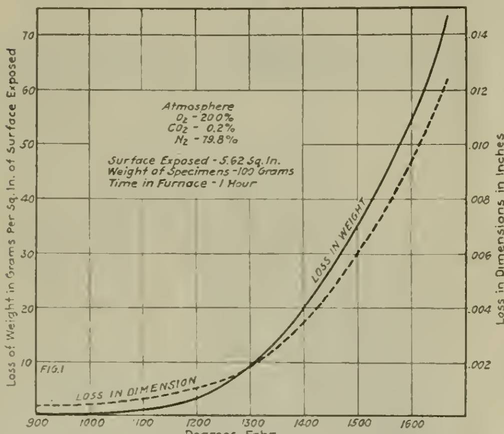


Fig. 1—Extent of Scaling or Oxidation on a 0.12-0.20 Per Cent Carbon Steel

The several grades of specimens were heated simultaneously in an electric muffle furnace for one hour each at different temperatures ranging from 900 to 1,700 deg. F. The gases in the furnace at all times corresponded in analysis to the atmosphere of the room, which was: oxygen, 20 per cent; carbon dioxide, 0.2 per cent; carbon monoxide, nil; nitrogen, 79.8 per cent by difference.

* Abstract of a paper presented before the Detroit Convention of the American Society for Steel Treating.

On removal from the furnace, the specimens were rapidly quenched in oil, the quantity of scale was then determined.

Method of Determining Scale

In determining the weight and thickness of the scale, it is mandatory to effect a complete removal of the oxidized layers without removing any metallic iron. Experiments were made with several chemical methods, each of which was subject to the same criticisms—excessive removal of metallic iron or failure to completely remove the oxides.

A method was suggested of heating in cyanide for 10 minutes at 1,450 deg. F., followed by water quenching and

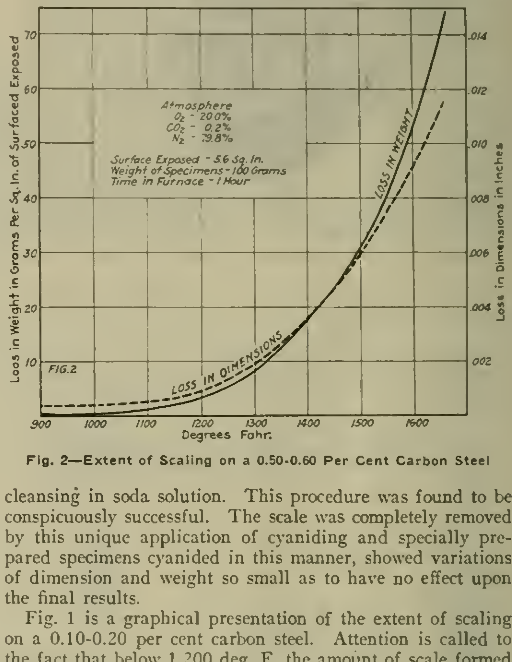


Fig. 2—Extent of Scaling on a 0.50-0.60 Per Cent Carbon Steel

cleansing in soda solution. This procedure was found to be conspicuously successful. The scale was completely removed by this unique application of cyaniding and specially prepared specimens cyanided in this manner, showed variations of dimension and weight so small as to have no effect upon the final results.

Fig. 1 is a graphical presentation of the extent of scaling on a 0.10-0.20 per cent carbon steel. Attention is called to the fact that below 1,200 deg. F. the amount of scale formed in one hour is practically negligible. Above this temperature, however, the curve rises rapidly and at 1,600 deg. F. the specimens scaled on the average 0.55 grams per sq. in. of surface exposed, and lost approximately 0.009 in. in each dimension.

Fig. 2 portrays the amount of scaling on a 0.50-0.60 per cent carbon steel. As in the case of the low carbon material, little scaling takes place below 1,200 deg. F. Attention is called to the extent of scaling at 1,600 deg. F. In this range, the metal scales 0.45 grams per sq. in. of surface exposed and loses 0.007 in. in each dimension.

In Fig. 3, the scaling of a 1.00 per cent carbon steel is depicted. As in the previous figures, little or no scale forms below 1,200 deg. F. In the higher temperature ranges, for example, at 1,600 deg. F., the steel loses 0.40 grams in weight for every square inch of surface exposed and suffers a decrease of 0.006 in. in each dimension.

Summary of Scale Formation

From a study of these curves, it is evident that:

1. Little or no scale forms below 1,200 deg. F.
2. The amount of scale formed under the given conditions varies inversely with the carbon content of the steel.
3. The formation of scale increases rapidly with the rise in temperature above 1,200 deg. F. and at 1,600 deg. F. may be fittingly described as excessive.

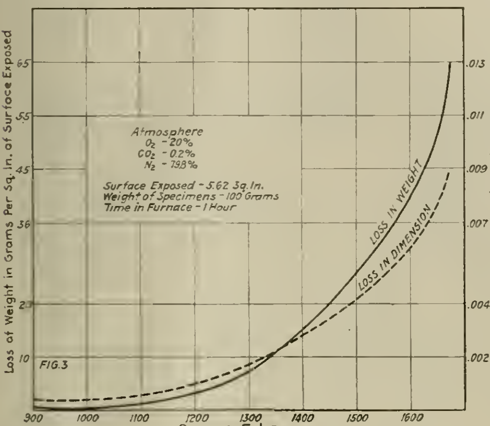


Fig. 3—Extent of Scaling on a 1.00 Per Cent Carbon Steel

Kinds of Atmosphere

In furnace literature, frequent mention is made of "oxidizing," "neutral," and "reducing" atmospheres. Consideration has been given in this work to the extent of scale formation in an atmosphere containing 20 per cent oxygen. Such an atmosphere is described as "oxidizing" and permits of the rapid formation of scale. Believing that certain misconceptions concerning the scaling properties of the "neutral" and "reducing" atmospheres are in existence, it is the writer's purpose to subsequently record the results of various experiments conducted in these atmospheres.

The distinctive qualities of the "neutral" atmosphere are as follows: (1) The absence of free oxygen. (2) The absence of combustible material. (3) The presence of either carbon dioxide or water vapor or both. (4) The presence of nitrogen.

It is logical that a consideration of the effect of nitrogen, water vapor and carbon dioxide upon heated steel will throw light upon the non-scaling properties of the "neutral" atmosphere.

Nitrogen—Since scale is an oxide of iron, it is evident that nitrogen will not enter into the formation of scale and may be dismissed from the discussion.

Water Vapor—Chemistry has established beyond the shadow of doubt that when heated in the presence of iron, water vapor dissociates and reacts with iron to form scale. The reaction may be expressed as follows:

$$3\ Fe + 4\ H_2O = Fe_3O_4\ (Scale) + 4\ H_2$$

Thus, the second constituent of the so-called "neutral" atmosphere is capable of producing scale.

Carbon Dioxide—When heated in the presence of metallic iron breaks down and reacts with the metal to form scale as follows:

$$2\ Fe + 3\ CO_2 = Fe_2\ O_3\ (Scale) + 3\ CO$$

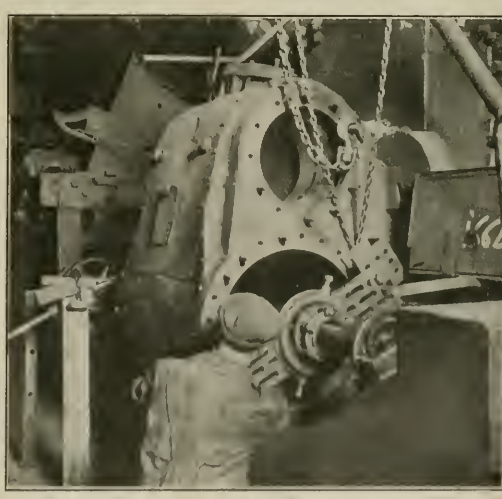
The validity of this equation was established by experiments conducted in which cylindrical pieces of steel were heated in a very slow current of pure dry carbon dioxide.

Tests were made and tables prepared showing the comparative scaling activity of the oxidizing atmosphere containing 20 per cent oxygen and the following reducing atmosphere: Carbon dioxide, 11.5 per cent; carbon monoxide, 0.8 per cent; oxygen, 0.0 per cent. From these tests it developed that the scaling activity of the reducing atmosphere at 1,700 deg. F. is only half as intense as the scaling activity of the oxidizing atmosphere. Several experiments have been conducted in which small pieces of tool steel were held from 10 to 15 min. at 1,400-1,600 deg. F. in reducing atmospheres. The pieces were discolored but no measurable quantity of scale formed. It, therefore, appears logical to conclude that regardless of the presence of carbon monoxide in the furnace atmosphere, scaling will take place when the temperature is sufficiently high and the time of heating is sufficiently long.

Conclusions

As a result of the data obtained in the foregoing investigation, the following conclusions are drawn:

1. In an atmosphere containing 20 per cent oxygen, little or no scale forms on steel exposed to a temperature of 1,200 deg. F. for one hour.
2. For straight carbon steels heated under identical conditions, the quantity of scale formed varies inversely with the carbon content of the metal.
3. The formation of scale becomes appreciable at 1,200 deg. F. in atmospheres containing 20 per cent oxygen, and from that point increases rapidly. At 1,600 deg. F. the quantity of scale formed may be fittingly described as excessive.
4. The neutral atmosphere, because of the carbon dioxide and water vapor which it contains, is active in the formation of scale.
5. Steel may be heated in mixtures of carbon dioxide and illuminating gas without the formation of scale. Such gaseous mixtures may be correctly described as non-scaling.
6. Reducing atmospheres, found under actual operating conditions, permit the formation of scale when the temperature is of sufficient intensity and when the time of heating is of adequate duration.
7. Pieces of steel may be heated for a short time in reducing atmospheres without the formation of appreciable quantities of scale.



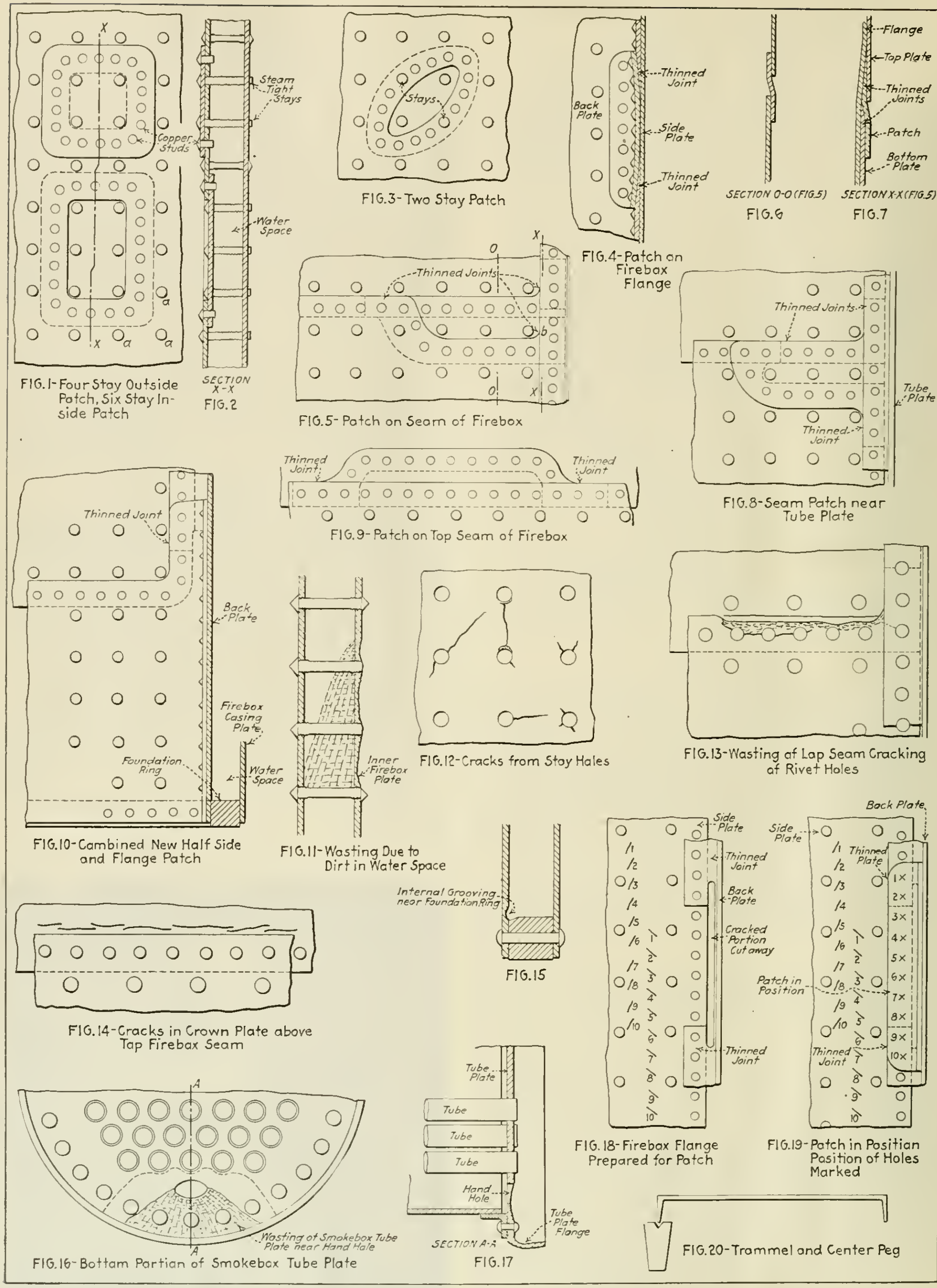


FIG. 1—Four Stay Outside Patch, Six Stay Inside Patch

FIG. 2

FIG. 3—Two Stay Patch

FIG. 4—Patch on Firebox Flange

FIG. 5—Patch on Seam of Firebox

FIG. 6

FIG. 7

FIG. 8—Seam Patch near Tube Plate

FIG. 9—Patch on Top Seam of Firebox

FIG. 10—Combined New Half Side and Flange Patch

FIG. 11—Wasting Due to Dirt in Water Space

FIG. 12—Cracks from Stay Holes

FIG. 13—Wasting of Lap Seam Cracking of Rivet Holes

FIG. 14—Cracks in Crown Plate above Top Firebox Seam

FIG. 15

FIG. 16—Bottom Portion of Smokebox Tube Plate

FIG. 17

FIG. 18—Firebox Flange Prepared for Patch

FIG. 19—Patch in Position Position of Holes Marked

FIG. 20—Trammel and Center Peg

Typical Patches Used in Locomotive Boiler Work

Practical Methods of Patching Locomotive Boilers*

British Railroad Boiler Makers Develop Effective Flange, Side Sheet, Barrel and Various Other Types of Patches

By A. Wrench†

PATCHING is extensively employed in the repair of locomotive boilers. This is brought about by the defects which occur in the firebox plates and seams. Firebox patches present many difficulties to the boilermaker owing to the narrow water spaces which in many cases make the water side of the plates inaccessible. This necessitates the use of studs instead of rivets as a method of securing the laps.

The most common form of patch is the side-plate patch, which varies in size to cover the defective portion. Such patches are called after the number of stays which they contain, thus 2, 4, 12 and 36 stay patches. Three types of these patches are shown in Figs. 1, 2 and 3.

Types of Outside Patches

The four-stay patch must be a laid on or outside patch, as must all square patches. The disadvantage of these patches lies in the fact that a large seam is exposed to the flame and pressure tends to force the patch off. This is not the case where the patch is inserted through the hole into the water space. The pressure on these tends to make a good joint.

The six-stay and two-stay patches shown in Figs. 1 and 3 are of this latter kind. It will be noticed that the studs with which the patches are secured to the firebox are between the rows of stays. This method has been found to make a better joint than when the seam is made between the stays, as stays in the seam of a patch tend to restrict breathing and cause leakages. The two-stay patch has two stays in the lap and is of irregular shape. This enables the patch to be passed through the hole and into the water space.

Method of Inserting Patches

It is necessary when inserting patches to remove three stays from near the bottom of the patch to allow it to be turned after it has been passed into the water space. These stays are marked *a* in Fig. 1. When using the outside patch this is, of course, not necessary. The marking-off of the holes in these patches is mostly done from standard templates. The stud holes should be marked so as not to be in line with the stays; this reduces the tendency to crack from stud to stay hole.

Mud Burns and Corrosion

An accumulation of dirt in the water spaces as shown in Fig. 11 is often found in locomotive boilers, and if neglected will allow the plates to burn and necessitate a patch. Cracks from stay holes and corrosion around stay heads Fig. 12 are also repaired by patching. Seam and flange patches are often used in the repair of locomotive fireboxes, and are more difficult to fit than the side-plate patches. The method of fitting usually involves the use of thinned joints.

Applying the Flange Patch

The flange patch, Fig. 4, is used to repair flanges which have cracked in the root or bend. The cracked portion is cut away and also a portion of the flange is removed. The joints are then thinned and made ready to receive the patch. The patch is placed in position, and the holes marked off by the trammel method. This method of marking off is explained by Figs 18 and 19. Centered pegs are inserted in the hole prior to the patch being placed in position, and points marked in two places on the firebox side. The patch is then fixed with a screw and pipe, and the position of the holes marked from the two corresponding places on the firebox side. This method of marking-off is adopted on all laid-on seam patches where the water space does not permit the use of a scriber.

Fig. 5 shows a patch used to renew a portion of the lap of a seam which is found to be wasted and badly cracked. This patch has one seam inserted in the water space while the other is on the fire side of the plate. This is necessary as the position of the patch shown in the illustration is near the fire-hole flange and in a position where it is in contact with the flame. Thinning of joints is employed to enable the patch to fit properly. The thinning of the joint marked *b*, Fig. 5, is very difficult, as this work has to be done under the flange of the fire-door plate. To enable this to be done this flange is lifted by a wedge after several rivets have been removed. This patch forms a good repair and gives very little trouble from leakage in service.

A similar patch to this one is shown in Fig. 8, but this is an outside patch, the two thinned joints of the patch being passed under the flange. This type of patch is usually employed on the seam near the tube plate, and being well away from the fire gives satisfaction during working.

Combination Half Side Sheet and Flange Patches

Frequently when a firebox has been working for some years it is found advisable to renew the bottom half of the side plates. In addition to this, the flanges may need patching. It is the practice of some firms to fit new half-sides and then patch the flanges. Fig. 10 shows a combined half-side and flange patch. It will be noticed that the flange is transferred from the side plate to the back plate, a row of rivets being dispensed with. The top of the new flange must extend above the half side seam to enable a good-shaped thinned joint to be made. This method of repair is considerably cheaper than the fitting of a flange patch separately and is quite satisfactory in service.

Cracks, such as shown in Fig. 14, which occur about the side plate seam which are due to the upward expansion of the firebox, are repaired by a patch inserted under the lap, the cracked portions having previously been cut away. Such a patch is shown in Fig. 9. Grooving near the foundation ring and cracked outer firehole plates are repairable by patching.

Smoke Box Tube Sheet Repairs

Figs. 16 and 17 show a defect of the smoke-box tube-plate caused by leakage from the hand hole. This is repairable by a patch which should be made of copper to enable it to be properly fitted on to the wasted portion. The writer once fitted a steel patch on a tube-plate similar to the one shown, and had considerable difficulty in making a proper fit. The patch had to be bolted up several times while hot, and some of the holes were drawn out of true. This drawing was allowed for by drilling the holes small, but this necessitated the use of bolts of small diameter and little drawing power.

Inserting and screwing up bolts in a hot patch is difficult

*Reprinted from Engineering, July 28, 1922.
†Member Institute of Locomotive Engineers.

and the patch cools considerably before the hammer can be applied to do the necessary bedding-on. Filling the corroded portions with cement or red lead is not to be recommended.

The throat plates of some types of boilers crack on the shoulders, and boilers fitted with Belpaire fireboxes develop corrosive grooving at the junction of the throat plate with the barrel at the top. These two defects have been successfully patched, and new boilers are now built with extension plates to cover each of these two places. This practice stiffens the boiler at the two points and delays the time when a patch will be necessary.

Strength of Barrel Patch Seams

When the bottom of a locomotive boiler becomes corroded, patching, when properly designed, makes a good repair. It is not always recognized that the riveting of a "barrel" patch in a longitudinal direction should be equal in strength to that of the longitudinal joint. Many of these patches are merely single riveted with a narrow pitch of rivets. Considering that these patches are cover patches, a narrow pitch of rivets is not necessary and an efficiency of plate section should be maintained equal to that of the longitudinal joint.

When designing the rivet section to be used in these patches the tenacity of the corroded plate may be considered, as, unlike the longitudinal joint, the boiler plate underneath the patch would have to break before the rivets could shear. "Barrel" patches are usually joggled to fit over the circumferential seam, the seam being chipped near the seams of the patch to make a good fit. If any space then occurs between the plate and the patch a wedge is driven in and calked.

It will be seen from the foregoing remarks that repairing boilers by patching is an important branch of boiler maintenance which should be studied by those responsible for the safety of steam boilers. Inspectors occasionally find that the strength of a boiler has been much reduced by improper patching, and several explosions have been found to be due to this cause.

Principles of Oxyacetylene Fusion Welding Part 8—Cutting Cast Iron

By Alfred S. Kinsey*

WHILE on the subject of the fusion *welding* of cast iron, it might be of interest to describe the *cutting* of cast iron by the oxyacetylene torch. Until a few years ago it was thought that the only metal which could be cut in this way was low carbon steel. Oxyacetylene writers had said that cast iron could not be cut by the oxyacetylene torch because of the proportionately high percentage of carbon in the metal. The carbon was supposed to prevent the oxidation of the metal, as occurs in the cutting of steel. Another explanation of the failure to cut cast iron was that its oxide melted at a higher temperature than the pure iron, called ferrite, and that the oxide insulated the ferrite from the heat of the flame so that ignition could not be obtained.

Fig. 1—Cutting Through 12 Inches of Cast Iron

However, there were reasons for believing that cast iron could be cut with the oxyacetylene flame, which led the writer about two years ago to perform experiments to determine just what could be accomplished. It was soon determined that the metal could be cut, and that the chief reason this had not been discovered before was that the cutting flame had not been powerful enough and experimenters had not gone far enough.

Theory of the Cutting of Cast Iron

It will be remembered that cast iron contains carbon, silicon, manganese, phosphorus and sulphur to the extent of about 7 per cent, the remaining 93 per cent being pure iron. The cutting of cast iron by the oxyacetylene flame depends largely on the oxidation; that is, the actual burning of the metal, and it is well known that the smaller the amount of chemical elements in the metal the easier it may be cut. Therefore steel cuts more readily than cast iron.

The carbon in cast iron is in two forms, graphitic and combined. The graphitic carbon is not part of the pure iron itself, but lies between the flat-sided grains in flakes. On the other hand the combined carbon, just as the name implies, combines with the pure iron and becomes part of it, thus forming iron carbide.

When the cutting torch starts to oxidize, or burn its way through cast iron the oxygen from the torch tries to reach the pure iron, which would readily receive it; *i. e.*, they have an affinity for each other, because it was the original nature of the iron to be united with oxygen and it is the way iron is always found in the earth, *i. e.*, as iron oxide In cast iron, however, the chemical impurities may interfere, especially the graphitic carbon whose flakes lying between the grains of metal retard the burning, just as for example some sheet steel placed between layers of wood would delay the burning of the wood.

Therefore the cutting of cast iron is inclined to go slowly and is not as perfect as the cutting of soft steel, which has

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less than one per cent of chemical impurities and no graphitic carbon flakes to interfere. It is quite possible to bring about a combined burning of the pure iron and melting of the oxide, which undoubtedly is due to the unusually large supply of oxygen and acetylene used by the torch, and to

Fig. 2—Cutting 14-In Steel. Very Little Smoke

the additional fire created in the kerf by the excess of acetylene.

The cutting of cast iron is accompanied with quite some fire and smoke, as shown in Fig. 1. This is caused undoubtedly by the burning of the large amount of graphitic carbon. In comparison there is very little smoke when cutting steel (Fig. 2).

Effects of Cutting on Cast Iron

There is a liberal amount of slag and molten metal from the cutting. The kerf is quite a little wider than that of


Fig. 3—Completion of 12-In. Cut of Cast Iron

steel. The surface of the cut will be covered with a heavy oxide scale, but a hammer blow will shatter and remove this (Fig. 3). The cutting will probably take some of the carbon out of the iron at the cut, but practically there will be no increase of the hardness of the surfaces of the kerf. This very likely is due to the fact that the slag from the cutting covers the surface of the metal with a scale which allows the iron to cool slowly enough to keep the carbon in the graphitic condition and thereby avoid the hardening of the metal.

How to Cut Cast Iron

A regular medium pressure torch for cutting steel may be used, and only a special tip is necessary. The torch should be held so that it is tilted slightly backward for soft gray iron and more so for the harder irons.

The ignition spot on the iron must be bigger and hotter than for steel in order to insure a good start. The variableness of the hardness of the iron in most castings, and also blow holes will affect the cutting, sometimes "putting out the fire." A little spiral motion of the tip, however, usually will overcome the trouble. On the other hand, such a motion also will widen the kerf, thereby increasing the gas consumption.

The preheating flame should be adjusted with an excess of acetylene in order to give a carbonizing jet from 1 to 2 in. long when the high pressure oxygen is snapped on.

The gas pressures are higher than those used for steel, and may be taken from the following table:

Cast Iron Cutting Pressures

Tip Number	Thickness of Metal in Inches	Oxygen Pressure Lb. per Sq. In.	Acetylene Pressure Lb. per Sq. In.
1	½	20	4½
1	¾	30	4½
2	1	30	5
2	1½	35	5
2	2	45	5
3	3	55	7
3	5	75	7
4	7	95	9
4	9	125	9
5	10	130	10
5	12	150	10

These pressures are necessarily approximate as they will vary with the hardness of the casting.


Fig. 4—Cutting Up Scrap Locomotive Cylinders

The cutter should make certain that the oxygen supply is maintained at constant pressure. It is liable to drop due to rapid consumption and thereby affect the flame so as to stop the cutting.

The casting will not need to be preheated other than by the preheating flame of the cutting torch. The oxygen does not need to be warmed. The cutter will find it necessary to protect his flesh, shoes and clothing from the heat and flying sparks.

Economy of Cutting Cast Iron

The cost of cutting cast iron is about five times that of cutting steel. Cast iron can be cut at a rate of about 7 sq. in. per min., while steel can be cut at 30 sq. in. per min. The following are safe figures to use:

To Cut 100 Square Inches of

	Cast Iron	Steel
Time, min.	15	3.5
Oxygen, cu. ft.	123	25
Acetylene, cu. ft.	21	2
Cost for oxygen	$1.85	$ .35
Cost for acetylene	$ .55	$ .05
Cost for labor	$ .20	$ .05
Total cost	$2.60	$ .45

While these figures show the relative cost of cutting cast iron to be high, it is fair to note that the only other way to cut the metal, which is by machinery, would cost at least twice as much as cutting it with the torch. Fair comparative figures would therefore be:

To cut steel by the oxyacetylene torch	$0.45 per 100 sq. in.
To cut cast iron by the oxyacetylene torch	2.60 per 100 sq. in.
To cut cast iron by machinery	5.00 per 100 sq. in.

While it is not to be expected that cutting cast iron with the oxyacetylene torch will have as wide application to shop practice as cutting steel, it is proving to be of valuable service in many ways, of which we may well give some illustrations.

Worn out locomotive cylinders are too big to get through

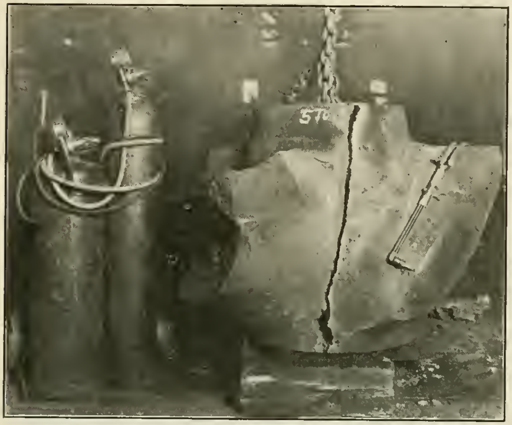


Fig. 5—Cut Made by Torch Through Cast-Iron Propeller Hub Weighing 5 Tons

the charging door of a cupola for remelting. It was the practice to break up these scrapped cylinders with the skull-cracker in the scrap yard, but safety committees are now condemning the use of the skull-cracker, unless the breaking of the castings is done within the confines of a high brick wall, to prevent the flying pieces of cast iron from injuring workmen. Not many railroad scrap yards have such a high wall. Here is where the cutting torch will be of value, as the cutting up of the cylinders may be done quickly and at reasonable cost, considering that the cylinders must be disposed of (Fig. 4).

Another application of the cutting torch on cast iron is to be found in the removal of worn bushings of locomotive cylinders and steam chests. These were formerly chiseled out, but the torch is now cutting them out in one-tenth the time. No damage is done to the cylinder wall by the cutting.

Heavy sections of cast iron are easily disposed of, as may be illustrated by the cutting up of a hub of a propeller. A cloud of smoke usually comes from the graphitic carbon in the cast iron. Fig. 5 gives a good idea of the slot, or kerf, made by the cutting torch, while Fig. 6 reveals the character of the cutting as the two parts of the hub are separated. The cut is rougher than would be found in a more important job. This scrap casting was a problem to its owners. It could not be smashed, it dare not be thrown overboard, it looked as if it would have to be buried to get it out of the way, when the cutting torch proved to be the solution.

The cost figures for this job may be of interest. They were:

Oxygen	$15.00
Acetylene	6.85
Labor	1.56
Total	$23.41

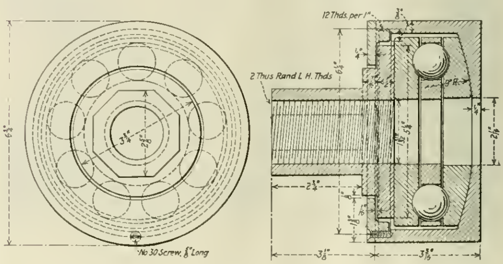
There are many other cases in which the oxyacetylene cutting of cast iron has proved of good advantage, such as

Fig. 6—Cast-Iron Propeller Hub After Being Cut by Oxyacetylene Cutting Torch

the beveling for big cast iron welds, cutting cast iron pipe, cutting up the cast iron bases of machines, making alterations in iron castings in locomotive shops, and other similar work.

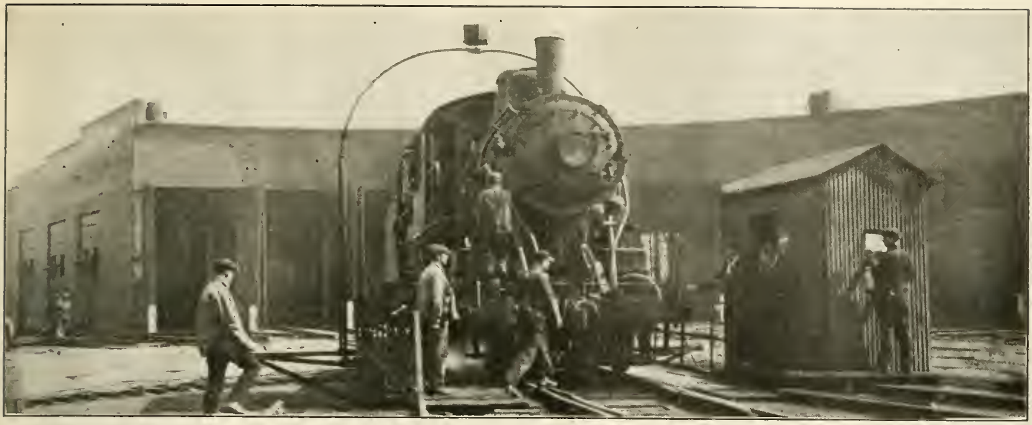
Ball Bearing Nut for Valve Bushing Puller

The work of pressing in or removing piston valve chamber bushings as ordinarily performed, is a laborious task. Power-operated devices for doing this work often are not satisfactory because they are unwieldy and require considerable time



Details of Construction of Ball-Bearing Valve Bushing Nut

to set up. A method which has proved highly satisfactory is to use a ball-bearing nut of the type illustrated. This reduces the friction materially so that by the use of a long-handled ratchet wrench the bushings can readily be applied or removed by hand.

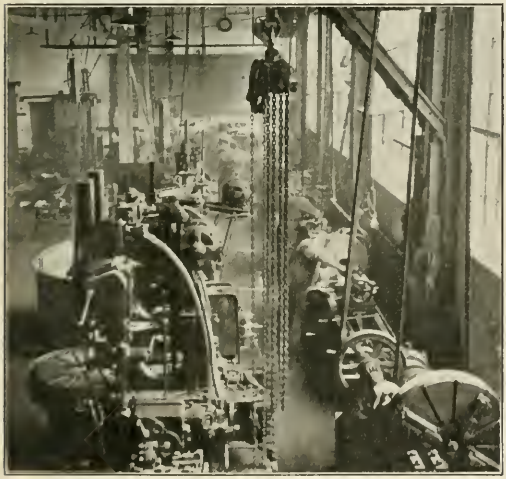


From the Turntable Side

Erie Builds New Enginehouse at Jersey City, N. J.

An Old Structure Destroyed by Fire Is Replaced Without Interference With Locomotive Operations

The Erie Railroad has recently completed a new engine terminal at Jersey City, N. J., which includes a 21-stall enginehouse, machine shop and other facilities, the construction of which was carried on "under traffic." It replaces an old layout which was destroyed by fire and was built on the old site without interference with operation, the old turntable and radial tracks being kept in use for the turning and servicing of both passenger and yard locomotives. Because of the restriction as to location and space and the necessity for non-interference with the motive power movements, the design and construction are both novel and interesting. The new building is a combination of a radial type 105-ft. enginehouse and a rectangular building.



General Arrangement of the Machine Shop

The old enginehouse was of timber construction with 21 stalls served by an 80-ft. turntable and adjoined Pavonia avenue, a heavy trucking thoroughfare ending at the ferries. The back wall of the structure was parallel to the street line, a plan that was followed in the construction of the new enginehouse. In conjunction with the 21 stalls in the enginehouse, there was a repair bay containing 8 tracks, which connected with 6 radial tracks at one end and with a transfer table at the other. This transfer table is located between and serves the repair bay and a rectangular enginehouse of 12 tracks known as the "long" house. The fire destroyed the main part of the layout, leaving only the transfer table and the "long" house. Most of the engine pits, which were of timber, were badly damaged.

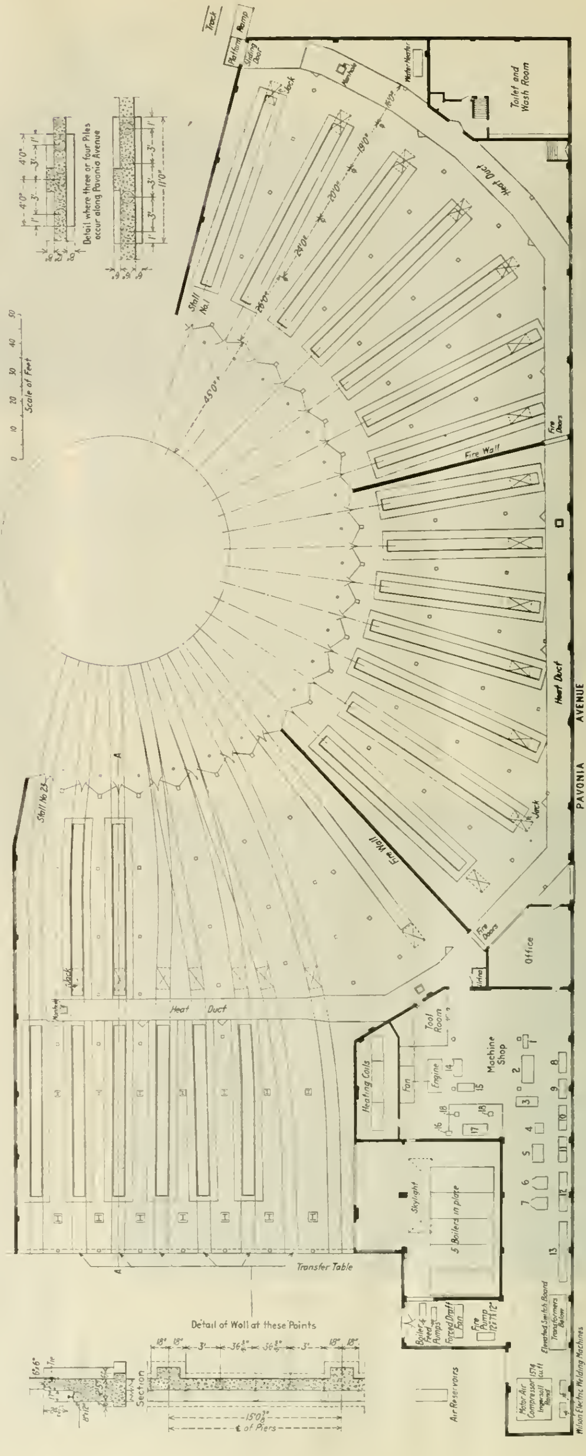
Jersey City is the eastern terminal of the Erie and, as a result, a large freight and passenger business is handled at this point. In addition there is a heavy commuter traffic. The freight engines and through line passenger engines as well as a large number of switching and yard locomotives are turned at the Secaucus engine terminal in the Hackensack meadows. The Jersey City enginehouse is primarily for the servicing of the commuter engines although all of the New York division passenger locomotives and a few yard locomotives are also handled there. About 200 engines are turned daily at Jersey City which, in connection with the congested layout, presented a problem that was easily rendered serious by the loss of the enginehouse. It became imperative that the utmost speed be developed in erecting another structure with a minimum of interference to engine movements and motive power repair requirements since under the circumstances the old tracks had to be continued in use. At the same time it was desired to use this opportunity to modernize the layout. The result was that construction and design proceeded almost simultaneously and both were largely prescribed by the existing conditions, predominant among which was the location of the turntable.

The new layout is a rectangular shaped building, having straight walls on three sides and the customary inner circle of doors facing the turntable. It is of brick and concrete construction with a timber superstructure of the shed roof type modified to fit the rectangular shape at the corners and where joining into the machine shop and the repair bay monitor. There are 21 stalls, divided into three sections of seven stalls each, one section adjoining and actually being a part of the eight-track repair bay of the monitor type. In one corner of the rectangular house beyond the radial section is located a large machine shop, the boiler and engine room, forges, air compressors and pumps, hot air heating equipment and the offices. A similar corner, although smaller, at the other end has been utilized for the washroom, shower baths, and lavatories and above this, in a small second floor, are located the lockers. A lean-to adjoining the north wall of the repair bay houses the pumps, tanks and other machinery for a complete boiler washing system.

The engine stalls are designed on the basis of a standard 105 ft. house with five bays spaced from inner to outer wall at distances of 26 ft., 24 ft., 20 ft., 19 ft., and 16 ft. The limiting factor of the distance from the center of the turntable to the street line made it necessary to continue the old angle between tracks of about 8 deg., 12 min., 49 sec. in order to secure sufficient clearance at the doors, instead of the usual standard of the Erie for this length of stall of about 7 deg. The roof structure is of timber overlaid with Barrett roofing and is supported upon wooden posts spaced as described above.

The repair bay is of the monitor type with a steel superstructure fabricated from floor beams, chords, etc., taken from an old steel bridge across the Susquehanna river. This work was done by company forces, the erection being handled by the bridge gangs. A 15-ton electric traveling crane will be installed in this section of the building, provision having been made in the design and construction for this purpose. The crane bay is 42 ft. 7½ in. wide from center to center of posts and runs the full length of this section. A Whiting hoist of 200-ton capacity has also been installed in this section in conjunction with four new concrete pits. Other crane and hoisting facilities consist of a series of six post cranes of 16-ft. radius installed at convenient points throughout the house.

Within the circle there are three stalls without engine pits, five with old wooden pits, four of which have been extended with concrete, and 13 new concrete pits with inside lengths varying from 52 ft. to 89 ft. This seven-stall section at the east end of the house has been floored with 6 in. of concrete poured with depressed drains on each outer side of the pit rails. These drains connect with the engine pits and carry off quickly any water which may accumulate on the floor during boiler washing, this section being used chiefly for that purpose. One pit contains a concave section of track with a 5½ in. drop, an arrangement which permits of easy removal of spring hangers, etc., without use of drop pits



General Plan of the Erie Enginehouse Layout or hoists. The remainder of the enginehouse and repair bay has a cinder floor. The machine shop floor is Kreolite wood block laid on concrete while the boiler room, blower room and pump room are floored with concrete. Alternate installations of Johns-Manville and Dickinson smoke jacks have been made on which to secure comparative performance data.

The structure is heated by a modern installation of heating coils and blower discharging into a concrete air duct situated below the floor and around the outer circle. This duct is tapped between each two stalls by lines of vitrified clay pipe which carry the heated air to the engine pits. Wherever the enginehouse tracks cross the duct, the upper slab has been reinforced and in addition, the running rails are carried in a double rail trussed construction of ample strength.

Electrically Equipped for Economical Operation

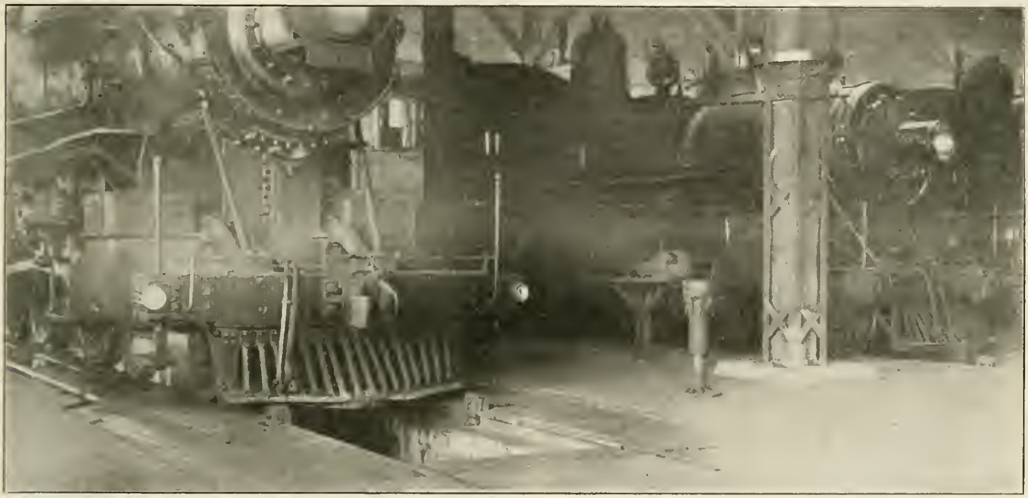
The power used in the enginehouse for machine shop and other uses, is purchased from an outside source supplying two-phase energy at 2,300 volts, and 60 cycles which is stepped down to 220 and 110 volts according to needs. A unique method has been utilized to prevent the destructive action of gases on wiring installed in conduits above the gas line. From the switchboard at one end of the enginehouse, the conduit is led out through the street wall and along and over the exterior of the building. At points where it was necessary to run wiring above the gas line, it was accomplished by mounting the wire on glass petticoated insulators supported on the rafters.

Lighting and Welding Facilities

On the inside of the street wall, two 100-watt lighting units are installed between stalls and so arranged that the light beams from each will cross each other, both also being inclined downward to an angle of about 15 deg. from the horizontal. A single unit of this type is mounted on the door posts. The circuits for this latter installation are brought over the roof of the enginehouse and down on the outside of the door posts. Three flood lights mounted on the roof, keep the turntable well lighted at night. Facilities for arc welding are furnished by two Wilson two-man sets delivering sufficient current for four welders through cables tapped at each stall and terminating in a 150-ampere charging receptacle. The welder simply plugs in his welding lead at the proper receptacle, removing it when he has completed his work.

The majority of the machine tools are belt-driven from an overhead line shaft operated by a 50-hp., 220-volt, two-phase motor with a 30-hp. motor in reserve which can be substituted immediately by throwing on a belt. Two large turret lathes, a blower fan, and a large Ingersoll-Rand air compressor unit have individual motor drives. The latter unit is of the duplex, two-stage, constant speed type with a capacity of 1,574 cu. ft., the regulation of the supply being accomplished by a five-step clearance control which loads or unloads the compressor in five successive steps, according to needs. The motor is a 260-hp. synchronous motor operating on 2,300 volts. The plant supplies air at 100-lb. pressure for use in the electro-pneumatic interlocking plant, for charging train lines and for various shop and enginehouse requirements.

The air line to the enginehouse stalls is carried on brackets with other pipe lines suspended from the rafters and following around the building 30 ft. inside of the doors. There are five distinct lines, aside from the steam line, consisting respectively of a 3-in. air, a 4-in. cold water, a 4-in. filling, a 4-in. washout and a 5-in. blow-off line. Each pit has individual connections.



Boiler Washout Section, Showing Depressed Drains, Post Cranes, Etc.

The Machine Shop Equipment

The machine shop is well arranged and well equipped for the work to be performed, which consists entirely of light running repairs. Should heavier repairs be required, a locomotive is sent to the North Shop on the other side of the tracks. At the entrance from the enginehouse to the shop there is a toolroom which serves all the men whether working in the shop or on locomotives. Adjoining this on the same side is a double blacksmith forge with a blower, two anvils and a trip hammer. A 3½-in. bolt threader is also placed on the same side of the room in a position for convenient use.

Six engine lathes are arranged in line along the street side of the shop. These range in size from 14 in. by 6 ft. to 36 in. by 20 ft. In front of the lathes is a 60-ton rod press, a double-end emery wheel grinder, a 42-in. drill press, a 4½-ft. radial drill, a 28-in. shaper, a 24-in. vertical turret lathe, and a 42-in. vertical boring mill.

List of Shop Tools and Equipment

The location of the various machine tools is shown on the general plan by numbers given in the following table:

1—60-ton rod press.
2—4½-ft. Mueller radial drill press.
3—28-in. Smith & Mills shaper.
4—20-in. by 3-in. double-end emery wheel grinder.
5—42-in. drill press.
6—24-in. Bullard vertical turret lathe.
7—42-in. Colburn vertical boring mill.
8—14-in. by 6-ft. Cisco engine lathe.
9—17-in. by 8-ft. National engine lathe.
10—18-in. by 8-ft. National engine lathe.
11—18-in by 8-ft. National engine lathe.
12—28-in. by 12½-ft. Boye & Emmes engine lathe.
13—36-in. by 20-ft. New Haven engine lathe.
14—3½-in. Adams bolt threader.
15—Trip hammer.
16—Buffalo forge blower.
17—Double blacksmith's forge.
18—Two anvils.

Protection Against Future Fires

Ample precautions have been taken for proper fire protection in addition to the fire walls between each of the seven stall sections and between the machine shop and the enginehouse proper. A fire pump situated in the machine shop connects with the main intake water supply by a system of valves which are normally set so that the water is by-passed around the pump. Each valve is plainly numbered while a large chart shows clearly what valves should be turned to deliver water to any section of the building or the yard. Fire hose connections have been installed between every two pits within the building, as well as on the roof structure, there being five in the latter instance alone. In addition numerous other hydrants are installed in and around the remainder of the building.

Methods Necessitated Close Co-operation

The construction of the Erie house necessitated close cooperation between the engineering, motive power and operating departments. The broad plan adopted was for the construction forces to be allowed three tracks at a time, free from interference while the operating department would deliver each 24 hours the designated cars of material before the starting of work each morning. The engineer in charge of construction was given authority to move engines in the roundhouse not under repair from stall to stall according to the needs of the occasion. This factor in itself eliminated much waste motion since it was possible to return one or more tracks to the motive power department and take possession of others promptly, thus keeping the construction forces and equipment steadily at work.

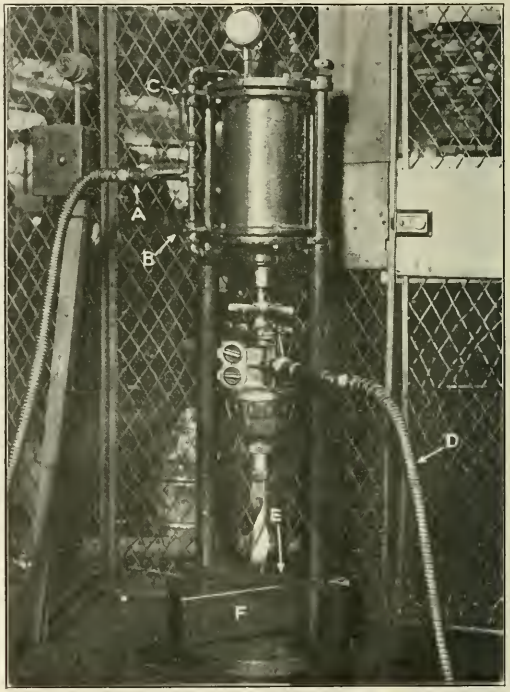
The new enginehouse was designed by the engineering department of the Erie, R. C. Falconer, assistant to the president and chief engineer, C. H. Splitstone, superintendent of construction and surveys; F. A. Howard, engineer of structures, and O. V. Derr, resident engineer, in active charge of construction in the field. The Austin Company, Cleveland, Ohio, was the contractor for the superstructure and Frank D. Brown of Jersey City, N. J., for the substructure.

Air Motor Testing Device

In view of the large number of pneumatic motors used in railroad shops it is essential that they be kept in good repair and operating as near as possible at maximum efficiency, otherwise there will be a large aggregate loss of time and effort in doing the work. There is nothing much more discouraging to a machinist on locomotive frame work, for example, than to be compelled to drill out old frame bolts with a motor which lacks power or cannot be accurately controlled by the valve.

Various forms of brakes have been developed for testing air motors but results obtained with this form of apparatus are not wholly reliable since the motor spindle is not subject to pressure as in actual service. The apparatus shown in the illustration has been developed at the McKees Rocks shops of the Pittsburgh & Lake Erie for the purpose of testing motors under actual working conditions. As shown in the illustration the device is simple, consisting of an 8-in. air brake cylinder mounted in a vertical position between two heavy rods secured in a substantial base casting. The upper ends of the rods are turned down to 1½ in. in diameter to accommodate the special cylinder heads which serve to hold the cylinder in place. The lower sections of the vertical rods are retained at their original diameter of 2¼ in.

For purposes of test, a motor is mounted in the device as shown, being guided at the drill by crossbar *E* and resting on test block *F*. Air is supplied to the cylinder through the flexible hose on the left and valve *A*. Valves *B* and *C* are three-way cocks so arranged that when *B* is closed and *C* opened, for example, air is admitted on top of the cylinder and exhausted from the bottom. This forces the piston down on top of the air motor with a pressure indicated by the gage and which can be regulated to any desired amount. Air is supplied to the motor by means of hose *D*, and after the test is over the motor can be released by closing valve *C* and opening valve *B*. There is approximately 100 lb. pressure on the shop line.



Home-Made Air Motor Tester

For testing, the air motor is set up as illustrated with a 2-in. drill in the socket, the drill point resting on test block *F*. Pressure is applied slowly until the air motor is pulling to capacity. The revolutions per minute can then be counted and the pressure noted. The pressure required to stall the motor can also be noted, and, provided the condition of the drill point as regards sharpness is kept constant, this pressure will be a measure of the efficiency of the air motor. If the motor does not come up to the requirements it can be overhauled and the difficulty corrected.

Some Faulty Shop Methods

By Thomas E. Stuart

It is often said that we learn by making mistakes. The wise man, however, does not make the same mistake twice, nor does he knowingly repeat mistakes made by others. It is my purpose to cite some examples of bad shop practice and while some of these practices are palpably wrong they are still followed in a few shops.

Blocking Under Cylinders

The first pertains to boring locomotive cylinders. In a certain shop, locomotives after being stripped for heavy repairs are placed upon blocks. A timber is placed across the pit at the firebox end under the frames. The weight of the front end is carried on blocks placed under the cylinders. In this position cylinders are bored.

To ascertain the distortion of the cylinder walls due to the weight thus placed upon them, they were calipered and found to be from .030 in. to .060 in. less in vertical diameter than in horizontal diameter. As the vertical diameter is always greatest in worn cylinders due to the wear being largely concentrated on the bottom of the cylinder, it will be seen that the distortion was in excess of the amount shown by calipering. Boring in this position did possibly produce a truly round cylinder, but it would remain round only as long as the weight remained on the cylinder walls. On relieving the cylinders of the stress they would naturally return to their normal shape, when it would be most difficult to determine what the actual shape of the bore was.

It is not an easy matter to secure perfectly fitting rings in a truly round cylinder. The fit of rings in a cylinder bored in the manner just described, would be difficult to imagine. It is doubtful if they would ever wear down to a bearing during the time a locomotive ordinarily spends between shoppings.

In the same shop, it is the practice to press in cylinder bushings with an allowance of from .008 in. to .012 in. over the bore. I do not believe it is possible to attain the larger figure in cylinders of ordinary size even when properly bored. With cylinders bored as stated, it could not be done. The allowance should not exceed .004 in. for cylinders up to 30 in. in diameter, and measurements must be carefully made to attain this accuracy. Bushings should in every case be pressed in solidly against a shoulder formed in the cylinder wall, and the front end should project enough to face off flush with the front end of the cylinder so that the cylinder head has a firm bearing against the bushing in a ground joint.

Excess Wheel Lathe Capacity

A new driving wheel lathe of the most modern type was installed in a shop and tried out to the limit of its capacity for the purpose of making a record. The machine proved capable of turning three times as many tires as the output of the shop required when working normally and without overtime. Since the overhead cost on the machine much exceeded the operating cost, including labor, power, tools, etc., there was nothing gained in a financial way by pushing the machine to its limit of output. On the other hand, some of the work was so hurriedly done that roughing tool marks were visible in the treads of the turned tires, in some cases 1/32 in. deep in the center of the tread. If there is one thing that should be essential in a newly turned tire, it is that the contour be exact and the tread smoothly finished, otherwise the wear is most severe and greatest in the first few hundred miles run. The tool marks would be speedily rolled out, causing at the outset considerable wear and loss of contour. If the remainder of the tire wore out at an equal rate, the tire bill would be out of reason.

In fitting piston valve bushings, it is essential that the bores be perfectly round and true and that the two halves of the bushing be in perfect line. This can only be accomplished by making the external surface and the bore exactly concentric, or by boring the bushings after they have been pressed in.

To make the outer and inner surfaces of the bushing truly concentric both of these surfaces should be finished at one chucking. Yet in one shop the bore is finished on a vertical boring mill and the bushing then removed to a lathe to finish the exterior. No mandrel or other absolute centering device is used in the lathe and consequently much time is lost in centering with much probability that the centering is not accurately done. Bad fitting bushings frequently are the result. It would be much simpler to alter the pattern for bushing castings so that these could be chucked, bored, turned and cut off with absolute certainty of true, concentric work, thus securing better fitting and working valves.

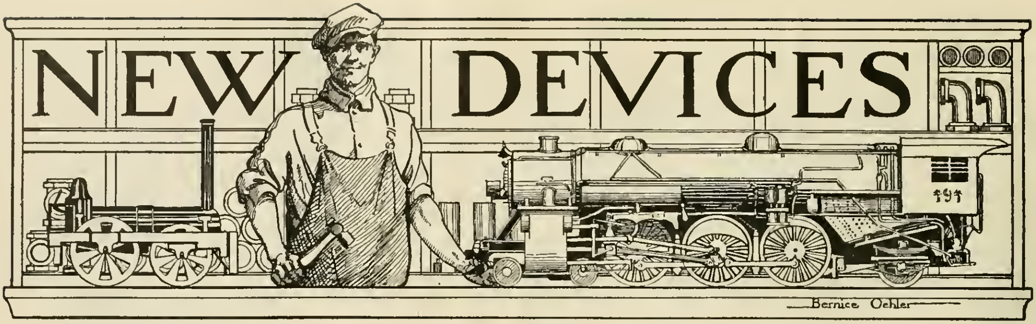
Long practice has conclusively demonstrated that valve motion parts having a reciprocating movement, should have bearings formed of a case-hardened bushing, with case-hardened and ground pins. When properly made and fitted, the wear is comparatively light and the life equal to the engine's mileage, or more. Yet I have seen the practice followed of making the bushings in a lathe, case-hardening them and pressing them into place without grinding. The lathe work was none too good and the finish consequently poor, yet the shop which followed this practice nearly always ground the pins using a tool room cylindrical grinder with a wheel having a ½-in. face. This was a waste of time and labor when the nicely finished pin was put into a rough case-hardened bushing. In the present day, small internal grinders capable of a large output in the hands of even an apprentice boy, can be had for a moderate price. Plain cylindrical grinders are in use in every shop where production is a first consideration and high class work the only thing that will be tolerated.

At another shop, the practice of making bushings from seamless drawn steel tubing was followed until a blacksmith shop foreman demonstrated that bushings, as good or better, could be made to rough sizes in a forging machine at about one-sixth the cost.

Main and Side Rod Replacements

As a final illustration of the effect of shop methods on locomotive maintenance costs, no better example can be offered than a comparison of the practice of two separate roads as regards main and side rod replacements. On road *A* the rod replacements average about one a month for approximately 300 locomotives, practically all of which are of heavy type. In the shops of this road it is the practice to mill rods all over, providing a finish equal to or better than the locomotive builders. On road *B* which has about 1,000 locomotives of all classes, I have seen as many as 100 new rods going through the shops at one time, and it is customary to order them in lots of ten or more. Main rods are finished on the planer, the only milling done being that necessary to afford a tool clearance on fluted rods. Side rods are left as they come from the hammer except at the ends which are planed and slotted. The rod breakage on road *B* is many times that on road *A*.

What is responsible for the difference? It is a well known fact that parts of a machine that are subjected to a reversal of stress will invariably break at some point where there is a flaw, tool mark, or some other weakening influence which serves as the starting point of a crack that eventually terminates in a failure. This is true, regardless of what the original material may be. High tensile strength steel will obey this rule just the same as will ordinary material, the only difference being that it requires a longer time to bring it about. Properly designed and above all, properly machined rods of good material, will inevitably prove to be cheaper.



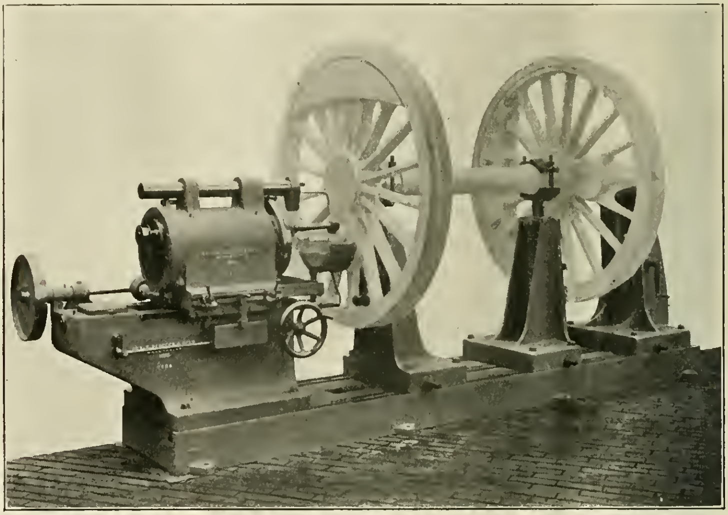
Modern Crank-Pin Grinding Machine

THE machine, illustrated, is designed by Beyer, Peacock & Co., Ltd., Manchester, England, for grinding locomotive crank-pins when mounted in position in the wheels. An accurate, smooth surface is produced, concentric with the original center, and a minimum amount of material is removed, necessary to produce a true pin.

The machine consists of a horizontal grinding head in which a high-grade steel spindle revolves at high speed, and in addition has an eccentric motion imparted to it by sleeves driven by worm gearing. The amount of eccentricity is variable while the machine is running, and by this means the grinding wheel is fed to or from the work being ground. The spindle runs in ball and roller bearings, having dust-proof caps, and is supported close to the wheel by a smooth bearing. The head has longitudinal traverse on the bed, controlled by a sensitive reversing gear and stops. The bed is bolted to a substantial base-plate on which slide the quartering tail-stock and axle support brackets. Hand motion is provided by rack pinion. The tail-stock has vertical adjustment obtained by means of screw gearing and is fitted with a centering bracket for right and left hand cranks. The cranks are accurately quartered at the grinding head by a pin which enters the turning center of the crank-pin to be operated upon, the other crank-pin is centered by a pin in the bracket of the tail-stock, this latter pin being placed at right angles to the grinding head pin.

The wheels are set in alignment by poppet centers on the grinding head and tail-stock, a feature which insures the pin being ground parallel with the center line of the journals.

The machine is provided with countershaft, pumps and fittings. It will deal with pins up to 7½ in. diameter by 15 in. long, 9 ft. maximum distance over pins, and the supports will take wheels up to 8 ft. diameter with crank throws varying from 9 in. to 14 in. The Beyer, Peacock Company is now designing a crank pin grinding machine of similar type to the one, illustrated, to grind crank pins up to 9 in. in diameter.



Crank Pin Grinding Machine Made by Beyer, Peacock and Co., Ltd., Manchester, England

Construction of the Street Locomotive Starter

IN the past numerous efforts have been made to utilize the auxiliary carrying wheels of the locomotive as well as the driving wheels as a source of tractive force. Recently this practice has become more general with the adoption of boosters acting either on the trailing wheels or on the tender truck. The most recent development in appliances of this type is the Street locomotive starter, originated by Clement F. Street, Greenwich, Conn., which was briefly described in the Railway Age of June 22, 1922, page 1710. The function of the starter is somewhat different from that of the booster as it is intended to assist the locomotive only when starting and is designed for use only at very low speeds. The method of application and details of construction of this device are clearly shown in the drawing.

The starter consists essentially of a heavy cast steel ratchet wheel pressed and keyed on an axle and driven by a steam cylinder. The piston of this cylinder is driven through its working or forward movement by steam pressure and through its return or backward movement by a spring. The piston rod has a crosshead on its outer end which engages a wrist pin carried by a pair of lever arms, which on their lower ends surround and are carried by a pair of collars formed on the ratchet wheel. A ratchet which engages the ratchet wheel is carried by and pivoted in the lever arms.

When the machine is idle and during the return stroke of the piston this ratchet is held out of contact with the ratchet wheel by a pair of springs attached to the lever arms. When steam pressure is admitted to the cylinder it passes through the hollow piston rod and through a hole in the crosshead to a small cylinder formed in the crosshead and forces the ratchet down into contact with the ratchet wheel and holds it there as long as the pressure exerted by the steam is greater than that of the springs which hold the ratchet up. The area of this small piston and the strength of the two small springs as well as that of the main spring are so proportioned as to result in the ratchet being forced down before there is any forward movement of the main piston and lifted before it begins its return movement. This arrangement eliminates any dragging of the ratchet over the ratchet wheel and the unnecessary wear and noise which would result if this were permitted.

Steam is admitted to and exhausted from the main cylinder through a piston valve embodied in the rear cylinder head and controlled by a small slide pilot valve which is operated by a stop on the piston rod. This construction has been in use for many years in air brake compressors.

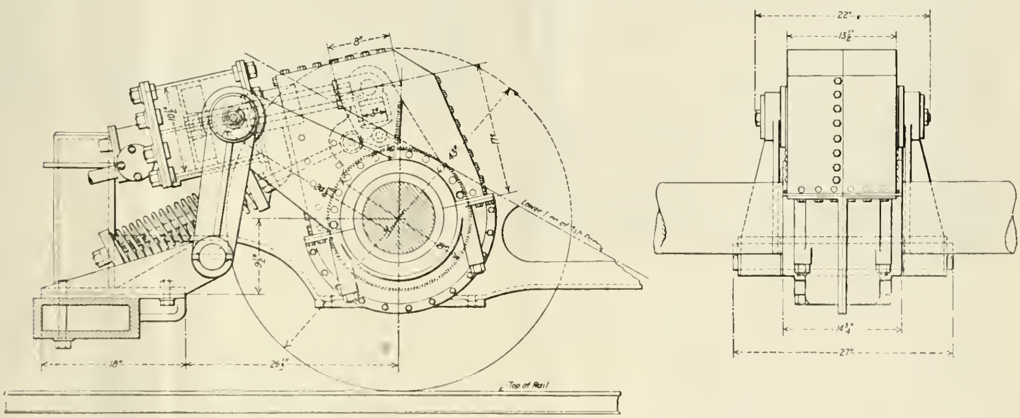
The weight of the forward end of the starter is carried by the axle through the lever arms and the weight of the rear end by the truck frame through a pair of cylinder supporting arms. The lower ends of these arms are carried by a pivot pin secured to the truck frame and their upper ends surround a pair of trunnions cast on the cylinder. These trunnions are tied to the axle through a housing which surrounds the entire front end of the machine. This method of supporting and tying eliminates any possibility of a spreading action between the truck frame and the axle and results in all strain transmitted to the truck frame by the starter being in almost a direct downward direction. As the only connection between the truck frame and the starter is pivotal it can move vertically in relation to the axle without hindrance or limit. Lateral movement of the axle is cared for by clearance between the hubs of the ratchet wheel and the lever arms. The casing is water and dust proof and carries lubricant for the bearing between the ratchet wheel and lever arms.

The face or bearing surface of the ratchet and ratchet wheel at the point of contact is four inches in width, the ratchet teeth are ¼ in. in depth and five in number.

The maximum pressure coming on these teeth is 32,000 lb. and while five teeth are provided, any single tooth has ample strength to withstand any strain which must be transmitted through this point.

The control mechanism has been reduced to the most simple form and consists of a one inch steam line leading from the dome of the locomotive to the cylinder of the starter with a throttle at the dome and a flexible joint at the cylinder. The throttle is opened and closed through the medium of a ¼ in. copper pipe leading from the throttle to a push button in the cab. When the push button is held down the machine will run and when it is released it will stop. This button can be operated by either the foot or the hand of the engineer.

A machine of this character must respond instantly when action is demanded and there is no time to wait for water to run out of pipes and cylinders. Therefore the throttle must be placed near the dome or source of steam supply and the cylinder and all steam passage must be free of water when the machine is not working. The Street starter has an automatic drain valve at the lowest point of the cylinder which remains open at all times when there is a pressure of less than about 10 lb. in the cylinder and closes automatically under any greater pressure. There are no pockets in the piping and when the throttle is opened the steam has an unobstructed passage to the piston. The throttle is of the double seated balanced type and is fully opened as soon as the button in the cab is pressed.



Side and End Views of Starter as Applied to Locomotive Trailing Axle

The starter exerts its greatest force when standing when it is needed most. It has no dead points and the tractive force exerted at the rim of the wheel is practically constant and the maximum permissible at all times when the machine is working.

The machine shown in the drawing is designed for application to a locomotive trailing truck having wheels 43 in. in diameter and carrying a weight of 52,500 lb. The tractive force exerted at the rim of the wheel with a 10½ in. cylinder and 200 lb. boiler pressure would be 12,900 lb. When making applications to trucks requiring more or less power than this the cylinder and piston are made of different diameter but all other parts of the machine remain practically the same.

The machine illustrated is called the Type A; another smaller and less powerful, called Type B, is built for application to tender trucks. The starter is intended for moving a locomotive in one direction only, and if it is wanted for backing a second machine can easily be applied.

The device is primarily a locomotive starter and is cut out as soon as the train is well under way. In passenger service it will eliminate starting shocks resulting from taking slack. In freight service it will eliminate the need for taking slack in order to get a train under way and in so doing reduce break-in-twos, and draft gear and coupler failures.

Double Cutter Tool-Holders Withstand Tests

SOLID forged tools are superior to most inserted cutter tool-holders because the latter do not afford the same rigid support to the cutter point, and the heat conductivity of the tools is diminished. These defects, which prove serious on heavy turning and planing operations, are said to be overcome in the new line of tool-holders with interchangeable double cutters, made by the Morris Tool Company, Inc., New York City. Recently, various sizes of Morris tools were tested under actual working conditions in a prominent eastern railroad shop and found well suited to meet the severe requirements of this work. These tools, in the large sizes, will stand up under the heaviest wheel lathe roughing cuts, and the small sizes are adapted to the finest toolroom work.

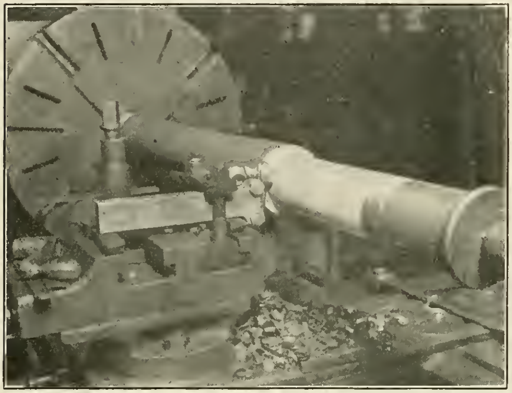


Fig. 1—Roughing Tool Taking $\frac{7}{8}$-in. Cut on Car Axle

From Figs. 1 and 2, the general design of Morris double-cutter tools will be evident. The double cutter, made of scientifically heat-treated high-speed steel, is firmly secured to the heat-treated chrome-nickel holder by two bolts and nuts. These bolts, also of heat-treated chrome-nickel steel, unite the cutter and holder firmly and intimately so that they are virtually one as regards support and conductivity.

The side and front angles of the double cutter are always correct, as fixed by the manufacturer, and sharpening is accomplished by grinding the top surface at the required angle. Allowing 1/32 in. for each grinding, the cutter can be ground 20 times on each side, as shown at *A*, Fig. 2, giving a service equivalent to that of two forged tools. Twenty more grindings on each side, equivalent to two more forged tools, can be made, leaving the cutter worn away as shown at *B*. The tool is used finally, as shown at *C*, as a draw stroke or goose-neck planer tool, obviously of efficient design for this work. Ten grindings can be made on each side of the draw stroke tool and a total of 100 grindings is therefore obtained on one No. 6 double cutter (more on larger sizes), equivalent to six forged tools.

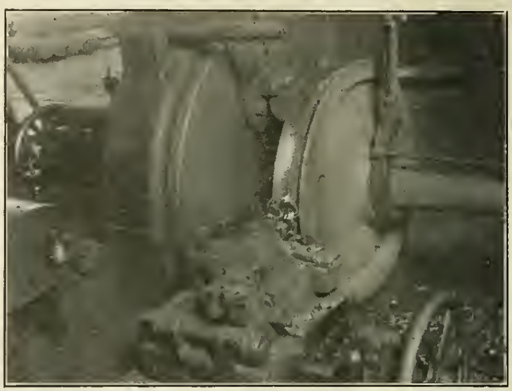


Fig. 3—No. 18A Roughing Tool Used in Sellers Car Wheel Lathe

Morris tools are made in 13 sets (No. 2 to No. 18B), the tool-holders varying from $\frac{1}{4}$ in. by $\frac{1}{2}$ in. by 4 in., to $2\frac{1}{2}$ in. by 3 in. by 24 in. Tool No. 18A is $1\frac{3}{4}$ in. by 3 in. by 22 in., being made to fit the turret tool post of a Sellers car wheel lathe. The blade thickness varies from $\frac{1}{8}$ in. to $1\frac{1}{8}$ in. The tool-holders are made with straight and offset shanks and, being reversible, one offset shank provides for both right-hand and left-hand positions. Threading, cut-off and side tools are also furnished. The cutters are interchangeable for either position and may be used until practically ground down to nothing at the cutter point, thereby economizing on high-speed steel. A unique feature is the vertical offset of the cutter holding bolts with respect to the holder center line which, by turning the tool-holder over, provides for adjusting the cutting point to the proper height as it wears down. Another important feature is that tool dressing expense is eliminated, the cutters being purchased from the manufacturer who makes them in quantity and

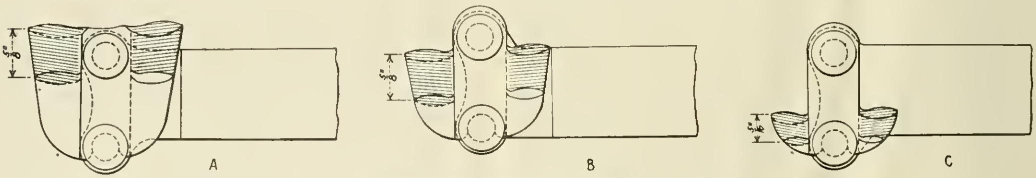


Fig. 2—Morris No. 6 Tool-Holder and Double Cutter, the Equivalent of Six Forged Tools

naturally knows what heat treatment will give the best results.

In the railroad shop tests referred to, the No. 12 tool, illustrated in Fig. 1, was first used in roughing down a 6-in. steel engine truck axle. The lathe was driven by a belt which started to slip before a fair chip could be taken. The belt slack was then taken up and a roughing cut taken, as illustrated. The reduction on the axle in this case was 1¾ in., the depth of cut being ⅞ in. and the feed 1/16 in. A speed of 50 ft. per min. was maintained. At the highest capacity of this belt-driven lathe the tool showed no signs of distress.

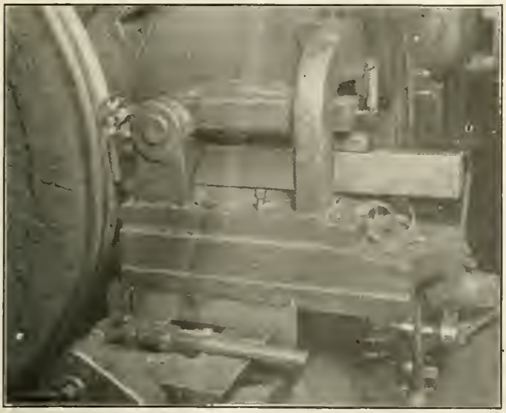


Fig. 4—No. 18AA Roughing Tool in Driving Wheel Lathe

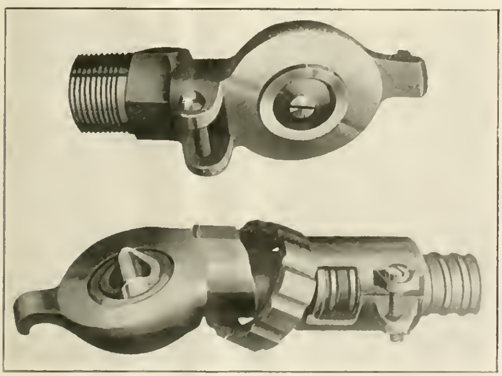
In Fig. 3 a No. 18A tool was put in the car wheel lathe and a pair of 36-in. steel car wheels applied ready for turning the tires. On the roughing cut, a feed of ⅜ in. was used, the depth of cut being ½ in. and the speed 11 ft. per min. The roughing cut was taken up to the flange and the flange turned to the proper height in 15 min., two roughing tools being used and two tires turned at the same time. These tires were finished with the usual forming tools held in the wheel lathe turret, 10 min. being required to finish the tire. With 3 min. for applying the wheels in the lathe, the total time from floor to floor was 28 min. This was quite a severe test of the tool, the chips coming off a deep blue and indicating the severe duty which any tool must stand to cut under the crystallized tread of a steel car wheel.

A No. 18AA Morris tool (2 in. by 3 in. by 22 in.) was tested in the big driving wheel lathe on a pair of main drivers, as shown in Fig. 4. A feed of ⅜ in. was used, the depth of cut being approximately ⅜ in. on this pair of wheels and the surface cutting speed 11 ft. per min. Forty minutes were required to take the roughing cut across both tires. While the cut in this case was not very deep, due to small wheel mileage and wear, at ⅜-in. feed the Morris tool is said to take whatever depth of cut may be necessary to restore the normal tire contour.

Air Hose Coupling with Automatic Stop Valve

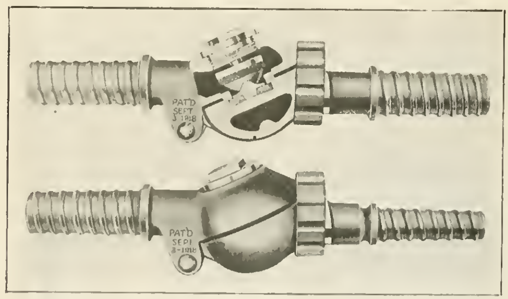
A SHOP air hose line coupling, one half of which is automatically closed by a check valve when the coupling is separated, is being placed on the market by the Robinson Machine Company, Muskegon, Mich. The coupling is made for use in hose lines or for connecting hose to the permanent pipe line.

In the latter case, the pipe line half, which contains the automatic check valve, is machined and fitted with a valve cap opposite the connecting face. The valve consists of a brass stem fitted with a specially treated leather disc facing, which is easily replaced without the use of special tools. The valve stem is centered in a reamed hole in the valve cap. The pressure of the air acts on the top of the valve, causing it to close automatically when the couplings are separated and keeping the opening tightly sealed as long as the pressure continues. Two lugs project beyond the face of the coupling at its hose or pipe line connection end, which serve to protect the seat when the coupling is being dragged along the floor at the end of a hose. These lugs are connected by a pin under which the hook on the end of the other coupling half is inserted when making a connection.



View of Coupling Showing Automatic Stop Valve

The other half of the coupling has two small projections on opposite sides of the port opening. When the coupling is made these projections push the valve open, automatically admitting air to the hose line. The face of this half of the coupling is recessed to receive a specially treated gasket which is cemented permanently in place. These gaskets under severe tests in actual operation have held up for from six months to one year. When the connection is made the two halves of the coupling are locked together by an eccentric clamping ring on the hose shank by turning the ring in either direction from a central position.



Coupler or Hose Connections Showing Shanks for ½ and ¾-In. Cylinders

For use in hose lines both halves of the coupling are made with hose shanks. All hose couplings are fitted with a positive grip clamp which eliminates the tendency for the coupling to blow out of the hose line.

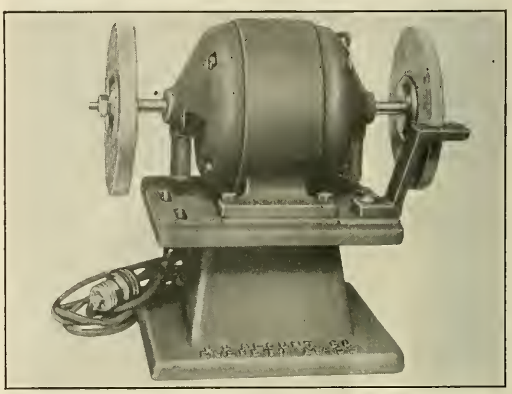
By using this type of coupling on the termini of service pipe lines, it is said to be unnecessary to employ a globe valve for shutting off the air. The check valve in the coupling closes automatically when the hose line is disconnected and maintains a tight joint as long as the air pressure is on. The use of these couplings thus saves considerable time in connecting and disconnecting pneumatic tools from the hose line, since it is unnecessary to leave the work to open and close a valve at the end of the pipe line. By closing the line at the point where the connection is to be made they also eliminate the loss of air pressure contained in the hose line.

Bench Type Motor Grinder and Buffer

DESIGNED to operate on either alternating or direct-current circuits, a new combination motor grinder and buffer of the bench type has been developed by the J. G. Blount Company, Everett, Mass. This machine is provided with so-called Blount special plain bearings and a standard Westinghouse single-phase, ¼-h.p. motor designed to run at 1,800 r.p.m. The machine runs on alternating current, either 110 or 220 volts, 60 cycle, or single-phase. Thirty-two, 110, or 220-volt direct current can also be used as desired.

A substantial base is provided for this machine, of ample strength and weight sufficient to minimize vibration. The flanges are machined all over to insure balance. The grinder has a pan to support the guards and rests. The guards can be furnished for either side for use with grinding wheels and an extra rest for the left side if it is required. The buffing wheel is of the standard make and is placed on the left side of the machine. The equipment furnished with this grinder consists of one 6-in. by ½-in. standard grinding wheel, medium grit; and two rests for right-hand side; one 7-in. by ⅜-in. buffing wheel (sewed); and attaching cord with standard plug.

This combination grinder and buffer is a convenient bench tool, being adapted to use in almost every department of railroad shops. For grinding tools, small castings and small machine parts, also for buffing operations it should prove convenient and adaptable, saving considerable hand work.

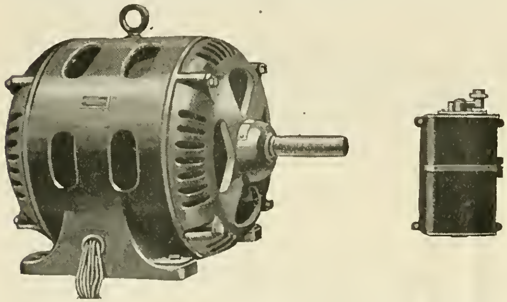


J. G. Blount Bench Type Motor Grinder and Buffer

Multi-speed Alternating Current Motors

THE Louis Allis Company, Milwaukee, Wis. is announcing a new line of multi-speed induction motors which provide for speeds of 600, 700, 900 and 1,200 r.p.m. The principal point of distinction claimed for these motors is the introduction of the 720 speed.

The multi-speed motor is of the squirrel cage type, having a rotor similar in construction to that of the standard single speed polyphase squirrel cage motor, manufactured by the same company. The external appearance of the motor is identical with that of the standard induction motor except that additional leads are brought out from the several stator windings. The motor is built for either two, three or four speeds. A separate stator winding is used for each speed, giving approximately the same operating characteristics as the squirrel cage motor running at this particular speed. As each stator winding is independent of the other, the winding may be designed for any required horsepower at that speed, providing the capacity for that particular motor frame size is not exceeded. The motors are designed for constant horsepower, constant torque or any combination of both.



Watson Multi-Speed Induction Motor and Drum Controller

The standard single speed squirrel cage motor when wound for three phase current has three stator leads. The multi-speed motor has one common lead and two leads for each of the various windings. The changes in speed are accomplished by a simple drum controller for either two, three or four-speed motors. In the case a two-speed motor is used for non-reversing service it is only necessary to provide a three-pole double throw knife switch for speed changing. The drum controller is so designed that any selected winding of the motor may be connected to the line giving the desired speed. The windings not in use at any particular moment are open. The manufacturer states, however, that no appreciable voltage is generated in these windings during this period.

The starting or protecting device used with the multi-speed motor may consist of any standard or automatically controlled switch which is adapted to a single speed squirrel cage motor. In the case of a constant horsepower multi-speed motor which has the same horsepower rating at all speeds, one set of overload relays on the starter will afford protection throughout the complete speed range. With a constant torque multi-speed motor it is necessary to supply an additional set of relays for each stator winding, if overload protection is to be provided at all speeds. The speed changing device which may consist of a knife switch or drum controller is a separate unit of control and except in the case of automatic control is used for speed changing only. The manufacturers offer several different types of automatic control for these motors consisting of the drum controller and an automatic starting panel. For automatic control, the drum is provided with auxiliary contacts which actuate the starter at the proper intervals.

The motors are built in sizes of from 3 to 15 hp. and are built for either three-phase or two-phase current with one exception. Two winding four-speed motors in which the speed changes are accomplished by polar grouping are suitable for three-phase operation only.

Electric Sifter with High Capacity

A FORWARD step in foundry practice is taken with the advent of an electric sifter made by J. D. Wallace & Co., Chicago. The Wallace electric sifter is said to sift a ton of moist molding sand in four minutes through a No. 2 riddle, delivering the sand perfectly cleaned and thoroughly mixed. The light weight of the sifter permits it to be hung from any convenient support at any desired height and a molder can easily move it over his sand pile, or sift directly over core trays or flasks. The greatest vibration is only 5/16 in. from its vertical position. The drive is by means of a special electric motor connected direct to the riddle. The motor is a vertical General Electric motor in which the armature and shaft remain stationary and the field and housing revolve at high speed. The housing, being weighted on one side results in an extremely rapid and regular vibratory motion similar to that of an eccentric fly-wheel.

Wallace Sifter Driven by Special Electric Motor

This motor is enclosed in a dust and grit proof casing and cooling air is circulated around the motor by its own peculiar motion. The air is drawn in at the top of one arm of the supporting frame tubing and after circulating around the motor is expelled at the top of another arm. A valve trap at the air intake prevents dust and dirt entering the motor.

The machine comes equipped with an 18-in. riddle with No. 2 screen which can be readily changed or removed by simply loosening the riddle clamps. The Wallace electric sifter should prove of value in railroad iron or brass foundries because of its time- and labor-saving features, coupled with portability, light weight and sturdy construction.

Gage for Measuring Steel Wheel Wear

A GAGE for measuring the wear on steel wheels, adopted as a standard by the American Railway Association in 1920, is now being manufactured by the Pratt & Whitney Company, New York. This gage, as shown in the illustration, gives a direct reading of the amount of service metal on a steel, or steel-tired wheel as the basis for billing foreign roads for wheel replacements according to the Interchange Rules. It tells whether or not a worn wheel is worth re-turning to restore the standard contour, and the amount of service metal which will remain after turning. This measurement can be made either before or after turning as desired.

The gage can be set to the wheel in a dark place if necessary, and then taken to the light for reading, thus avoiding errors and guess-work. The witness groove (limit of wear groove) should be checked to insure that it is of the right diameter—29½ in. for a 33-in. wheel. The contour should also be taken at several points so that the point of maximum wear may be found.

As shown in the illustration, this gage consists of a main frame to which a sliding front plate with a standard tire contour is fitted. The position of the front plate with respect to the main frame is indicated by the upper scale. The distance from the tread to the witness groove is indicated by the sliding scale and pointer shown at the right. Four adjustable sliding pointers are arranged to make contact with the worn tire, as plainly shown in the illustration.

In using this gage it is applied over the worn tire with the sliding pointer swung to engage the witness groove, as

Pratt & Whitney Gage Applied to Worn Tire

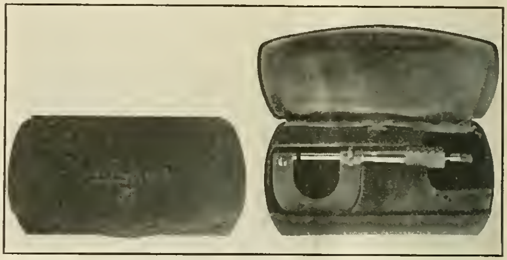
illustrated. The four sliding pointers are pushed down to contact with the tire and the gage is then removed for reading. The sliding front plate is moved down until its lower edge coincides with the lowest point of the four sliding pointers. The amount of metal which must be removed to restore the standard contour will then be indicated on the upper scale. The amount of service metal remaining will be indicated on the sliding scale.

Leather-Covered Metal Pocket Micrometer Case

A POCKET micrometer case is being placed on the market by the Brown & Sharpe Manufacturing Company, Providence, R. I., in connection with this company's line of micrometer calipers. This case protects the micrometer from dirt and injury and is serviceable and handy. It represents a new departure in micrometer cases and is well adapted for the purpose intended. It is made of metal, leather covered and plush lined, and its shape adapts itself for the pocket so that it takes up very little room.

The illustration shows the case at the left closed and at the right open with a micrometer inside. Two styles of pocket micrometer cases are furnished for the regular Brown & Sharpe 1-in. micrometers and for the Rex 1-in. sizes. Men who own micrometers will be interested in this case as it offers a good protection for the micrometer and a handy place to keep it.

Good tools are essential to accurate work and if there is one thing which distinguishes an experienced, reliable workman from an indifferent one, it is the care with which the former looks after his tools and keeps them from dirt and injury.



Browne & Sharpe Pocket Micrometer Case

Electric Motor-Driven Chain Hoist

AN electrically-operated material-handling device, known as the Motorbloc, has been placed on the market by the Motorbloc Corporation, Summerdale, Philadelphia. This device has been developed to serve the operations lying between the field of standard hand chain hoists and traveling electric hoists. The Motorbloc is a rugged and readily portable hoist, which can be installed without engineering preliminaries in any location where electric current is available. It is put in service with the facility of an electric drill or vacuum cleaner, and the self-contained pendant controller permits convenient operation as soon as the cord has been plugged into the nearest electric circuit.

Motorbloc Hoist As Used in Machine Shop

In the design, great care has been used to avoid stressing the hoisting mechanism beyond the loads and speeds for which it is proportioned for hand operation.

The Motorbloc consists of a standardized chain hoist of steel construction, electrified by the application of a specially designed heavy-duty motor, liberally proportioned reduction gearing and slip friction clutch. This mechanism is applied by means of a malleable iron supporting bracket, comprising a self-contained electrifying unit, to which the pendant controller is also attached. In this way a simple, rugged mechanism has been developed for the electrification of the standard spur-geared chain hoists in capacities ranging from ¼ to 10 tons.

Extreme care has been given to features of compactness, symmetry and balance, combined with lightness and strength through the use of high grade materials, liberally proportioned to meet the most severe service conditions. The armature shaft and worm are carried in heavy duty ball-bearings and liberal provision has been made for adequate, automatic lubrication.

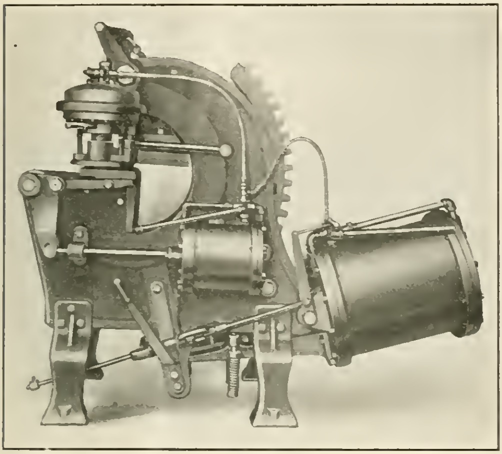
The self-contained pendant controller is easily operated by the fingers of one hand, leaving the other hand free to guide the load. This arrangement makes it possible for one man, without physical effort, to accomplish what would otherwise require two or more men for lifting and placing the same load.

The simplicity of this mechanism is promoted and the operation safeguarded by the use of the ring-oiled slip friction clutch which prevents damage from over-running to the hoist parts and chain and at the same time completely protects the motor from overload, without the complication of an electric limit switch.

The illustrations show the Motorbloc built on a Franklin-Moore all-steel suspension spur-geared chain hoist. For occasional use at points where electric current is not available, or in the event of the temporary failure of electric power, the hand chain can be quickly applied, and the hoist operated as an ordinary block.

Heavy Type Pneumatic Flanging Machine

THE pressing demand for a pneumatic flanging machine which would successfully flange the heavy plates now being used in the construction of locomotives, prompted the McCabe Manufacturing Company, Lawrence, Mass., to build a heavy type machine shown in the illustration. This machine will flange cold any thickness of boiler plate up to and including ¾ in. Circular heads, half heads, dished heads, segments of circular heads and straight flanging are flanged cold. Corners varying from 1¼ in. radius to 8 in. radius are flanged in one heat and with one complete stroke of the bending ram.



New McCabe Machine Which Flanges ¾-In. Boiler Plate Cold

The new McCabe flanging machine is equipped with a patented pneumatic plate clamp. This clamp eliminates most of the manual labor that was required in the former models. By adopting this new clamping device, the speed of flanging circular work has been increased over 50 per cent. The machine is of cast steel construction; is self-contained; requires no foundation; and can be operated anywhere about the shop within range of the air system. All that is required to put the machine into operation is an air hose (100 lb. pressure) and a jib crane for handling the plates. Light plates can be supported by hand but for heavy work the jib crane is practically indispensable.

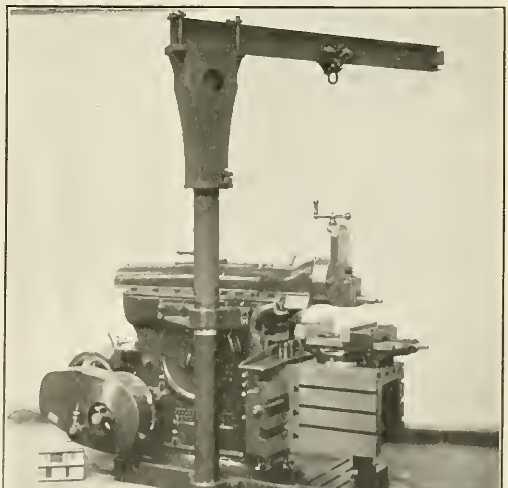
The advantages claimed for previous models are retained in this machine and include ability to flange similar pieces with uniform accuracy, convenience of moving from one part of the shop to another, or from one job to another, flexibility so as to handle various steel-plate shapes used in locomotives and car repairs, coupled with ease of operation. There are two operating levers, one controlling the pneumatic clamp or locking arrangement and the other controlling the movement of the piston which in turn moves the flanging arm.

Jib Crane Applied to Crank Shapers

FOR greater convenience of handling heavy parts to be machined, Gould & Eberhardt, Newark, N. J., have brought out for their shaping machine a simple but substantial jib crane as illustrated. This eliminates the need for overhead cranes, and shapers equipped with the jib crane can therefore be placed wherever is most convenient without regard to overhead crane location. The jib crane is attached to the shaper in the most efficient location, being opposite to the operating side of machine. The machine being direct driven makes it possible to revolve the crane completely around and handle all work which lies within its range.

The design and capacity of the crane is such that it is self-supporting and will handle the maximum weight of work that the machine can accommodate. It also has valuable structural features, including a boom composed of a single I-beam of the required strength to safely provide for a load of 1,000 lb. at its extreme end; a mast of heavy wrought steel pipe securely clamped against the frame at two positions, thus distributing the load to the shaper frame more equally, and an upper pintle of cast steel, rigidly held in a cap attached to the mast and having the ball and socket type bearings which insures proper alinement of the boom at all times, thus making it possible to revolve the crane with a slight pressure.

The machine, as shown, is of modern design being both powerful and compact, and having all levers within easy reach from the operating position. The new start and stop lever is arranged in a convenient location and permits the operator to start or stop the machine while remaining close to the work being done. Single pulley drive is provided; also selective type gear boxes which have all gears heat treated and running in heavy oil. By means of the patented double train gear drive combined with the selective type gear drive, eight changes of speed for every stroke ranging from 9 to 115 strokes per min. are possible. This feature makes



Jib Crane of 1,000-Lb. Capacity Applied to Gould & Eberhardt Shaper

the shaper especially adaptable to use in machine shops where a variety of work is done.

Chambersburg Punching and Shearing Machines

VERTICAL punching and shearing machines, with settings and adjustments of the sliding-head stroke quickly made by means of a patented electric clutch control, have recently been developed by the Chambersburg Engineering Company, Chambersburg, Pa.

A direct motor-driven double-end machine, equipped with the electrical control, is illustrated in Fig. 1. This line of equipment is so designed that machines of different capacities may be operated end to end, as well as machines of like capacity. Belt-driven machines may also be provided with a mechanical pedal control, as illustrated in Fig. 3, instead of the electric control. However, this control is recommended to be used only when proper electric current is not available.

Rapid Stroke Adjustment

The stroke adjustment is made at the head end of the machine when the control head *A*, Fig. 2, is in the adjusting position shown, at which time the electric circuit has been automatically opened, and the clutch disengaged. The stroke adjustment is then made by positioning around cap *B*, a headless set-screw which is exposed. Cap *B* has graduations

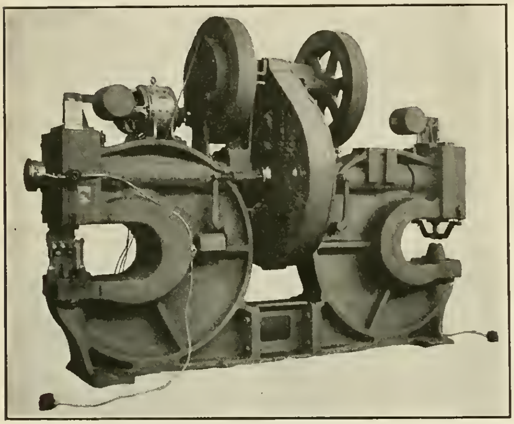


Fig. 1—Double End Motor-Driven Punching and Shearing Machine Arranged with Electrical Control

which indicate the position at which the stroke will be ended when the set-screw has been brought to that graduation. Fig. 2 also shows the control head in the position it occupies when the machine is in operation. A momentary depression of the push-button causes the engagement of the clutch, and this member is automatically disengaged as the sliding head reaches the point indicated by the setting of control head *A*. The machine may also be operated continuously.

A portable push-button switch is provided for operating by either hand or foot. The clutch disengages as a safety measure in case the electric circuit fails. With this automatic control it is unnecessary for an operator to leave the front of the machine while punching or shearing work.

Arrangement of Clutch

The clutch is of the solid-jaw renewable-face type. The sliding half is a steel casting and the fixed half is cast integral with the large gear and reinforced by a steel ring shrunk into place. The machine frame is an I-beam type semi-steel casting with a solid jaw. The sliding head is also a semi-steel casting and has a bronze take-up wedge. The eccentric shaft is a one-piece steel forging, accurately finished, which rotates in large bronze bushings. The main bearings and the sliding head are lubricated by sight-feed oil-cups, and oil-grooves provide for the efficient distribution of the oil.

The machine-molded gears are made of semi-steel, the pinion being shrouded. Fractional ratios insure the alternate stressing of the gear teeth. When a machine is motor-driven, a cut steel gear is furnished on the motor shaft. Gear guards may also be supplied. A one-piece safety capstan provides for turning the eccentric shaft by hand, and

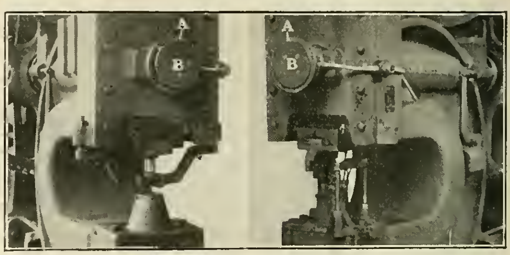


Fig. 2—Control Head in Adjusting Position on Punching Machine (Right) Shearing Machine with Control Head in Operating Position

for camming the capstan bar out of the capstan, should the machine be accidentally started. The driving shaft is turned from machine steel, and runs in babbitted bearings. The tool-blocks are made of cast steel, the upper block being tongued to the sliding head and the lower block bolted to the frame. All tool-blocks are interchangeable on machines of like capacity. A patented floating punch which combines a fixed and a floating punch in one tool facilitates spacing

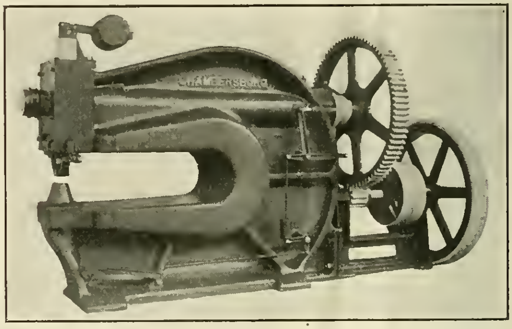


Fig. 3—Single End Punching Machine with Mechanical Control and Belt Drive

table work. A tool-block can be removed in an instant by a quarter turn of a handle.

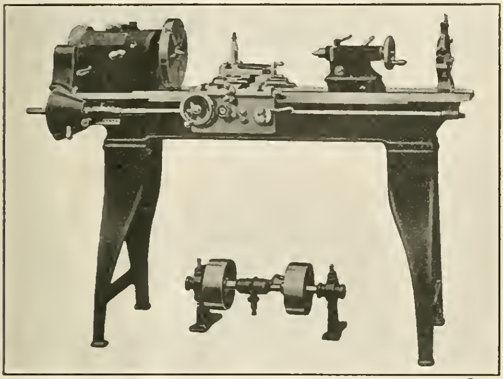
Eight Sizes of Machines Made

This line of machines is made in eight sizes, the smallest of which has a capacity for punching a ⅝-in. hole through mild steel plate ½ in. thick; shearing 3-in. by 9/16-in. flat stock, 1⅛-in. round stock, and 2-in. by 2-in. by 3/16-in. angle-iron; and splitting plate up to 7/16 in. thick. The standard throat dimensions are made 6, 12, 18 and 24 in. The largest size machine has a capacity for punching a 2½-

in. hole through mild steel plate 1 in. thick; shearing 8-in. by 1¼-in. flat stock, 2½-in. round stock and 6-in. by 6-in. by 11/16-in. angle-iron; and splitting plate up to 15/16 in. thick. The standard depths of throat for machines of this size are 15, 24, 36 and 48 in., which sizes provide for covering an extremely wide range of work.

New Sizes of Engine Lathes Brought Out

Until recently the Oliver Machinery Company, Grand Rapids, Mich., confined its engine lathe line to sizes from 16-in. to 30-in. swing inclusive. These lathes are now made, however, in 10, 12 and 14-in. sizes, the 12-in. lathe being illustrated. The new machines are versatile, being adapted to a wide variety of turning, threading and screw cutting operations.



Oliver 12-In. All Steel Geared Head Engine Lathe

Cone pulley or all-steel geared head stocks may be furnished, and either belt or motor drive. The single pulley drive geared head stock is of the enclosed box type, fitted with steel gears running in oil. All head stocks are equipped with a positive tooth feed reversing clutch by means of which both the longitudinal and cross feed and the direction of the lead screw may be instantly reversed. This can be accomplished without engaging or disengaging gears, stopping the lathe, shifting belts or reversing the spindle rotation. This feature greatly simplifies the cutting of threads and decreases the time of operation. Thoroughly tested and valuable features of construction are included in the carriage, apron and taper attachment. The latter can be readily applied later if not specified when the lathe is purchased.

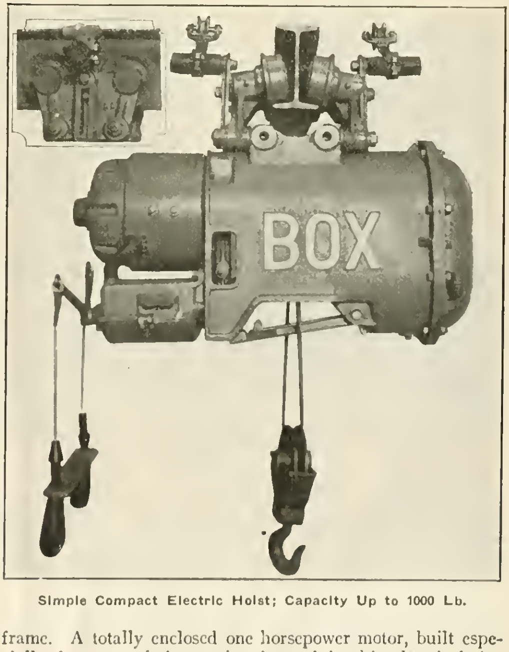
The 12-in. lathe, illustrated, has an actual swing over the bed of 13 in. and over the carriage of 9 in. Thirty-six inches is provided between the centers and all standard thread from 3 to 40 per in. can be cut. The feed range is from .0025 to .039 in. per revolution. Six spindle speeds can be obtained from 25 to 500 by means of the patented selective quick change gear box. The 12-in. machine with a 5-ft. bed weighs 875 lb. crated.

Simple Rugged Construction Feature Electric Hoist

An electric hoist of substantial but simple construction, handling loads up to 1,000 lb. and known as the Load Lifter, has been developed by Alfred Box & Company, Inc., Philadelphia, Pa. This hoist has a lifting speed without load of 30 ft. per min.; with 500-lb. load, 32 ft. per min., and with 1,000-lb. load, 20 ft. per min. The standard lift furnished is 15 ft., the maximum being 39 ft.

Many advantages are claimed for this electric hoist, among which may be mentioned automatic lubrication from one point. By an ingenious combination of the splash and force feed system, it is only necessary to pour oil into the housing at one point and then only about once in six months. All operating parts are enclosed and the unit is highly efficient due to the use of flexible and self-alining ball bearings throughout. The lack of complicated mechanism eliminates the necessity for adjustment after installation. Improved load brakes control and hold the load automatically, and the load may be moved a fraction of an inch in either direction by proper co-ordination of brakes and controller. This is provided for automatically so that the hoist may be safely operated by any person. The controller is of rugged construction and totally enclosed in a water-proof housing.

The Load Lifter takes up little more space than the ordinary chain block. Adjustable trolleys are provided and an interchangeable upper hook and trolley. Any Load Lifter may be easily converted into either hook or trolley suspension, the two types being interchangeable. To prevent overwinding of the hoist hook and subsequent damage, an improved upper safety stop shuts off the current from the motor and applies the band brake so that the hoist instantly stops. The rope may be readily removed from the winding drum but, on account of deep flanges, cannot come off the drum accidentally or become wedged between the drum and the frame. A totally enclosed one horsepower motor, built especially for severe hoist service, is used in this electric hoist.



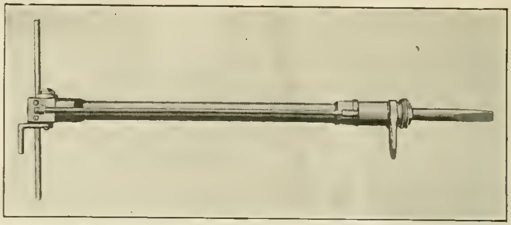
Simple Compact Electric Hoist; Capacity Up to 1000 Lb.

Rivet Cutter Designed to Obviate Plate Distortion

On the principle that when cutting rivets, a number of comparatively light, rapid blows cause more vibration and therefore more distortion of steel plates than a few intermittent, heavy blows, the Chicago Pneumatic Tool Company, New York, has designed and manufactured a new type of rivet cutter known as the Boyer Superior.

In construction it consists of a dead handle, a throttle handle of the crank design, a throttle valve of the taper type, a back head screwed onto the cylinder and secured by a locking device, a cushion chamber in the rear end of the cylinder, a cylinder of seamless steel tubing, a bypass from back to front head, a non-removable electrically-welded front head, square coiled spring buffer, adjustable chisel lock, hand hold of the spade handle type, and chisel.

To operate, the throttle handle is moved in a line parallel with the cylinder. Each forward and return stroke of the piston is hand controlled. About four blows, requiring approximately 10 to 15 sec., are said to be required to cut off the head of a ¾-in. rivet. Two men are required to operate the machine. It is designed to be used wherever rivets are cut, and is especially adapted to steel car repair work.

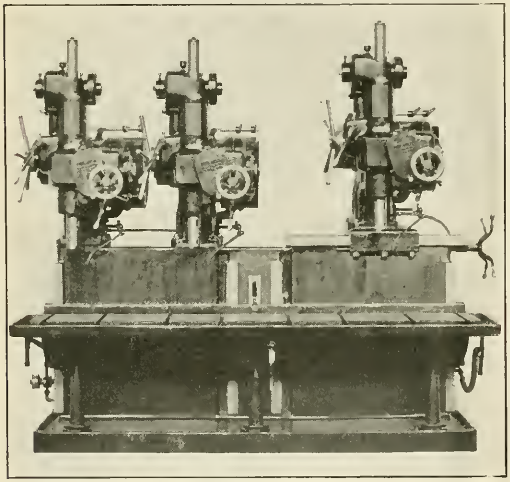


Boyer Superior Rivet Cutter for Boiler and Steel Car Repair Work

Special Gang Drill with One Moving Head

A special gang drill has been developed recently with longitudinal movement for the right-hand spindle, as shown in the illustration. A four spindle column is used and regular four spindle table. The two left-hand heads are permanently placed on the column and have a fixed center distance. Head No. 3 is mounted on a plate having finished ways, this plate being attached to the column.

The third head has a horizontal adjustment of 27 in. and is moved by means of a screw and capstan handle. Provision is made for clamping the head securely in any desired position. The minimum center distance between the second spindle and the adjustable spindle is 27 in. The maximum distance is 54 in. The minimum distance betwteen the extreme left-hand head and the adjustable head is 54 in. and the maximum distance is 81 in. Thus the total range between spindle centers is 27 to 81 in. Instead of having the finished ways extending only half the length of the column they can be lengthened and extend under the second spindle if desired. A fourth head can also be mounted on the finished ways so as to make a regular four-spindle machine with 27-in. center distances between the spindles. The machine illustrated is a Colburn No. 4 drill press, but the smaller No. 2, or larger No. 6, can be arranged similarly.



Colburn Heavy Duty Multiple Drill Press With Horizontal Adjustment for One Head

The driving and feed gears of this drill press are mounted inside of each head and run in oil. The gears are made from chrome nickel steel, hardened and heat treated. The shafts are of large diameter and mounted on ball bearings. Automatic trip is provided. The spindles are double splined to equalize the strain and each spindle has a drilling capacity of 2 in. in solid steel. The distance between the center of the spindle and the face of the column is 12½ in. The machine is, therefore, rated at 24-in. swing. Supporting brackets are provided under the center and ends of the table. The column and table are heavily ribbed, the table having a three-point bearing in the column.

This multiple drill press is said to have great power, stiffness and rigidity and is one of the many types of heavy duty drills built by the Colburn Machine Tool Plant of the Consolidated Machine Tool Corporation of America. The main offices of this company are in New York City.

P & A Photo

Derailment at Suterville, Pa., on October 23

GENERAL NEWS

The Illinois Central has announced that all shop employees who lost their pension rights as a result of a strike in 1911, but who remained at their posts during the strike last summer, will have their lost pension rights restored.

The American Railway Association is to hold a special session at the Blackstone, Chicago, on Wednesday, December 6, to consider rules relative to distribution of freight cars and methods of securing observance of car service rules.

The Delaware, Lackawanna & Western has reached an agreement as to wages and working conditions with all its mechanical department employees, represented by a new association known as the Lackawanna Association of Mechanics, Helpers and Coach Cleaners.

The Eastern Railroad Association announces that James T. Wallis, chief of motive power of the Pennsylvania, has been elected president of the Association, in the place of A. W. Gibbs, deceased. John M. Henry, Long Island Railroad, has been elected a member of the executive committee. The office of the Association is at 614 F street, Washington, D. C.

Five hundred dollars fine and three months' imprisonment were imposed as penalties for contempt of court, in the Federal Court at Macon, Ga., on October 28, against two striking shopmen of the Central of Georgia who had violated the injunction against interfering with railroad employees. The two men were found guilty of attacking two workmen several weeks ago. A third man who was tried was found by the jury not guilty.

One of the six new superheated locomotives which have been put into operation on the Glasgow & South Western Railway (Scotland) during a trial run between Glasgow and Carlisle, attained a speed of 69 miles an hour with a load of 325 tons. The normal maximum load for a single engine on the section at which this speed was attained is 240 tons. The locomotives are of the Baltic or 4-6-4 type, and are 47-ft. 7-in. in length, with a weight of 99 tons.

The riding characteristics of one of the Baldwin-Westinghouse electric locomotives used on the Chicago, Milwaukee & St. Paul have been improved by dividing the cab in two parts, according to a report called the "Log of the Manhattan" issued by the Baldwin Locomotive Company which describes a trip made through the west by President Vauclain and party. The report states: "Engines 10306 and 10307 took the curves easily and rode well. It is only in comparison with engine 10301 that they suffer, because engine 10301 seems to leave nothing to be desired." The last mentioned locomotive has a divided cab, while the other two have not.

Railroads in Wisconsin Ordered to Repair Cars

Railroads operating in Wisconsin were ordered last week by the railroad commission of that state to take immediate steps to relieve the freight car shortage situation by repairing the cars now idle because of unfitness for service. The roads are called on to make daily reports on the results of their car repair work.

Cab Signals on the Northern of France

The Northern Railway of France, as is well known, has used an audible cab signal for 40 years or more, the simple contact apparatus known as the "crocodile." From an inquiry which has been made in connection with the action of the French Government in calling upon all the railroads of the Republic to adopt some kind of cab signal it appears that the Northern now has in service 2,906 locomotives of which all but 43 have the cab signals. These 43 are at present in the shops. Of the engines fitted, 752 are in the passenger service, 1,726 in freight service and 385 are switching locomotives.

English Firm to Build 17 Locomotives for Spain

Messrs. Babcock & Wilcox, a British concern, have received an order from the Northern Railway of Spain for 17 locomotives. These locomotives will be built at the company's Spanish works at Galindo, near Bilbao. These locomotives will be the most powerful in use in Spain, according to the Times (London) Trade Supplement.

Tennessee Central Shops Destroyed by Fire

The machine, blacksmith, tin and woodworking shops of the Tennessee Central at Nashville, Tenn., were destroyed by fire on October 27, with an estimated loss of $80,000. Six freight cars were also burned and four locomotives damaged. The company intends to replace immediately both the shop buildings and the machinery which was destroyed within.

Tank Car Safety Valves

The Mechanical Division of the American Railway Association has issued a circular granting permission to companies having stocks of tank car safety valves of the 1920 design to place in service prior to July 1, 1923, any valves now on hand of that design. All patterns should be changed at once so that future castings will comply with the requirements shown in Supplement 1 to the Tank Car Specifications for 1920, Fig. 9-A and 10-A.

Air Brake Association Proceedings

The printed proceedings of the 29th annual convention of the Air Brake Association will be issued later this year than usual, according to advice from Secretary F. M. Nellis. There are two reasons for the delay: First, the postponement of the convention from its usual time early in May to the latter part of June. Second, the shopmen's strike, during which air brake men were pressed into extra duties, making it impossible for them to find time to correct and return their remarks to the secretary. However, the book is now on the press and should be ready for distribution about December 15.

British Concern to Build Locomotives in India

A group of influential Indian gentlemen, early in the year 1921, invited Kerr, Stuart & Company, Ltd., of Stoke-on-Trent, England, to form a company in India for the purpose of building railway locomotives. In their annual report submitted to the shareholders, the directors of the company state that they have decided to accept this invitation after having fully considered and investigated the proposition. An undertaking known as the Peninsular Locomotive Company has been formed, the capital having been subscribed privately in India. The production of locomotives on an extensive scale is expected to begin shortly.

A Love-Feast

The shopmen of the Central of Georgia at Macon, Ga., several hundred of them, entertained the Rotary Club of Macon, and other friends, at luncheon in the mammoth machine shop; 92 Rotarians and 60 other guests. The tables were decorated with chrysanthemums and the colors of the Rotary Club. A number of officers of the railroad were present, and one of them, John D. McCartney, assistant to the president, acted as spokesman for the hosts. Following the luncheon, the visitors inspected the shops. This luncheon appears to have been given in recognition of the friendly relations existing between the railroad and the people of the city during the recent disturbances due to the strike.

Brotherhoods Oppose Changes in Working Conditions

A controversy, which labor leaders claim represents the inauguration of an attack on the eight-hour day, came before the Railroad Labor Board on November 2 when W. G. Bierd, receiver of the Chicago & Alton and other officers of that road appeared before the board in support of a petition asking for the elimination of time and one-half for overtime in road-freight transfer and hostler service, the extension of the present eight-hour rule to nine hours in short turn-around passenger service and a modification of the working schedules in outlying switching yards on the road.

Operating Statistics for August and Eight Months

The net ton miles of revenue and non-revenue freight handled by the railroads in the month of August totaled 30,452,000,000 as compared with 30,420,000,000 in August, 1921, according to the monthly bulletin of operating statistics issued by the Interstate Commerce Commission. The car miles per car day averaged 21.8 as compared with 22.7 last year, the net tons per loaded car 26.3 as compared with 27.4 and the net ton miles per car day 406 as compared with 400. For the eight months ended with August, the net ton miles totaled 227,739,000,000 as compared with 222,411,000,000 last year.

P. R. R. Improvements at Pitcairn

The Pennsylvania has just completed and placed in service at Pitcairn, Pa., a modern 34-stall enginehouse with turntable at a cost of $1,385,000. This terminal is located on the main line of the Central Region and is one of the key positions of the system in expediting the movement of through trains. Nearly 200 engines are handled daily. In addition to preparing the engines for service the heaviest of running repairs will be made at Pitcairn. Among the important facilities at the new enginehouse is the turntable, 110 ft. long and electrically operated. Each stall is 140 ft. long and so constructed that it can be completely enclosed. The structure is steam heated.

Cab Signals on the Orleans Railway

The Orleans Railway of France, operating 2,969 locomotives, now has 547 of these equipped with apparatus for giving an audible signal in the cab. This system is of the ramp type and "crocodiles" (ramps) have been installed at 987 distant signals. By the end of this year the total number of locomotives equipped will be increased to 802. The Orleans is the railroad which for years has had torpedo machines in service at home signals—apparently throughout the whole of its more important lines—and concerning which an officer of the company has said that not for 50 years have trains been in serious collision because of an engineman overrunning a fixed stop signal.

Air Brake Hearings Resumed

Hearings before Examiner Mullen of the Interstate Commerce Commission in connection with the commission's general air brake investigation were resumed at Washington on Wednesday, November 8. Witnesses representing the Automatic Straight Air Brake Company presented a number of voluminous exhibits covering air brake failures and the results of tests and were to be recalled later for cross-examination after the representatives of the roads had had an opportunity to check them. The first witness was a conductor for the Virginian who filed records of several hundred air brake failures on the Virginian and other roads. On being questioned as to whether he was able to testify to these records from his personal knowledge he said that about 75 of the failures occurred on his own train and that these cases had been checked in his exhibit and that the others could be identified by the notation "B. S." which he had used to indicate that the information was taken from the records of the Bureau of Statistics.

Striking Shopmen Reopen Relations with the Labor Board

The first move to re-establish relations between the Railroad Labor Board and the Railway Employees' Department of the American Federation of Labor was made on October 21 when B. M. Jewell, leader of the shopmen's strike, called upon Chairman B. W. Hooper of the Board and gave notice that the shop crafts would present a petition for the reopening of a case against the New York Central, involving the question of the piece work system in the Elkhart (Ind.) shops. It was unofficially intimated at the board that Mr. Jewell's petition would be granted and that the Labor Board would resume its status as umpire in disputes affecting this organization and those roads on which it still retains a majority of the shop workers.

State Statute Regulating Car Repair Shops

The federal district court of the District of Minnesota, Third Division, holds that the requirement of the Minnesota statute of 1919, as amended 1921, c. 481, requiring buildings for the construction or repair of railroad cars, is in conflict with section 4 of the Safety Appliance Act, requiring defective cars on interstate carriers' lines to be repaired at the place where the defect is discovered, if feasible, or at the nearest available repair point, and, the federal statute being paramount, the state statute is void as to this requirement.

The whole statute was held void because the section providing for the protection of employees from working outside in inclement weather is too uncertain and indefinite to be valid, this section embodying the real ground of the statute.—C. & N. W. v. Railroad & Warehouse Commission of Minnesota, 280 Fed. 387.

Hungary Builds Locomotives with Water Tube Fireboxes

The Hungarian State Railways, with a view to testing the relative merits of the 4-6-0 type of passenger engine arranged for simple and compound operation, in both cases with superheated steam, have built one of each type at the shops at Budapest, and some extensive tests have been made. These tests favored the single-expansion type of locomotive and large orders for this class of locomotive are now in course of execution. The engines are fitted with water tube fireboxes, feed water heaters with purifiers and other special features. For freight traffic locomotives of the 2-8-2 and Mallet types have been introduced and both these are similarly equipped with water tube fireboxes and the other devices mentioned. The locomotives are of large proportions and designed for the highest tractive effort that circumstances permit. The difficulty in Hungary is that maximum axle loads of 14 tons cannot be exceeded in the eastern zone and 16 tons per axle in most of the other districts. These moderate loadings have naturally had their effect upon locomotive design, the weight having to be distributed over a greater number of wheels than would otherwise have been necessary.

Katy Employees Organize Union

Employees in the motive power and car departments of the Missouri, Kansas & Texas lines have completed the organization of the M. K. & T. Association of Metal Craft and Car Department Employees, "to promote the welfare and protect the interests of its members, to promote good feeling and constructive co-operation between the members and the officers of the railway, and, by joint action, protect and promote the interest of the public." The organization was completed at a meeting held recently in Parsons, Kan., attended by seventy delegates, representing employees at practically all terminal and shop points on the system.

A system adjustment board was created under the provisions of the Transportation Act, and the by-laws of the association provide that this board shall act as the official representative of the association. It is the duty of the adjustment board to place before the officers of the railway all matters submitted to it by local adjustment boards, concerning grievances and it will deal with all matters relating to interpretations of rules, rates of pay and working conditions.

The by-laws further provide that any disputes which cannot be settled in conference between the system adjustment board and officers of the railway, shall then be handled in accordance with the provisions of the Transportation Act.

New Freight Cars for the Southern Pacific

The immediate construction of 7,000 freight cars, to cost more than $8,000,000, has just been authorized by the executive committee of the Southern Pacific Company. This new equipment, which will be delivered during 1923, does not include refrigerator cars for handling perishables, as the company's supply of refrigerators is provided by the Pacific Fruit Express Company, in which the Southern Pacific owns a one-half interest. The new equipment program of the Pacific Fruit Express, soon to be announced, will add a substantial number of refrigerators to the 21,598 it now owns. Plans for the construction of the new cars for the Southern Pacific are nearing completion and it is expected that a large proportion of the cars will be built on the Pacific Coast with Pacific Coast materials and labor. The new cars will be of the most modern design. The total number of cars owned by the Southern Pacific Company at present is more than 58,000.

4-6-4 Type Tank Locomotives for Java

The Dutch Colonial Government Railway of Java, which is of 3 ft. 6 in. gage, has received some new tank locomotives of the 4-6-4 type from Sir W. C. Armstrong Whitworth & Co., England. These locomotives are capable of exerting a tractive force of 19,300 lb. at 85 per cent of the boiler pressure and weigh 147,840 lb. in working order, of which 72,800 lb. are on the drivers. The cylinders are 17¾ in. by 21⅝ in., driving wheels 53⅛ in., driving wheel base 9 ft. 10 in., and total wheel base 32 ft. 7¾ in. The boiler is of the straight top type with a maximum internal diameter of 4 ft. 7¼ in. and carries 176 lb. pressure. The firebox is of copper and the superheater of the Schmidt type. The tubes and flues contain 996.4 sq. ft. of heating surface, the firebox 83 sq. ft. and the superheater elements 332 sq. ft. The grate area is 20 sq. ft. Grate bars are arranged to be spaced for India coal, Australian coal or wood fuel. The cylinders are outside of the frames and the valve motion is of the Walschaert type, operating 8½-in. piston valves. The engine is fitted with vacuum, steam and hand brakes. The coal capacity is 3 tons while the water tanks hold 2,000 gallons.

Great Western to Increase Number of Motor Car Trains

The Chicago Great Western considers its recent experiment in gasoline motor driven cars for passenger service on branch lines such a success that it is planning to purchase several additional motor trains mainly for service in the more thickly settled sections of Iowa. The trains consist of a specially constructed motor car, equipped with a high-power gasoline engine and a trailer which resembles an ordinary interurban electric coach, although more heavily built. The motor car has room for freight and baggage just back of the compartment occupied by the engineer.

"My theory is," S. M. Felton, president, is quoted as saying, "that with the low overhead on the gasoline-driven train, we can afford to stop at every crossing, farmhouse or small station, if necessary. In this way we expect to give the kind of service which will be appreciated by the Iowa farmers and build up a good interurban traffic. The interurban trolley systems can do this and make it pay and so should the railroads. We have the tracks, the stations, and all the other equipment of a right-of-way. All that is necessary is to add the trains."

The four trains now in use in Iowa, Mr. Felton added, are running from 100 to 150 miles a day without difficulty. The Russell Company, Kenosha, Wis., supplied the equipment recently placed into service by this company between Des Moines, Ia., and Marshalltown.

Only Four Wooden Mail Cars

The wooden railroad car is almost gone, says a statement issued by the Post Office Department. "It is about ready to fade into the past, joining the passenger pigeons, the wild west, the horse drawn carriage and ginger-bread houses." According to the figures of the Post Office Department there are only four wood mail cars now in use out of about 5,000 cars formerly employed to transport United States mail. In 1913 a law was passed by Congress, later re-enforced by a law passed in 1916 requiring that no more mail cars be admitted for postal service unless they were all steel or steel under-frame. Those wooden cars which were in use were allowed to remain in service. With the gradual replacement of wooden cars with steel, injuries and deaths of post office employees are said to have greatly decreased. During the last year only two clerks were killed in accidents and 26 seriously hurt. Almost 20,000 railway postal clerks now are employed in the railway mail service.

Later, in order to correct any false impression which might be gained from the statement to the effect that there were only "four wood mail cars now in use," the department issued a statement giving the following statistics on the kinds of cars used in the service. Of the 1,087 Railway Post Office cars 862 are all steel, 154 are steel underframe, 67 are wood steel reinforced, and four are all wood construction. Of the 4,074 apartment cars in use 1,104 are all steel, 641 are steel underframe, 1,947 are wood, steel reinforced, and 382 are all wood construction.

Labor Board Decisions

No Authority Over Lines Outside of U. S.—In a case concerning track forces on the Great Northern lines in Canada, the Labor Board held that it had no authority over the rates of pay and working conditions for employees engaged exclusively in work outside the territorial limits of the United States.—(*Decision No.* 977.)

Contracting Coal and Water Supply Work.—The Chicago & Alton awarded a contract to Joseph Colianni & Brothers for the handling of coal, sand and cinders, the pumping of water and for engine watchmen, the employees of the railroad having the privilege of going to work for the contractors at a reduced rate of pay. This was brought to the attention of the Labor Board which decided that this case involved the same principles that applied in the case of the Indiana Harbor Belt, that the contract constituted a violation of the Transportation Act, in so far as it purported to remove the employees from the application of the act; and directed the carrier to take up with any employee the matter of reinstatement upon the application of the employee or his representative.—(*Decision No.* 1254.)

In 1921 the St. Louis-San Francisco advertised for bids for the personal labor required for the operation of individual water stations on a monthly basis. This case (No. 1230) the Labor Board decided substantially the same as that of the C. & A.

Dismissal of Bridge Employees for Refusal to Work Overtime.—About 7:15 p. m., on July 29, 1921, 645 ft. of double track trestle on the Stockton division of the Southern Pacific near Banta, Cal., was discovered on fire and 135 ft. was destroyed before the fire was extinguished. It was necessary to call men from adjoining divisions to restore the trestle and track as promptly as possible. Foremen and men were brought from the Sacramento division, arriving at nine the next morning. These men worked until 4 p. m., when they returned to their outfit cars and refused to perform further service at the pro rata rate, notwithstanding that an emergency existed; and for this action they were discharged. In a decision upon a protest registered by the United Brotherhood of Maintenance of Way Employees and Railway Shop Laborers the Labor Board decided that the management was justified in the action taken in this case and denied the request of the employees' organization for the reinstatement of the men.—(*Decision No.* 1118.)

The New Santa Fe Shop Employees' Association

Our attention has been called to the fact that the article appearing in the November *Railway Mechanical Engineer*, Page 667, omits the Atchison, Topeka & Santa Fe as one of the first railroads on which associations of shop employees were formed independent of the American Federation of Labor. The list of roads named at that time emanated from the Railroad Labor Board, as stated, but unfortunately the Santa Fe was not included in the board's announcement.

When the strike began, 2,300 mechanics remained in the service of the Santa Fe, and by August 22, the number of employees in the mechanical department had reached a total of 13,702 or 71 per cent of the normal force. These employees had already formed company unions among themselves and had made a request on the management to negotiate new agreements. Consequently on August 22 new agreements were signed with the shop craft associations; *i. e.*, machinists, boilermakers, blacksmith, sheet metal workers, electricians, and carmen and their helpers and apprentices. Agreements were also made with the stationary engineers, firemen and oilers. The date of this action, therefore, places the Santa Fe as one of the first railroads in the country to reach a satisfactory settlement of the strike. On October 19, the force in the mechanical department had reached 100 per cent, the road having at the present time 18,972 employees in the mechanical department.

In discussing the effect of the strike on the Santa Fe, one of the officers of that road recently said, "Never in the history of the Santa Fe System Lines has it been offered and handled as heavy a business as it has since the latter part of August. We have no embargoes in effect; we have no serious congestion of any kind; our condition of motive power is normal. Our bad-order freight car situation, as of October 25, showed only 4.69 per cent of all cars on our lines in need of repairs, the lowest point of record since the return of the roads to private control. We have 2,000 new box cars soon to reach us and we have ordered for delivery in the first quarter of next year 59 locomotives, 1,000 box cars, 1,000 automobile cars, 2,000 refrigerator cars, 500 double-deck stock cars and 500 coal cars."

Coal Analyses by Bureau of Mines

The results of analyses of hundreds of coals from 25 States and the territory of Alaska are given in Bulletin 193, "Analyses of mine and car samples of coal collected in the fiscal years 1916 to 1919," by Arno C. Fieldner, Walter A. Selvig, and J. W. Paul, just issued by the United States Bureau of Mines. Information as to the heating values of all coals tested is also given in the bulletin, which should be of interest to all extensive users of coal fuel.

Many mine samples of coal are analyzed each year in the laboratories of the Bureau of Mines. Descriptions of the coal samples collected between the beginning of this work, July 1, 1904, were compiled and published in Bureau of Mines Bulletins 22, 85 and 123.

In order that the material in this bulletin may be used to supplement that presented in earlier bulletins, the same plan of geological classification has been followed, the analyses and descriptions of the samples being grouped in alphabetical order according to the state, county and town near which the mines or prospects sampled are situated.

Information regarding coal sampling and analytical methods employed by the Bureau of Mines and a bibliography on the coal resources of the world are contained in the bulletin.

The entire distribution of Bulletin 193 will be through the superintendent of documents, Government Printing Office, Washington, D. C., from whom the report may be obtained at a price of 35 cents. Bulletin 22, 85 and 123 are sold by the superintendent of documents at prices of 85, 45 and 50 cents, respectively.

Electrification of the South Eastern & Chatham Railway, England

Plans and negotiations are being made for the purpose of obtaining a supply of electric power for the electrification of the South Eastern & Chatham. The railroad company has applied to the Electricity Commissioners for consent to the establishment of a 60,000-k.w. generating plant at Angerstein's Wharf, Charlton. The West Kent Electric Company, Limited, also applied for consent to build a 150,000-k.w. generating station at Belvedere in the urban district of Erith. During the course of the inquiry, offers to supply the railroad company were made by the West Kent Company and by the County of London Electric Supply Company.

An important factor in this case is the forthcoming grouping into one railway system of the London & South Western, the London, Brighton & South Coast and the South Eastern & Chatham Railways. The London & South Western Railway Company is supplied with electric power from its 25-cycle generating station at Wimbledon. The London, Brighton & South Coast purchases energy from the London Electric Supply Corporation. The further electrification of that railway's suburban lines will entail a supply which will be many times in excess of that now furnished by the London Electric Supply Corporation and this additional supply must be supplied at a frequency of 25 cycles, for the reason that the equipment of the company's rolling stock is designed for that frequency. The South Eastern & Chatham Railway Company also desire a supply at 25 cycles, but as their system of electrification will be direct current, a supply at a frequency of 50 cycles is also practicable.

It is expected that the first stages of the electrification of the South Eastern & Chatham will be completed by June 30, 1925, and arrangements have been made with the Treasury for a guaranteed loan of £6,500,000, five millions of which are to be expended on the electrification of the lines. This financial assistance is dependent upon making arrangements for an adequate power supply. If the railway company purchases its power supply from an outside source, it will be relieved from a capital outlay of something more than £1,000,000.

Mechanical Convention in 1923

The General Committee of the Mechanical Division of the American Railway Association decided at a meeting held in New York on November 8 not to hold in 1923 a convention of the kind ordinarily held in past years. It was decided to hold merely a business session of the Mechanical Section, at which reports dealing with interchange of cars, standard box cars and kindred matters will be received.

The explanation given for this action is that owing to the shop employees' strike no meetings of the committees of the section have been held to consider most of the regular reports, and that it will be impracticable to hold meetings of this kind during the rest of the present year. It was therefore decided that it would be impracticable to prepare the usual reports for the convention.

This decision, if left unchanged, means that the business session will be held at some place possibly Chicago, instead of the convention being held at Atlantic City, as originally intended. It also means that no exhibit of equipment and supplies will be given and that the session will last only two or three days.

MEETINGS AND CONVENTIONS

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

Air-Brake Association—F. M. Nellis, Room 3014, 165 Broadway, New York City. 1923 annual convention; Denver, first Tuesday in May.

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

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

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

Division V—Purchases of Stores.—W. J. Farrell, 30 Vesey St., New York.

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

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, A. F. Stuebing, 2201 Woolworth Building, New York.

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

American Society for Steel Treating.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio.

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

Canadian Railway Club.—W. A. Booth, 53 Rushbrook St., Montreal, Que. Next meeting December 12. A paper on Some Recent Developments in Car Construction will be presented by E. R. Viberg, mechanical engineer, Car & Foundry Co., Montreal.

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

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo.

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Regular meetings second Thursday in January, March, May, September and November, Hotel Iroquois, Buffalo, N. Y.

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

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Regular meetings second Tuesday, February, May, September and November.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill.

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

Master Boilermakers' Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting December 12. A paper on Creosoting Treatment for Railway Ties will be presented by F. C. Shepherd, assistant chief engineer, Boston & Maine, Boston.

New York Railroad Club.—H. D. Vought, 26 Cortlandt St., New York N. Y. Next meeting December 12. Fiftieth anniversary dinner.

Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo. Next meeting December 8. A paper on Railroad Masters will be presented by W. G. Besler, president, Central of New Jersey. Entertainment.

Traveling Engineers' Association.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio.

Western Railway Club.—Bruce V. Crandall, 605 North Michigan Ave., Chicago. Regular meetings third Monday of each month, except June, July and August.

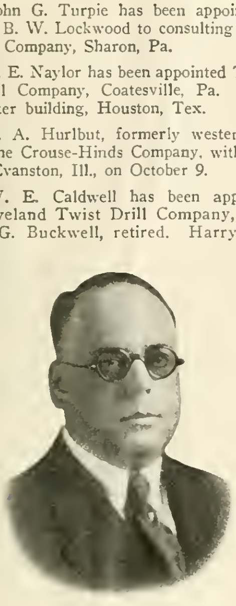
SUPPLY TRADE NOTES

John G. Turpie has been appointed assistant to the president and B. W. Lockwood to consulting engineer of the Standard Tank Car Company, Sharon, Pa.

C. E. Naylor has been appointed Texas sales agent of the Lukens Steel Company, Coatesville, Pa. Mr. Naylor's office is at 610 Carter building, Houston, Tex.

E. A. Hurlbut, formerly western railway sales representative of the Crouse-Hinds Company, with headquarters at Chicago, died in Evanston, Ill., on October 9.

W. E. Caldwell has been appointed sales manager of the Cleveland Twist Drill Company, Cleveland, Ohio, succeeding E. G. Buckwell, retired. Harry Jenson has been appointed assistant sales manager; Robert G. Berrington, sales representative in the Philadelphia district, and George Kast, treasurer, has taken on the duties of secretary. Mr. Caldwell, who has been with the Cleveland Twist Drill Company since 1901, was appointed assistant sales manager in 1916. Mr. Jenson was for more than 15 years a representative of the company in the Philadelphia territory, and Mr. Berrington, for 13 years a representative of the sales department in the central states and Canada, has returned to the Cleveland Twist Drill Company after resigning two years ago to act as sales agent for a line of machine tools in the Cleveland territory. Mr. Buckwell, retired secretary and sales manager, previous to 1899 was a traveling salesman for the Sargent Company and later a member of the retail hardware company of McClung, Buffat & Buckwell at Knoxville, Tenn.



W. E. Caldwell

The Black & Decker Manufacturing Company, Baltimore, Md., has removed its branch office and service station from 318 North Broad street to 824 North Broad street, Philadelphia, Pa.

The Carter Bloxonend Flooring Company, Kansas City, Mo., has received a contract from the Baltimore & Ohio for the installation of 12,000 sq. ft. of bloxonend flooring in a warehouse at Philadelphia.

W. W. Sayers, representative of the Link-Belt Company, with headquarters at Chicago, has been promoted to chief engineer of the Philadelphia works and Eastern operations, with headquarters at Philadelphia.

A. H. Hunter, president of the Atlas Steel Corporation, Dunkirk, N. Y., has resigned as president, but is still a member of the board. No action has been taken as yet toward electing a successor to Mr. Hunter.

The Norwalk Iron Works Company, South Norwalk, Conn., has opened a Chicago office at 627 W. Washington boulevard in charge of L. R. Bremser, who for 13 years was associated with the Gardner Governor Company.

The Southern Dry Dock & Shipbuilding Company, Orange, Tex., has arranged for a change of name to the Orange Car & Steel Company. Its operations in the future will be concentrated on steel railroad car construction and repairs.

William Le Compte has been appointed sales manager in charge of the New York territory for Jenkins Bros., 80 White street, New York. Mr. Le Compte has been a member of the sales organization of this company for a quarter of a century.

Paul A. Cuenot has been appointed mechanical representative to furnish special tool service to customers of the Alvord Reamer & Tool Company, Millersburg, Pa. Mr. Cuenot was formerly connected with the American Locomotive Company and the Pennsylvania Steel Company.

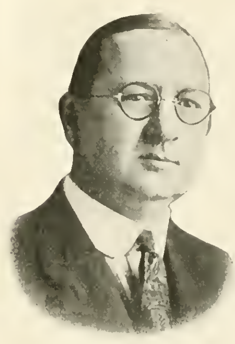
R. J. Platt, sales representative of the Sellers Manufacturing Company, with headquarters at Chicago, has been promoted to assistant general sales agent, with office at the same place, succeeding T. D. Crowley, who has resigned to enter the service of the Creepcheck Company.

R. S. Gay, formerly Chicago sales representative of Beal Brothers and the Beal Tool Company, and more recently plant manager of Hubbard & Co., Montpelier, Ind., has been appointed a sales representative of the Safety Car Heating & Lighting Company, with headquarters at Chicago.

E. C. Wilson, formerly connected with the U. S. Light & Heat Corporation and the Vapor Car Heating Company, with offices at Chicago, has been appointed western sales manager for the Ohio Locomotive Crane Company, of Bucyrus, Ohio, with offices in the Railway Exchange building, Chicago.

G. P. Atkinson, for several years connected with the sales department of the Weston Electrical Instrument Company, Newark, N. J., has established an office at Atlanta, Ga., to represent that company in Georgia, South Carolina and northern Alabama. In addition to Weston instruments, Mr. Atkinson will represent several other electrical equipment companies.

F. F. Rohrer, assistant to manager of both the power and railway departments of the Westinghouse Electric & Manufacturing Company, has been appointed general contract manager of that company. In his new appointment, which is effective immediately, Mr. Rohrer will be a member of the staff of W. S. Rugg, general sales manager. In his new position, Mr. Rohrer assumes responsibility for service to customers under contracts and will have general supervision of all contract and order work of the company. In addition to this general work, he will continue to have direct charge of the contract work of the power and railway departments, which duties he performed in his previous position. Mr. Rohrer was born in Harrisburg, Pa., April 22, 1876, and attended school there until 1895. He entered the employ of the Westinghouse Company as a student in 1896. After serving in the shops for four years, during which time he obtained extensive training in the manufacturing and testing departments he was transferred to the sales department. His services in the latter department have included a number of positions of responsibility. During the war. Mr. Rohrer was a member of the Committee of the War Industries Board appointed to conserve the production of turbine-generating equipment for government needs. After the armistice was signed, he became the representative of the Westinghouse Company in the settlement of contracts which were terminated as a result of the ending of the war. When this work was completed, he served in the capacity of assistant to the managers of both the power and railway departments.



F. F. Rohrer

J. G. Carruthers, manager of sales in the Chicago district for the Illinois Steel Company, and special sales agent of the Carnegie Steel Company, with headquarters at Chicago, has resigned to become general sales manager of the Otis Steel Company, Cleveland, O. He will be succeeded by D. T. Buffington of the structural and plate bureau, general sales department, Illinois Steel Company.

Frederick B. Larsen is now field representative for South Carolina, Georgia and Florida for the Bryant Electric Company, Bridgeport, Conn. Mr. Larsen's headquarters are at Atlanta, Ga. He was for three years manager of the Hunter Electric Company, of Clearwater, Fla., and prior to 1919 he was for 12 years sales representative of the Robbins & Meyers Company in the South Atlantic states.

Joseph T. Ryerson & Son Celebrates Eightieth Anniversary

One of the oldest companies in the railway supply business in this country is Joseph T. Ryerson & Son, which last month celebrated its eightieth anniversary. The history of the company and the earlier connection of the Ryerson family with the iron industry in this country are fascinating chapters in the development of industry and transportation in America.

Shortly after New Jersey was granted to Lord Berkeley, George Ryerson and a syndicate purchased 6,000 acres of land in the northern part of the state. In 1695 the development of this tract for agricultural purposes was begun. Later ore fields were discovered and developed so that Mr. Ryerson and his associates were among the first to work the iron mines in this region. His son, Marten Ryerson, further developed iron production and quite an amount of pig iron was made as early as 1740. The Ringwood and Wynokie mines in this region supplied the colonial army with great quantities of munitions material and equipment during the Revolutionary War.

About 1790 Marten's son, Thomas Ryerson, moved to Philadelphia and started business as a wholesale dealer in finished iron and steel products. Joseph, the son of Thomas Ryerson, continued in the same business. Hearing the call of the west, he started for Chicago in 1842 as the agent of Wood, Edwards & McKnight of Pittsburgh.

Some idea of the development of the country at this time can be gained from the transportation facilities. On his trip he went by railroad from Philadelphia to Columbia, Pa., then by stage coach to Pittsburgh and Cleveland; by boat to Detroit; by railroad to Jackson, Mich.; by stage to St. Joseph, Mich., and by boat to Chicago. The journey took eight days and he arrived November 1, 1842.

The rent for Mr. Ryerson's first store, near Clark and Water streets, was $200 a year. From this small beginning has developed the present company. As business expanded, Mr. Ryerson moved first to Lake street and then to South Water street, where the warehouse was located for many years.

Joseph T. Ryerson died in 1883 and his son, Edward L. Ryerson, succeeded him as the head of the business. The company was incorporated as Joseph T. Ryerson & Son in 1888. In 1908 the first buildings of the present Chicago plant were erected. They have been gradually expanded since until they now occupy over 19 acres. Other plants were established in St. Louis in 1914; in New York in 1915; in Detroit in 1917, and in Buffalo in 1919. The five plants now cover 40 acres, having a combined floor space of nearly 1,500,000 sq. ft.

Old Warehouse on South Water Street, Chicago, Occupied by Joseph T. Ryerson from 1852 to 1872

TRADE PUBLICATIONS

Taps and Dies.—The Tap & Die Institute, New York, has issued a 17-page catalogue which contains a few of the more important standard tables which it has prepared and adopted in an effort to obtain a greater degree of uniformity in the dimensions of taps and dies.

Centrifugal Pumps.—The Dayton-Dowd Company, Quincy, Ill., has issued bulletin No. 249 illustrating and describing its line of centrifugal pumps. This bulletin includes detailed specifications, efficiency and capacity tables and characteristic curves, as well as a description of the company's method of testing the pumps. The illustrations show the pumps in various combinations and installations.

Die Heads and Tapping Devices.—The Geometric Tool Company, New Haven, Conn., has just issued two neatly arranged, illustrated catalogues, one of which covers the Jarvis line of tapping devices, tapping machine, quick change chucks and collets, and self-opening stud setter; the other, the Geometric style DS die head as applied to Brown & Sharpe automatics and other single-spindle automatics.

Line Shafting Equipment.—Catalogue No. 43, giving dimensions, details of constructions and list prices, thus enabling engineers, designers, mechanics and power users to plan installations of and purchase the line shafting equipment described, has recently been issued by the Medart Company, St. Louis, Mo. The catalogue, which contains 192 pages, supersedes all previous catalogues and publications.

Express Refrigerator Cars and Tank Cars.—The Canadian Car & Foundry Company, Ltd., Montreal, has recently issued bulletins describing steel underframe express refrigerator cars built for the Canadian Pacific and all-steel tank cars of 8,000 gallons capacity built for the Russian Soviet Government. Another bulletin describes helical, semi-elliptic. and elliptic springs manufactured by this company.

The Gap Crane.—The H. K. Ferguson Company, Cleveland, Ohio, has issued a four-page leaflet illustrating the adaptation of the gap crane to an erecting shop for the handling of heavy locomotive repairs as worked out for the Hornell (N. Y.) shop of the Erie now under construction. This leaflet shows the manner of handling locomotives with this crane and points out the advantage of this new equipment.

Timber Statement.—The Century Wood Preserving Company, Pittsburgh, Pa., has published timber bulletin No. 24, which is devoted to the consideration of treated timber for flooring and pavements, poles, cross arms, fencing, bins, sheds, platforms, walks, trestles and similar industrial uses. The bulletin is well illustrated and contains data on the proper piling of ties, as well as tables showing the amount of preservatives required.

Holt Roof Leader and Vent Connections.—This 28-page booklet recently issued by the Barrett Company, New York, is descriptive of the eight types of Holt roof connections manufactured by this company. The different types are discussed in relation to their use in flat roof and saw-tooth construction and in places where vent pipes, leader lines, steam stacks, etc., passing through a roof require flashings. The illustrations show by photographs and drawings actual installations and the way in which they are made.

Spray-Painting Equipment.—An attractive illustrated folder describing a new series of portable spray-painting equipment designed to meet large or small painting requirements, has recently been issued by the DeVilbiss Manufacturing Company, Toledo, Ohio. This folder describes the uses, advantages and economy of DeVilbiss portable equipment for spray-painting houses, building interiors and exteriors, railway equipment, bridges and all kinds of large stationary work. Typical illustrations of various portable spray-painting outfits are shown on the interior of the folder, and photographs of this equipment in actual operation are included. A condensed, yet comprehensive, description of the outfits and methods of operation is also included.

EQUIPMENT AND SHOPS

Locomotive Orders

The Pere Marquette has ordered 20 switching locomotives from the American Locomotive Company.

The Central of New Jersey has ordered 10 Mikado type locomotives from the American Locomotive Company.

The Chesapeake & Ohio has ordered 2 Mountain type and 6 Pacific type locomotives from the American Locomotive Company.

The Illinois Central has ordered 85 Mikado type locomotives from the Lima Locomotive Works. It is expected that this road will place an order soon for 40 additional locomotives.

The New York, New Haven & Hartford, reported in the November *Railway Mechanical Engineer* as having ordered 5 electric locomotives from the Westinghouse Electric & Manufacturing Company, has ordered 7 additional electric locomotives from the same company.

The Mexican Railway Company, Ltd., has ordered 10 electric locomotives. These locomotives will be constructed and equipped jointly by the General Electric Company and the American Locomotive Company. The locomotives will have a total weight in working order of 300,000 lb.

Passenger Car Orders

The Chicago & North Western has ordered 40 coaches and 10 baggage cars from the American Car & Foundry Company.

The Pennsylvania has ordered 3 gasoline motor cars from the J. G. Brill Company. These cars are for use on the Smyrna branch, Bustleton branch and the Berwick branch.

The Central of New Jersey, reported in the November *Railway Mechanical Engineer* as having placed orders for 65 cars for passenger service, has placed additional orders for 25 coaches with the American Car & Foundry Company, and 25 coaches with the Standard Steel Car Company.

Freight Car Orders

The Union Pacific has placed an order with the American Car & Foundry Company for 100 tank cars.

The Cudahy Packing Company, Chicago, will build 200 refrigerator cars in its shops at East Chicago.

The Western Pacific has ordered 100 automobile cars from the Mount Vernon Car Manufacturing Company.

The Lehigh & New England has ordered 100 gondola cars of 50 tons' capacity from the Magor Car Corporation.

The Chicago & North Western has ordered 800 steel ore cars of 50 tons' capacity from the Pullman Company.

The Old Time Molasses Company, Inc., has placed an order with the American Car & Foundry Company for 72 tank cars.

The Charleston & Western Carolina has ordered 100 single sheathed box cars of 40 tons' capacity from the Standard Tank Car Company.

The Beacon Oil Company, Boston, Mass., has ordered 50 tank cars of 8,000 gal. capacity from the American Car & Foundry Company.

The West Penn Power Company, Pittsburgh, Pa., has ordered 60 hopper cars of 55 tons capacity from the American Car & Foundry Company.

The East Jersey Railroad & Terminal Company has placed an order with the American Car & Foundry Company for 36, 50-ton tank cars of 10,000 gal. capacity.

The New Orleans Great Northern is reported to have ordered 200 flat cars from the Southern Car Company and repairs to 197 gondola cars from the same company.

The Chicago, Rock Island & Pacific has ordered 500 box cars from the Western Steel Car & Foundry Company and 500 gondolas from the American Car & Foundry Company.

The Minneapolis, St. Paul & Sault Ste. Marie has ordered 500 box cars and 250 gondola cars from the Pullman Company and 500 box cars from the American Car & Foundry Co.

The Louisville & Nashville has ordered 2,100 hopper cars from the American Car & Foundry Company and has ordered 500 box cars each from the Chickasaw Shipbuilding Company and the Mt. Vernon Car Manufacturing Company.

Machinery and Tools

The Gulf & Ship Island has ordered from the Niles-Bement-Pond Company a 5-ton, 72-ft. span overhead crane.

The Chicago, Rock Island & Pacific has placed an order with the Whiting Corporation for a 200-ton transfer table.

The Lake Erie & Western has placed an order with the Shepard Electric Crane & Hoist Company for a 1¼-ton hoist.

The Baldwin Locomotive Works has ordered one 130-in. by 84-in. by 20-ft. planer from the Niles-Bement-Pond Company.

The Crucible Steel Company has ordered from Joseph T. Ryerson & Son an equipment for the repairing of locomotive boiler tubes, to be installed at its shops at Harrison, N. J.

Shops and Terminals

St. Louis-San Francisco.—This company will construct a storeroom at Ft. Smith, Ark.

Gulf Coast Lines.—This company will construct a six-stall concrete roundhouse at Brownsville, Tex., to cost approximately $50,000.

Tennessee Central.—This company will replace the machine shop, blacksmith shop, tin shop and woodworking plant at Nashville, Tenn., destroyed by fire on October 27.

Chicago, Rock Island & Pacific.—This company has awarded a contract to the International Filter Company, Chicago, for the construction of a water treating plant at Peoria, Ill.

Chicago, Rock Island & Pacific.—This company has awarded a contract to the Railroad Water & Coal Handling Company, Chicago, for the construction of a water treating plant of 25,000 gallons' capacity at Manly, Iowa.

Chicago, Burlington & Quincy.—This company has awarded a contract to Edgar Otto, Downers Grove, Ill., for the installation of a pumping plant, intake well, suction piping and intake piping for a reservoir at Galesburg, Ill.

Bangor & Aroostook.—This company has awarded a contract to the Howlett Construction Company, Moline, Ill., for a coaling station with 50 tons' ground storage and a 25 tons' overhead storage, using automatic machinery, at Squa Pan, Me.

Missouri Pacific.—This company has awarded a contract to the Ogle Construction Company, Chicago, for the construction of a 300-ton reinforced concrete coaling station at Bald Knob, Ark.; and to T. S. Leake & Co., Chicago, for the construction of a frame enginehouse 90 by 200 ft. with a composition roof at Pueblo, Cal.

Pennsylvania.—This company has awarded a contract to W. E. Wood, Detroit, Mich., for the construction of a frame enginehouse 60 by 120 ft. at Lincoln Park. The principal enginehouse, which will serve both passenger and freight locomotives, will be built by the Pere Marquette for the Pennsylvania at Nineteenth street and will cost approximately $1,000,000, including a turntable, water tank, coaling station and other buildings. A contract has also been awarded to the McClintic-Marshall Company for extensive additions to the shops at Juniata, Pa.

Improvements and extensions to cost $900,000 have been undertaken at its Enola Yard on its low grade freight line three miles west of Harrisburg, Pa. The work includes the erection of a new steel freight car repair shop, 100 ft. by 620 ft., the building of which has already been begun.

A modern 34-stall enginehouse with turntable has just been completed and placed in service at Pitcairn, Pa., at a cost of $1,385,000. The turntable is 110 ft. long and electrically operated. Each stall is 140 ft. long and so constructed that it can be completely enclosed. The building is steam heated.

PERSONAL MENTION

GENERAL

Alonzo G. Trumbull has been appointed chief mechanical engineer of the Erie.

W. B. Whitsitt has been appointed assistant mechanical engineer of the Baltimore & Ohio and W. R. Hedeman has been appointed chief draughtsman.

F. A. Torrey, general superintendent of motive power of the Chicago, Burlington & Quincy. with headquarters at Chicago, whose retirement was reported in the November issue of the *Railway Mechanical Engineer*, was born in Pennsylvania and when a boy served an apprenticeship in a machine shop. He entered railway service as a locomotive fireman on the Chicago, Burlington & Quincy at West Burlington, Ia., in March, 1874, and, until February 1, 1887, was a hostler and again a locomotive fireman and later a locomotive engineer. On the latter date he was promoted to road foreman of locomotives on the Ottumwa and Creston divisions, which position he held until April 1, 1889, when he was promoted to master mechanic, with headquarters at Ottumwa, Ia. He was transferred to Creston, Ia., on March 1, 1902, and on September 1, 1903, he was promoted to assistant superintendent of motive power, with headquarters at Chicago, which position he held until April 20, 1905, when he was promoted to superintendent of motive power, with the same headquarters. On January 1, 1911, he was promoted to general superintendent of motive power, with the same headquarters, from which position he retired on November 1 after 48 years of active service with the company.

J. E. O'Brien has been appointed manager of the mechanical department of the Seaboard Air Line, effective November 15. Mr. O'Brien will report to the president and to the vice-president and general manager. Mr. O'Brien was born on December 4, 1876, at Stillwater, Minn., and was graduated from the University of Minnesota in 1898, in which year he entered railway service as a special apprentice on the Northern Pacific at Livingston, Mont. From November 1, 1901, to November 25, 1903, he was in charge of general inspection of material and tests for that company at St. Paul, Minn. On the latter date he became master mechanic of the Dakota division at Jamestown, N. D. From December 1, 1904, to August 1, 1909, he was assistant shop superintendent at South Tacoma, Wash. On the latter date he was promoted to mechanical engineer, with headquarters at St. Paul. On January 1, 1910, he left the Northern Pacific to become superintendent of motive power of the Western Pacific, with headquarters at San Francisco. In 1913 he left this position to become assistant superintendent of motive power of the Missouri Pacific and a short time thereafter was promoted to superintendent of motive power, which position he resigned in the early part of 1922.

J. E. O'Brien

E. W. Smith, whose promotion to general superintendent of motive power of the Southwestern region of the Pennsylvania, with headquarters at St. Louis, Mo., as reported in the November *Railway Mechanical Engineer*, was born on September 21, 1885, at Clarksburg, W. Va. He was graduated from the Virginia Polytechnic Institute at Blacksburg, Va., in 1905 and entered railway service as a shop hand in the Wilmington shop of the Pennsylvania on June 5, of that year. On August 1, 1906, he was promoted to special apprentice in the Altoona machine shop. On July 26, 1909, he was promoted to inspector in the office of the assistant to the general manager and on March 12, 1913, to foreman in the office of the general superintendent of motive power. On October 15, 1913, he was promoted to assistant master mechanic at the Wilmington shop, which position he held until April 19, 1915, when he was transferred to the Altoona machine shop. He was promoted to assistant engineer of motive power in the office of the general superintendent of motive power on July 1, 1916, and to master mechanic of the Harrisburg shops on the Philadelphia division on October 10, 1917. On May 26, 1918, he was promoted to superintendent of motive power of the Central Pennsylvania grand division, with headquarters at Harrisburg, Pa., which position he held until December 1, 1919, when he was transferred to the Eastern Pennsylvania grand division, with headquarters at Altoona, Pa. On March 1, 1920, he was promoted to engineer of transportation in the office of the vice-president in charge of operation, which position he was holding at the time of his recent promotion.

MASTER MECHANICS AND ROAD FOREMEN

J. A. Buechler has been appointed master mechanic of the Port Huron & Detroit with headquarters at Bay City, Mich.

D. L. Ringer, general foreman of the Texas & Pacific at Baird, Tex., has been appointed assistant master mechanic of the Fort Worth division, with headquarters at Marshall, Tex., succeeding J. E. Friend.

W. J. O'Brien, master mechanic of the Kanawha & Michigan, with headquarters at Middleport, Ohio, has been appointed master mechanic of the Toledo & Ohio Central, with headquarters at Bucyrus, Ohio, succeeding C. Bowersox, who has resigned to engage in other business.

James E. Friend, assistant master mechanic of the Texas & Pacific at Marshall, Tex., has been appointed master mechanic of the Louisiana division with headquarters at Alexandria, Va. Mr. Friend was born on July 9, 1890, at Rawlins, Wyo., and was educated in the public and high schools of that town. In June, 1906, he entered the employ of the Union Pacific at Rawlins as a messenger, subsequently becoming call boy, engine dispatcher, machinist apprentice and machinist. He then served as a machinist on various roads in the northwest. From March, 1912, to June, 1915, he was a machinist on the Texas & Pacific at Texarkana, Tex., being promoted in June, 1915, to general foreman. From July, 1916, to November, 1916, he was roundhouse foreman at Big Spring, Tex.; from November, 1916, to March, 1917, general foreman at El Paso; from March, 1917, to August, 1917, general foreman at Toyah, Tex., and from August, 1917, to May, 1918, general foreman at Baird, Tex. From May, 1918, to July, 1919, Mr. Friend was a first lieutenant serving with the 50th Engineers in France as erecting shop foreman at Nevers; road foreman of engines, Base 6, Marseilles, and general road foreman of engines, Le Mans. Returning to the United States in July, 1919, he re-entered the employ of the Texas & Pacific as general foreman at Baird, being transferred in December, 1919, to El Paso. From November, 1921, to January, 1922, he was general foreman of the Los Angeles & Salt Lake at Milford, Utah.

SHOP AND ENGINEHOUSE

John Love has been appointed general foreman of the Central of New Jersey shops at Maunch Chunk, Pa.

A. W. Kovak, district boiler inspector of the Chicago, Milwaukee & St. Paul, with headquarters at Minneapolis, Minn., has been promoted to general boiler inspector, succeeding E. W. Young, assigned to other duties.

PURCHASING AND STORES

Winfield S. Haines, assistant to the vice-president of the Erie, has been appointed superintendent of reclamation service.

J. E. Toms has been appointed purchasing agent of the Tennessee Central, with headquarters at Nashville, Tenn., succeeding E. H. Gaines.

J. L. Higgins has been appointed purchasing agent and C. F. Leatherman storekeeper of the Kansas, Oklahoma & Gulf, both with headquarters at Muskogee, Okla.

J. D. McCarthy, purchasing agent of the Minneapolis & St. Louis with headquarters at Minneapolis, Minn., has been promoted to general purchasing agent in charge of purchases and stores of the Minneapolis & St. Louis, the Railway Transfer Company of the City of Minneapolis and the Hocking Coal Company.